Original Article
Millennium Journal of Health
Open access Journal

Common clinical presentations and isolated bacteria profile among burn patients, at Addis Ababa Burn and Emergency Trauma Hospital, Addis Ababa, Ethiopia

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Publication information

Received: 27-Oct-2024

Accepted: 13-Jan-2025

Published: 01-Feb-2025

Citation: Menjeta AB, Gize A, Feleke ST, Hassen IK, Muleta MB. Common clinical presentations and isolated bacteria profile among burn patients, at Addis Ababa Burn and Emergency Trauma Hospital (AaBET), Addis Ababa, Ethiopia: MJH, 2025, Volume 4 (1): eISSN: 2790-1378.

Abstract

Background: A burn is a devastating form of trauma, responsible for a significant percentage of morbidity and mortality caused by injuries and accidents worldwide. Thermal injury destroys the skin barrier that normally prevents the invasion of microorganisms and makes burn wounds susceptible site for colonization by microorganisms of endogenous and exogenous origin.

Methods: A hospital-based cross-sectional study was held at Addis Ababa Burn, Emergency and Trauma (AaBET) Hospital, Addis Ababa, Ethiopia, from December 01, 2020, to November 30, 2021. Data was collected using structured and pretested questionnaires through face-to-face interviews. Wound swabs were collected from all consented participants and evaluated for possible microbial isolates. The extracted data were analyzed using SPSS 20.1. This study was conducted following approval of the Saint Paul's Hospital Millennium Medical College Institutional Review Board.

Results: From a total of 75 patients who consented to the study, males accounted for 53.3% (n=42), and ages ranged from 6 months to 76 years, with the median age being 19 years. Children less than 15 years old account for 42.7% (n=32). Flame burn was the leading cause (n=30, 40%) followed by a scald burn (n=22, 29.3%) and high voltage electric burn (n=21, 28%). *Pseudomonas aeruginosa* was the commonest isolate (42 isolates; 61.7%) followed by *Staphylococcus aureus* (18 isolates; 26.4%). A significant percentage of the positive swab results were monomicrobial (84.7%).

Conclusion: Flame was the leading cause of burn wound. *Pseudomonas aeruginosa* is the most common bacteria causing burn wound infection among the study participants.

Keywords: Bacteria profile; Burn; Clinical presentations; Cross-sectional; Hospital, Addis Ababa

Background

A burn is a devastating form of trauma responsible for a significant percentage of morbidities and mortalities caused by injury and accidents. As the WHO report indicates in the year 2004 globally there were 11 million burn accidents that were severe enough to need medical attention. Globally every year an estimated amount of 180,000 death occurs due to burn injury mostly in low- and middle-income countries [1]. Although, multiple causes can be cited as an immediate cause of mortality in severely injured burn injury patients, burn wound infection followed by sepsis remains an important cause associated with 75% of the deaths [2]. Thermal injury destroys the skin barrier that normally prevents the invasion of microorganisms, and makes burn wounds susceptible site for colonization by microorganisms of endogenous and exogenous origin. In addition, decreased vascularity found in burned surfaces will significantly decrease the effectiveness of host immune defense and systemically administered antibiotics. These factors contribute to the development of invasive burn wound infections, which are the most frequent sources of sepsis in burn patients [1-3].

Invasive burn wound infections are largely associated with various host factors including the age of the patient, the extent of injury, and the depth of the burn. In addition, microbial factors such as type and number of organisms, enzyme and toxin production, and systemic dissemination of the colonizing organisms could also determine the severity of burn infections [4, 5].

According to research reports gram-positive bacteria from the patient's endogenous skin flora or the external environment are the first ones to colonize the burn wound [6,7]. Then in the first few days following injury burn wound will be colonized by endogenous gram-negative bacteria from the patient's gastrointestinal flora. Burn wound colonization by yeasts and fungi tends to appear last and is usually preceded by prior use of broad-spectrum antimicrobial agents [8,9]. In the face of the complex nature of microbiology of burn wound infection, the commonly identified microorganisms include *Staphylococcus aureus*, *Coagulase-negative staphylococci*, *Pseudomonas aeruginosa*, *Escherichia coli*, Klebsiella pneumoniae, *Proteus species*, *Enterobacter spp*., and *Acinetobacter species*. In addition, the administration of topical antimicrobial agents and systemic antibiotics has been shown to influence the type and nature of microbial identified in wounds [10-12].

Being mostly hospital-acquired in origin, the causative agents in burn wound infection differ from one center to the other. In addition, in any given burn unit there is a constant change of the infective microorganisms. New microorganisms that will be brought by the wounds of newly admitted burn patients will persist and become resident flora of the unit. These latter will be replaced by another group of microorganisms after a variable period which will transmit to newly admitted burn patients from the hospital environment [13-16]. Furthermore, there is a constantly aggregating challenge in the treatment of burn wound infections due to the emergence of antibiotic-resistant microorganisms. It is described that knowing the common bacteria causing infection and their antibiotic resistance pattern has a significant impact on the reduction of morbidity and mortality of the victims [17-19].

In this study, we assessed the common causes of burn injury clinical presentation, bacterial etiology, and associated factors among patients admitted to the AaBET Hospital burn unit. The reports of the study will be used as an essential input for improving the quality of care delivered to burn patients.

Materials and Methods

Study design, setting, and period

A prospective cross-sectional study was done from December 01, 2020, to November 30, 2021, at Addis Ababa Burn, Emergency, and Trauma (AaBET) Hospital, Addis Ababa, Ethiopia. AaBET Hospital is found in the Arada sub-city of Addis Ababa, Ethiopia. AaBET hospital is the burn, trauma, and emergency wing of St. Paul's Hospital Millennium Medical College. AaBET hospital has four service-delivering specialties, which are Plastic and Reconstructive Surgery (Burn Unit), Neurosurgery, Orthopedics Surgery, and Emergency Medicine. The burn unit at AaBET is the second burn unit in Addis Ababa city with a capacity of 20 beds for adults and children. SPHMMC is the second to largest public hospital in Ethiopia, built the Emperor Haile Selassie in 1961 with the help of the German Evangelical Church. It has 500 beds, with a catchment population of more than 5 million.

Population and eligibility criteria

All patients who visited the hospital were the source population, and all patients admitted to the AaBET burn unit with the diagnosis of acute burn and met the inclusion criteria were the study population. All acute burn patients who underwent treatment at AaBET Hospital during the stated study period were included in this study. Patients with chronic burn wounds, patients who already stayed in the burn unit for more than 3 weeks before the start of the study, and burn patients who presented to the burn center after three weeks of the initial injury were excluded from the study.

Sample size and sampling technique

To get the maximum sample size, we included all acute burn patients admitted to AaBET Hospital burns unit during the study period; based on a non-probability consecutive sampling method. Ninety-one patients were admitted to the burn unit during the study period. Out of which, 75 of them consented and enrolled in the study.

Study variables

Common clinical presentations and bacteria etiologies among presumptive patients were dependent variables. Whereas, socio-demographic characteristics, possible co-morbidities, and complications were independent variables.

Operational definition

Acute Burn- defined as a burn injury that occurred within the past three weeks due to sudden exposure to thermal, electrical, or chemical energy; with an injury to the skin or other organs [1].

Burn Wound Infection- is defined as the occurrence of a change in burn wound appearance or character and histological examination of burn biopsy specimen reveals invasion of organisms into adjacent viable tissue with quantitative cultures that yielded more than 10^5 colony-forming units /gram of tissue [2].

Data collection procedures

Data collectors were given training about collecting data was given for data collectors. The study participants' socio-demographic and related data were collected using a structured and pretested questionnaire (following its approval by the SPHMMC - IRB office), employing in-person interviews. For each patient with a diagnosis of acute burn, a wound swab was taken on the 7th day of admission by observing all the necessary aseptic precautions.

Laboratory procedures

The burn wounds were initially cleaned using saline to remove debris, drainage, or pus. Then, using sterile swabs the samples were collected from the wounds. The collected swabs were placed in a transport medium at room temperature and transported in a sterile, leak-proof container to the microbiology laboratory of SPHMMC. Then, the swabs were inoculated on 5% blood agar, MacConkey agar, and Chocolate agar plates and incubated overnight at 37 ˚C aerobically. After observing the color, shape, size, and hemolysis patterns on the cultured media, we performed Gram staining to differentiate between Gram-positive and Gram-negative bacteria. Then finally, we did Biochemical tests like: Use tests like catalase, oxidase, coagulase, and sugar fermentation tests for species-level identification.

Data quality assurance

The questionnaire used for the study was pre-tested and proper training was given for data collectors. The quality of data was maintained following the pre-analytical, analytical, and post-analytical steps through each day's supervision using standard laboratory procedures (SOPs).

Data analysis and interpretation

After coding the data obtained from participants of the study, all the necessary procedures for data clearance and consistency checks were followed. Then, the sorted data were exported and analyzed using SPSS Version 20.1windows software computer program for analysis. The data analysis results are presented as the means ±SDs for continuous variables and as proportions for categorical variables. Demographic and clinical data will be described. We used a CI=95% and a margin of error of 0.05 and p-value less than 0.05 was taken as statistically significant.

Ethical considerations

Ethical approval for undertaking this study was requested and obtained from the SPHMMC institutional review board. Written informed consent was secured from each participant greater than 18 years old and acceptances were obtained from parents/ guardians, for those less than 18 years old. Confidentiality of patients' information obtained during the study period was maintained throughout the study and during research finding dissemination.

Results

Sociodemographic characteristics

A total of 91 patients were admitted to the burn unit during the study period. Out of which, 75 of them consented and enrolled in the study. Among the participants of the study, males accounted for 53.3% (n= 42) of admissions with a male-to-female ratio of 1.14:1. (The age ranged from 6 months to 76 years, with the median age being 19 years (Interquartile range, IQR = 21.0), and children less than 15 years old accounted for 42.7% (n=32). The occupational status of the patients was as follows: Farmer, government worker, electrician, mechanic/machine operator, daily laborer, and housemaid. Epilepsy was the most common co-morbid and/or predisposing condition identified in our patients (Table 1).

Table 1: Sociodemographic characteristics of burn patients admitted to AaBET Hospital, Addis Ababa, from December 01, 2020 to November 30, 2021 (n = 75).

Characteristics	Response category	Frequency (N)	Percent (%)
Sex	Male	42	53.3
	Female	33	46.7
Age, in years	≤15	32	42.7
	16-49	38	50.7
	≥50	5	6.7
Marital status	Married	16	21.3
	Single	28	37.3
	Widowed	2	2.7
	Not applicable (children <15 yrs)	29	38.7
Occupational status	Farmer	8	10.7
	Government worker	3	4.0
	Electrician	4	5.3
	Mechanic/machine operator	2	2.7
	Daily laborer	4	5.3
	House-maid	1	1.3
	Other private business	2	2.7
	House-wife	8	10.7
	Student	18	24.0
	Children (≤5)	25	33.3
Comorbidities	Epilepsy	15	20
	Psychiatric Condition	1	1.3
	Malnutrition	1	1.3
Origin of referrals	From health centers	41	54.7
	From primary hospitals	21	28.0
	From referral hospitals	13	17.3

Clinical presentations

Table 2 presents the clinical presentations of the study participants. All of the admissions to the burn unit were after patients completed resuscitation at the emergency room which is the initial 24 hours post-burn injury. The median time of injury to admission to the burn unit was 3 days (range, 1-55 days; IQR = 3). The majority (n=48, 64%) of the patients were admitted to the burn unit within 3 days of injury. Of the 75 patients that got admitted, 54 (72%) sustained the burn injury at home while 16 (21.3%) got burnt at the workplace. Other places where patients sustained the injury include streets, neighbors' houses, and farmland.

The median estimated total body surface area (TBSA) of the burn wound was 22% (range, 5% - 56%; IQR=7). A majority (n=39, 52%) of the patients had a TBSA burn between 20% and 30%. Nine (11.8%) of the patients had TBSA burns greater than 30%. Regarding the causal agent, flame burn was the leading cause (n=30, 40%) followed by a scald burn (n=22, 29.3%) and high voltage electric burn (n=21, 28%). However, there are differences according to age. In the underage population (≤15 years), the most common cause was injury due to scald burn (n=18, 56.3%) and many of these children (n=28, 87.5%) sustained the burn injury accidentally while playing. Given this age difference, we present the clinical characteristics of burn agents by age group. Eight (10.7%) patients were found to have an inhalational injury, all of which were diagnosed based on clinical suspicion (Table 2).

Interventions

All 75 patients were treated at the burn unit after admission, the data of which was collected at the discharge of the patients. All 75 patients received wound care once a day. Normal saline was a solution used for wound cleaning. A honey-based antibiotic ointment (Moist Exposed Burn Ointment, MEBO) was applied to the wound before the final wound dressing. More than two-thirds of patients (n=53, 70.7%) were operated on. Escharotomy was needed in 19 (25.3%) patients while fasciotomy and amputation(s) were done in 12(16%) and 13 (17.3%) patients respectively (Table 3).

Table 3: Interventions done for patients admitted for acute burn management to the burn unit of AaBET hospital, Addis Ababa, Ethiopia from December 01, 2020 to November 30, 2021 (n = 75).

Interventions done		Frequency, n	Percent, %
Operated	Yes	53	70.7
	No	22	29.3
Escharotomy	Yes	19	25.3
	No	56	74.7
Fasciotomy	Yes	12	16.0
	No	63	84.0
Amputation(s)	Yes	13	17.3
	No	62	82.7
ICU care	Yes	9	12.0
	No	66	88.0
Ventilated	Yes	9	12.0
	No	66	88.0
Limb splinting	Yes	25	33.3
	No	50	66.7
Physiotherapy	Yes	46	61.3
	No	29	38.7
Administration of systemic antibiotics	Yes	16	21.3
	No	59	78.7

Complications

A total of 46 patients (61.3%) developed complications before and/or while being treated at our burn unit. These included wound infection, graft loss, sepsis, acute kidney injury, malnutrition, pressure ulcers, and limb compartment syndrome. Wound infection was the most common complication in 31 (41.3%) patients. Of these patients who developed complications, some had more than one complication occurring concurrently (Table 4).

Table 4: List of complications developed in patients admitted to AaBET Hospital for acute burn management between December 01, 2020 and November 30, 2021 (n = 75).

No	Complications	Frequency, n	Percent, %
1	Wound infection	31	41.3
2	Graft loss	22	29.3
3	Sepsis	9	12.0
4	AKI	1	1.3
5	Malnutrition	1	1.3
6	Pressure ulcer	4	5.3
7	Limb compartment syndrome	12	16

Isolated micro-organisms

A total of 75 swabs were taken from the burn wounds. Fifty-nine positive swab samples were identified from which 68 micro-organisms were isolated. Pseudomonas aeruginosa was the commonest isolate (42 isolates; 61.7%) followed by Staphylococcus aureus (18 isolates; 26.4%). Other isolates were Klebsiella pneumoniae (4 isolates; 6.1%), Aspergillus (3 isolates; 4.6%), and Kingella kingae (1 isolate; 1.5%) (Figure 1). A significant percentage of the positive swab results were monomicrobial (84.7%) as compared to those polymicrobial infections (15.3%). The most commonly found polymicrobial infections were Pseudomonas aeruginosa with Staphylococcus aureus (n=5, 8.5%) and Staphylococcus aureus with Klebsiella pneumoniae (n=3, 5.1%).

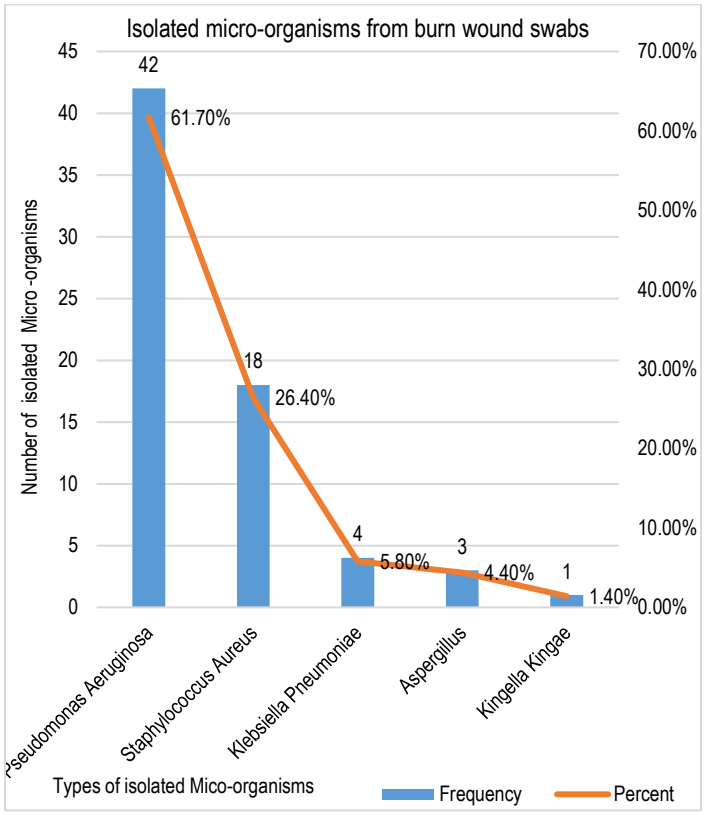

Figure 1: Isolated micro-organisms from patients admitted to the burn unit of AaBET Hospital for acute burn management (n = 75)

Table 2: Clinical characteristics of patients who were admitted for acute burn management at AaBET Hospital, Addis Ababa from December 01, 2020to November 30, 2021 (n= 75)

Variables		Age ≤15 years, n=32 (N, %)	16 – 49 years, n=38 (N, %)	≥50 years, n=5 (N, %)	Total	
					Frequency (N)	Percent (%)
Where did the injury occur?	Home	29 (90.6)	20 (52.6)	5 (100.0)	54	72.0
	Workplace	-	16 (42.1)	-	16	21.3
	Streets	2 (6.3)	-	-	2	2.7
	Neighbors' house	1 (3.1)	1 (2.6)	-	2	2.7
	Farm-land	-	1 (2.6)	-	1	1.3
How did the injury occur?	Accidentally while cooking	3 (9.4)	19 (50.0)	4 (80.0)	26	34.7
	Accidentally while playing	28 (87.5)	2 (5.3)	-	30	40.0
	Accidentally while fixing the electric system	-	12 (31.6)	-	12	16.0
	Contact with electric line	1 (3.1)	3 (7.9)	1 (20.0)	5	6.6
	Fire accident in the work area	-	2 (5.3)	-	2	2.7
Cause of burn	Flame	6 (18.8)	21 (55.3)	3 (60.0)	30	40.0
	Scald	18 (56.3)	3 (7.9)	1 (20.0)	22	29.3
	Hot surface (contact)	1 (3.1)	-	-	1	1.3
	Low-voltage electric burn	-	1 (2.6)	-	1	1.3
	High-voltage electric burn	7 (21.9)	13 (34.2)	1 (20.0)	21	28.0
Inhalational injury	Yes	1 (3.1)	7 (18.4)	-	8	10.7
	No	31 (96.9)	31 (31.6)	5 (100)	67	89.3
TBSA	<10%	3 (9.4)	2 (5.3)	-	5	6.7
	10 - <20%	15 (46.9)	5 (13.2)	2 (40.0)	22	29.3
	20 - <30%	12 (37.5)	24 (63.2)	3 (60.0)	39	52.0
	≥30	2 (6.3)	7 (18.4)	-	9	12.0

Discussion

Throughout the world, infection followed by sepsis is responsible for 50-60% of mortalities among burn patients. In the case of developing countries, it is estimated that 75% of burn mortalities are due to sepsis. It is reported that overcrowding, lack of essential elements for optimal burn care, and delayed presentation of patients are among the common factors for increased burn-related complications and mortalities in developing countries [20]. Studies undertaken in the 1950s through 1990 have contributed a lot to our current understanding of the epidemiology of burn wound infections and associated complications. That era was characterized by burn care practices of delayed excision of burn eschar and limited use of topical antibiotics. Consequently, it has been reported that the overall morbidity and mortality following burn wound infections, tissue invasion, and secondary sepsis were extremely high, with a case fatality rate of 40% and above following severe burn injury [21- 22].

According to the result of our study, a total of 46 patients (61.3%) developed complications before and/or while being treated at our burn unit. These included wound infection, graft loss, sepsis, acute kidney injury, malnutrition, pressure ulcers, and limb compartment syndrome. Burn wound infection was the most common complication identified in the study, occurring in 31 (41.3%) of patients. Of these patients who developed complications, some had more than one complication occurring concurrently.

Multiple factors play major roles in impacting the outcome of burn wound infections and associated complications. These factors include patient demographics, burn severity, obesity, diabetes, immunosuppression; use of topical antibiotics, early excision, and infection prevention measures taken in the burn unit. Several research reports from various centers indicate that the very young and the very old members of the population have an increased risk of developing a worse clinical outcome following burn injury than patients in other age groups [23 - 25].

The presence of a significant percentage of young patients in our study indicates that our study population was most likely to develop a worse clinical outcome following burn injury. In addition, the majority (n=39, 52%) of the patients had a TBSA burn between 20% and 30%, while nine (11.8%) of the patients had TBSA burn greater than 30%. These findings indicate that there were multiple risk factors among our study population, which could lead to several severe burn complications.

Among victims of severe burn injury, there will be the destruction of the skin, which results in loss its barrier function. After enduring sterile for the first 48 hours following injury, burn wounds will eventually become colonized with various microorganisms [26 - 28]. Gram-positive bacteria which reside deep in the skin adnexa are the first to heavily colonize the wound surface. Then after an average of 5 to 7 days burn wounds will further become colonized with other microbes, which include gram-positive bacteria, gram-negative bacteria, and yeasts derived from the host's normal gastrointestinal and upper respiratory flora. Additionally, colonization of burn wounds could result due to the transfer of nosocomial microbes from the hospital environment [29]. The introduction of penicillin during the 1950s resulted in a significant reduction of *Streptococcus pyogenes-caused* burn wound infection among severely burned patients. Consequently, *Staphylococcus aureus* became the principal etiological agent of burn wound infections in the decades following the 1950s. In addition, the decades following the introduction of antibiotics are marked by a gradual increment in the identification of less common microbes as a cause of burn wound infection which includes other gram-positive and gram-negative bacteria, anaerobic bacteria, fungi, and viruses [30 - 32].

In our study, *Pseudomonas aeruginosa* was found to be the commonest isolate followed by *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Aspergillus*, and *Kingella kingae*. In addition, we identified more monomicrobial-positive swabs than polymicrobial ones. These findings of our study are comparable with reports of several other studies held in other centers [33-38].

Nowadays effective treatment of burn wound infection is being severely challenged due to the emergence of antimicrobial-resistant pathogens causing burn wound infections [36]. The presence of nosocomial isolates which include MRSA, *methicillin-resistant coagulase-negative staphylococci, vancomycin-resistant enterococci*, and multiply resistant gram-negative bacteria that possess several types of beta-lactamases, including extended-spectrum beta-lactamases, *ampC* beta-lactamases, and metallo-beta-lactamases, in burn centers which can increase the risk of acquiring invasive and life-threatening infections among hospitalized burn patients [37]. Additionally, amplified use of broad-spectrum topical and systemic antibiotics for the treatment of burn infections resulted in increased identification of opportunistic pathogens, particularly *Candida spp*. which have shown increasing

degrees of antifungal drug resistance [38].

The limitation of this study is small sample size considering the number of patients who visited the hospital during the study period. However, this study presented valuable insight about the topic under the study. The study identified common clinical presentations and isolated micro-organisms contributing to wound infection among burn patients.

In conclusion, *Pseudomonas Aeruginosa* is found to be the most common bacteria isolated from the wounds of our study participants. Based on the findings of our study we recommend that standard treatments of burn wound infections and associated sepsis should target the common bacterial isolates. In addition, we recommend a large-scale study to be conducted in the unit, to identify the common microbial residual sites, and contamination points and to characterize the common bacterial isolates further.

Abbreviations

AaBET: Addis Ababa Burn Emergency and Trauma Hospital; AIDS: Acquired Immune Deficiency Syndrome; DM: Diabetes Mellitus; E. coli Eshersha Coli; GI: Gastro-intestine; HTN: Hypertension; IRB: Institutional Review Board; MRSA: Methicillin Resistant Staphylococcus Aureus; SPHMMC: St. Paul's Hospital Millennium Medical College; Spp.: species; TBSA%: Total Body Surface Area Percentage of burn; WHO: orld Health Organization

Acknowledgments

We are very much grateful to all the participants of our study for their willingness to provide the necessary information. The authors also acknowledge the AaBET Hospital burn unit staff for their cooperation during data collection for the study.

Declarations

Consent for publication

Further, informed consent for publication was also obtained from each study participant under the consent form by mentioning to all of them that the data would be published in international journals. So, this is to confirm that informed consent for publication was obtained from all the study participants. The collected data is kept confidentially under the primary investigator and co-investigators.

Authors' contributions

AB, AG, SU, IK, and MB were involved starting from conceiving the idea, developing the proposal, the study design, reviewed the article. AB and IK are involved in data cleaning, analysis, report writing, and write-up of the manuscript; AG, SU, and MB are involved in data analysis and review of the drafted manuscript. All authors read and approved the final manuscript submitted to this journal.

Funding

The authors did not receive funds or a grant for conducting this study.

Competing interest

All authors read and approved the final manuscript. The authors declare that they have no competing interests.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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