DAHUDER MEDICAL JOURNAL

Volume 5, Issue 1, January 2025

e-ISSN 2791-9250

DAHUDER Medical Journal

https://dergipark.org.tr/tr/pub/dahudermj

e-ISSN:2791-9250

Aim and Scope

DAHUDER Medical Journal (DAHUDER MJ) is an international, independent, double-blind peer-reviewed, open access, and online publishing journal, which aims to publish papers on all the related areas of clinical medicine. Manuscripts must describe original data that has not been published previously nor submitted for publication elsewhere. Manuscripts that adhere to the DAHUDER MJ submission guidelines and are deemed appropriate for the scope of the journal are sent to two reviewers who are specialists in the field.

The members of the DAHUDER MJ Executive Editorial Board who discuss the suitability then consider the reviewers' comments on each submission. The final decision for all submitted manuscripts rests with the Editor-in-Chief.

Editorial Board of the DAHUDER Medical Journal complies with the criteria of the International Council of Medical Journal Editors (ICMJE), the World Association of Medical Editors (WAME), and the Committee on Publication Ethics (COPE).

The journal is published quarterly (January, April, July, and October).

No fee is required for publishing the manuscipt.

All articles are detected for similarity.

Abstracting & Indexing

The journal is abstracted and indexed with the following: EBSCO, Google Scholar, ResearchGate, CrossRef, DRJI, ResearchBib, Asos Index, ROAD, and OUCI.

Publisher

The Association of Internal Medicine Specialist (DAHUDER)

ltayçeşme Mah. Çam Sok.

DAP Royal Center D Blok Daire: 500

34843 Maltepe / İSTANBUL

https://dergipark.org.tr/en/pub/dahudermj

EDITORIAL BOARD

Table of Contents

Review
Internal Medicine
DOI: 10.56016/dahudermj.1597919

DAHUDER
Medical Journal
e-ISSN: 2791-9250

Point-of-Care Ultrasound (POCUS) Curriculum for Internists in Turkey: A Position Paper by the DAHUDER Internal Medicine Society Ultrasound Working Group

Alper Tuna Güven[1], Gökhan Tazegül[2], Sibel Ocak Serin[3], Nazif Yalçın[4]

[1] Başkent University Faculty of Medicine Department of Internal Medicine Division of General Internal Medicine, Ankara, Türkiye
[2] Marmara University Faculty of Medicine Department of Internal Medicine Division of General Internal Medicine, İstanbul, Türkiye
[3] University of Health Sciences Umraniye Education and Research Hospital, Internal Medicine Clinic, İstanbul, Türkiye
[4] University of Health Sciences, Bursa Faculty of Medicine, Bursa City Training & Research Hospital, Department of Internal Medicine, Bursa, Türkiye

ABSTRACT

Background: Point-of-care ultrasound (POCUS) is the application of ultrasound imaging by clinicians at the point of healthcare delivery. Emergency medicine physicians and intensivists have used POCUS for a long time, but its use in internal medicine is relatively recent. Around the world, there are many position papers, curricula, and training programs regarding POCUS in internal medicine, but there is no standardized curriculum in Turkey. We aimed to set national standards for internists in the POCUS curriculum.

Methodology: The DAHUDER Internal Medicine Society Ultrasound Working Group convened members to establish the POCUS Internal Medicine curriculum. We conducted a literature search and informal clinician assessment to create a curriculum that meets the needs, demands, and resources of Turkish internists while also guaranteeing its compatibility with international curricula.

Results: We identified ten main domains under the basic and advanced POCUS curriculum as follows: Principles of ultrasound physics, machine basics, thorax imaging, abdominal imaging, cardiac imaging, vascular imaging, thyroid & neck imaging, musculoskeletal imaging, interventional imaging, and approach to clinical scenarios: Protocols. We expect these domains and their content to establish the POCUS imaging standard for internists in Turkey.

Conclusion: We expect the POCUS education curriculum to set standards, increase clinicians' skills, and improve patient care as the ultimate outcome.

Keywords: Diagnostic Ultrasound, Ultrasonographic Imaging, Internal Medicine, General Internal Medicine

Received: *December 9, 2024;* ***Accepted:*** *December 21, 2024;* ***Published Online:*** *January 29, 2025*

How to cite this article: *Guven AT, Tazegul G, Ocak Serin S, Yalcin N. Point-of-care Ultrasound (POCUS) Curriculum for Internists in Turkey: A Position Paper by the DAHUDER Internal Medicine Society Ultrasound Working DAHUDER MJ 2025,5(1):1-6. DOI: 10.56016/dahudermj.1597919*

Address for correspondence: *Alper Tuna Guven, Taşkent Caddesi, 77. Sokak, No:11 06490 Bahçelievler, Çankaya, ANKARA email: alper.tuna.guven@gmail.com*

Available at http://dergipark.org.tr/en/pub/dahudermj

Point-of-care Ultrasound (POCUS) is the acquisition of an ultrasonographic image of interest to answer a specific question and guide the clinician's performance of an invasive procedure at the place where the care is delivered.[1] This point of care could be any of the following: outpatient clinic, inpatient ward, intensive care unit, palliative care unit, or emergency department. POCUS is not a novel means of imaging but a novel paradigm, thanks to relatively low costs, reduced sizes, higher availability of new ultrasound devices, and a short learning curve. The traditional imaging paradigm consists of specialized physicians, namely radiologists, who conduct imaging processes in a designated area after completing a formal clinical assessment, including a thorough history and physical examination by a clinician, which is not a part of the imaging process.[1,2] While radiologist-provided imaging is highly reliable, quantitative, and anatomically descriptive, there are several downsides to this traditional paradigm. Firstly, the full availability of radiologists at any given time at any given hospital means allocating too many resources, which is impossible even in the most prosperous countries. Secondly, there is a clinical need for rapid and sequential imaging to monitor treatment response, such as imaging cardiac contractility after each cycle of cardiopulmonary resuscitation.[3] Lastly, standard procedures done at the bedside, like paracentesis, thoracentesis, and central line insertion, are performed faster and have lower rates of complications when performed with ultrasound imaging than without it.[4-6] These main points form why clinicians should be involved in imaging processes. These clinical demands led to a new imaging paradigm, namely, POCUS. POCUS has begun to be regarded as an extension of conventional physical examination by adding clinical data that routine physical examination cannot obtain.[7-10] POCUS imaging dramatically differs from traditional radiologist-based imaging in the following ways: The criteria for evaluating images are mostly qualitative and dichotomous, serving as a complementary tool for specific conditions instead of gross anatomical imaging. Most importantly, the purpose of POCUS is not to supplant a comprehensive radiologist examination but rather to facilitate the rapid and guided resolution of clinical problems and questions.[11, 12]

There is no globally accepted POCUS training curriculum for internists. Furthermore, there has yet to be a universal agreement on whether every internal medicine physician should acquire POCUS skills or to what extent clinicians should apply them. Several societies and groups have published their position papers to standardize POCUS education.[11-15] However, research reveals that most internal medicine residency programs do not provide formal POCUS training. Several underlying causes lie beneath this, but the most crucial drawback for POCUS education seems to be the low number of POCUS educators.[16] Regarding our country, Turkey, there is no formal POCUS education program for internists. Besides, there is no certified POCUS educator as well.

DAHUDER Internal Medicine Society is a general internal medicine society formed in Turkey whose primary aim is to provide education, improve the clinical skills of internal medicine specialists and residents, and strengthen the generalist view of internists. The society established the Ultrasound Working Group to cater to all the POCUS needs of internists. With this mission, we have developed a roadmap with the ultimate goal that "every internal medicine physician should be able to perform basic POCUS applications." Our first aim is to create a national internal medicine POCUS curriculum that matches the country's needs and resources per global standards. Later, we plan to provide POCUS education in local universities and state hospitals, cover the entire country, reach as many internists as possible, and improve their POCUS skills.

In this paper, we would like to present our internal medicine POCUS curriculum and define the expected outcomes as a position paper.

METHODS

Since no national POCUS training standard exists for internists in Turkey, we started by developing a POCUS training curriculum. For this purpose, the DAHUDER Ultrasound Working Group performed an unstructured literature search using PUBMED. Despite the existence of several society position papers, we found that university- or hospital-level scales shaped many curriculums. While there is some shared curriculum content, many differences exist between programs.[11-15] The DAHUDER Ultrasound Working Group analyzed each piece of curriculum content and reached a consensus on its inclusion or exclusion during curriculum preparation meetings.

Besides a literature search, the DAHUDER Ultrasound Working Group also conducted an informal assessment during the 3rd DAHUDER National

Internal Medicine Congress to understand the needs and claims of practicing internal medicine physicians. After discussing each claim, the DAHUDER Ultrasound Working Group reached a consensus on whether to include or exclude the content.

RESULTS

We determined that the curriculum should cover ten main areas, split into two difficulty levels: the basic and advanced POCUS curriculum. These areas and their content are as follows:

1. Principles of Ultrasound Physics

- The basic principles of the ultrasound physics domain consist of ultrasound physics & principles, namely acoustic impedance, reflection & refraction, echogenicity & attenuation, common artifacts, safety, and bioeffects.
- The advanced principles of the ultrasound physics domain consist of Doppler imaging (color, power, pulse wave, and continuous wave Dopplers) and elastography.

2. Machine Basics

- The basic machine-basics domain consists of types of ultrasound machines (cart-based, hand-held devices), machine interface & settings, namely knobology (i.e., freeze, gain, depth, measure, focus), probe types and selection (convex, phased-array, and linear probes and their properties), image acquisition & scanning (probe movement types), and imaging modes (B- and M-modes).
- The advanced machine basics domain does not include any content.

3. Thorax Imaging

- The basic thorax imaging domain consists of understanding lung artifacts (A- and B-line detection in a similar fashion to the BLUE protocol)[17], determining pleural fluid, and pleural fluid-related findings (e.g., spine sign, curtain sign, jellyfish sign, etc.), and the presence or absence of lung sliding using both B- and M-modes, with their clinical implications for pneumothorax, consolidation, pulmonary edema, and pleural effusion.
- The advanced thorax imaging domain consists of diaphragmatic ultrasound to detect diaphragmatic thickness and mobility.

4. Abdominal Imaging

- The basic abdominal imaging domain includes abdominal free fluid detection using the FAST criteria[18]; liver size (normal, decreased, or increased) and parenchyma evaluation (homogenous or heterogenous, liver surface nodular or not), spleen size (normal, decreased and increased) and parenchyma (homogenous or not) assessment, gallbladder stone (present/absent), biliary sludge (present/absent), gallbladder anterior wall thickness measurement, gallbladder wall edema (present/absent), and biliary tract dilatation (present/absent) assessment; renal size (normal, decreased and increased) and parenchyma thickness assessment (normal or reduced), hydronephrosis (present/absent), nephrolithiasis (present/absent), bladder urinary retention (present/absent), as well as assessment of gross liver, spleen, and kidney cysts & masses in dichotomous fashion.
- The advanced abdominal imaging domain covers abdominal aorta aneurysm screening, ileus evaluation, and appendicitis assessment.

5. Cardiac Imaging

- The basic cardiac imaging domain mainly parallels the FoCUS core curriculum[11] and starts with the acquisition of five core echocardiographic windows: parasternal long and short axes (PLAX and PSAX), apical and subcostal four-chamber views (A4C and S4C), and subcostal vena cava inferior view (SVCI), followed by the determination of pericardial and pleural fluid, gross left ventricular systolic functions (trichotomously as normal, reduced, or severely reduced), chamber size measurements, detection of right ventricular strain, gross valvular abnormalities (without the use of Doppler imaging), inferior vena cava diameter and collapsibility, and the presence of gross intracardiac masses.
- The advanced cardiac imaging domain comprises the determination of left ventricular diastolic dysfunction and acquiring Doppler imaging of the valves.

6. Vascular Imaging

- The basic vascular imaging domain involves detecting deep vein thrombosis using a 3-point compression test (without Doppler imaging).
- The advanced vascular imaging domain consists of carotid intima-media thickness measurement.

7. Thyroid & Neck Imaging

- The basic thyroid & neck imaging domain consists of thyroid size measurement, nodule assessment (present/absent), and vascularity assessment (increased, not increased).
- The advanced thyroid & neck imaging domain consists of assessment of thyroid nodules in accordance

with the Ti-RADS classification and assessment of cervical lymph nodes (reactive, not reactive).

8. Musculoskeletal (MSK) Imaging

- The basic MSK imaging domain does not include any content.
- The advanced MSK imaging domain comprises joint effusion assessment and soft tissue collection evaluation.

9. Interventional Imaging

- The basic interventional imaging domain consists of paracentesis, thoracentesis, vascular access, bladder catheter placement, and confirmation of endotracheal intubation & position under ultrasonographic guidance.
- The advanced interventional imaging curriculum consists of synovial joint aspiration and abscess & collection aspiration under ultrasonographic guidance.

10. Approach to Clinical Scenarios: Protocols

- The basic protocols domain includes BLUE[17] and eFAST[19] protocols for lung assessment in critically ill patients and free fluid assessment in trauma patients, respectively.
- The advanced protocols domain includes the RUSH[20] protocol for assessment of a patient with undifferentiated shock.

Table 1 provides a brief overview of the POCUS curriculum for internists.

Table 1. Basic and advanced POCUS curriculum for internists

Domains	Basic POCUS Curriculum	Advanced POCUS Curriculum
Principles of US Physics	-US physics & principles	- Doppler imaging - Elastography
Machine Basics	- US machines & knobology - Probe types, imaging modes, and image acquisition	N/A
Thoracic Imaging	- Lung artifacts and sliding - Pleural fluid	- Diaphragmatic thickness and mobility
Abdominal Imaging	- Free fluid - Liver, spleen, and kidney parenchyma & size - Gross liver, spleen, and kidney cysts & masses - GB pathology & biliary tract dilatation - Hydronephrosis, nephrolithiasis, and bladder urinary retention	- Ileus - Appendicitis - Abdominal aorta aneurysm
Cardiac Imaging	- Main windows - Pericardial & pleural fluid - LV systolic functions - RV strain - Chamber sizes - Gross valve and mass assessment - IVC assessment	- LV diastolic dysfunction - Doppler imaging of the valves
Vascular Imaging	- Deep vein thrombosis	- Carotid IM thickness
Thyroid & Neck Imaging	- Thyroid size, nodule & vascularity	- Thyroid nodule characterization - Assessment of lymph nodes
MSK Imaging	- N/A	- Joint effusions - Soft tissue collections
Interventional Imaging	- Paracentesis & thoracentesis - Vascular access - Bladder catheter placement - Endotracheal intubation and position confirmation	- Synovial joint aspiration - Abscess & collection aspiration
Approach to clinical scenarios: Protocols	- BLUE protocol - eFAST protocol	- RUSH protocol

GB: Gallbladder, IM: Intima-media, IVC: Inferior vena cava, LV: Left ventricle, MSK: Musculoskeletal, N/A: Not applicable, POCUS: Point-of-care ultrasound, RV: Right ventricle, US: Ultrasound

CONCLUSION

Prior studies indicate that POCUS imaging applications are reliable and efficient after adequate education and training.

This paper marks the first comprehensive examination of Turkish internal medicine specialists' specific needs and objectives regarding POCUS training. It addresses a significant gap in the existing literature by focusing on the particular context and requirements of clinicians in Turkey, which paves the way for tailored education and skill development in this vital area of medical practice. We expect the POCUS education curriculum to set national standards, provide a reference point, increase clinicians' skills, and improve patient outcomes in Turkey.

As both the data supporting evidence-based applications of POCUS and the technology itself continue to evolve, we recognize the necessity for this paper to adapt accordingly. We intend to implement a dynamic framework that not only captures the current landscape of POCUS training but also commits to regular updates. By doing so, we aim to ensure that the curriculum remains relevant and meets healthcare providers' and patients' continuously changing needs. Through ongoing revisions, we strive to enhance the quality of POCUS education, ultimately contributing to better patient outcomes in Turkey.

Conflict of Interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding Sources

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Ethical Approval

No ethical approval needed

Authors' Contribution

Study Conception: ATG, GT; Study Design: ATG, GT, SOS, NY; Supervision; ATG, GT; Funding: N/A; Materials: ATG, GT, SOS, NY; Data Collection and/or Processing: ATG, GT, SOS, NY; Analysis and/or Data Interpretation: ATG, GT, SOS, NY; Literature Review: ATG, GT; Critical Review: ATG, GT, SOS, NY; Manuscript preparing: ATG, GT.

REFERENCES

1. Díaz-Gómez JL, Mayo PH, Koenig SJ. Point-of-care ultrasonography. N Engl J Med. 2021 Oct 21;385(17):1593-1602. doi:10.1056/NEJMra1916062.
2. Elhassan MG, Grewal S, Nezarat N. Point-of-care ultrasonography in internal medicine: limitations and pitfalls for novice users. Cureus. 2023 Aug;15(8):e43655 . doi:10.7759/cureus.43655.
3. Breitkreutz R, Price S, Steiger HV, Seeger FH, Ilper H, Ackermann H, et al. Focused echocardiographic evaluation in life support and peri-resuscitation of emergency patients: a prospective trial. Resuscitation. 2010 Nov;81(11):1527-33. doi:10.1016/j.resuscitation.2010.07.013.
4. Kurup AN, Lekah A, Reardon ST, Schmit GD, McDonald JS, Carter RE, et al. Bleeding rate for ultrasound-guided paracentesis in thrombocytopenic patients. J Ultrasound Med. 2015 Oct;34(10):1833-8. doi:10.7863/ultra.15.14.10061.
5. Krackov R, Rizzolo D. Real-time ultrasound-guided thoracentesis. JAAPA. 2017 Apr;30(4):32-7. doi:10.1097/01.JAA.0000513340.37329.7a.
6. Saugel B, Scheeren TWL, Teboul JL. Ultrasound-guided central venous catheter placement: a structured review and recommendations for clinical practice. Crit Care. 2017 Aug 28;21(1):225. doi:10.1186/s13054-017-1814-y.
7. Ricci V, Ricci C, Gervasoni F, Giulio C, Farì G, Andreoli A, et al. From physical to ultrasound examination in lymphedema: a novel dynamic approach. J Ultrasound. 2022 Sep;25(3):757-763. doi:10.1007/s40477-022-00663-6.
8. Kimura BJ. Point-of-care cardiac ultrasound techniques in the physical examination: better at the bedside. Heart. 2017 Jul;103(13):987-994. doi:10.1136/heartjnl-2016-309915.
9. Henning RJ. Handheld ultrasound as an adjunct to physical examination in the diagnosis of cardiopulmonary disease. Future Cardiol. 2022 Jul;18(7):585-600. doi:10.2217/fca-2021-0121.
10. Jackson SS, Le HM, Kerkhof DL, Corrado GD. Point-of-care ultrasound, the new musculoskeletal physical examination. Curr Sports Med Rep. 2021 Feb 1;20(2):109-112. doi:10.1249/JSR.0000000000000811.
11. Neskovic AN, Skinner H, Price S, Via G, De Hert S, Stankovic I, et al. Focus cardiac ultrasound core curriculum and core syllabus of the European

Association of Cardiovascular Imaging. Eur Heart J Cardiovasc Imaging. 2018 May 1;19(5):475-481. doi:10.1093/ehjci/jey019.
12. Torres-Macho J, Aro T, Bruckner I, Cogliati C, Gilja OH, Gurghean A, et al. Point-of-care ultrasound in internal medicine: a position paper by the ultrasound working group of the European Federation of Internal Medicine. Eur J Intern Med. 2020 Mar;73:67-71. doi:10.1016/j.ejim.2019.11.016.
13. Olgers TJ, Azizi N, Blans MJ, Bosch FH, Gans ROB, Ter Maaten JC. Point-of-care ultrasound (PoCUS) for the internist in acute medicine: a uniform curriculum. Neth J Med. 2019 Jun;77(5):168-176. doi:10.1007/s12471-019-01289-8.
14. Gaudreau-Simard M, Wiskar K, Kilabuk E, Walsh MH, Sattin M, Wong J, et al. An overview of internal medicine point-of-care ultrasound rotations in Canada. Ultrasound J. 2022 Sep 2;14(1):37. doi:10.1186/s13089-022-00288-0.
15. Badejoko SO, Nso N, Buhari C, Amr O, Erwin JP. Point-of-care ultrasound overview and curriculum implementation in internal medicine residency training programs in the United States. Cureus. 2023 Aug;15(8):e42997 . doi:10.7759/cureus.42997.
16. Reaume M, Siuba M, Wagner M, Woodwyk A, Melgar TA. Prevalence and scope of point-of-care ultrasound education in internal medicine, pediatric, and medicine-pediatric residency programs in the United States. J Ultrasound Med. 2019 Jun;38(6):1433-1439. doi:10.1002/jum.14828.
17. Lichtenstein DA. Lung ultrasound in the critically ill. Ann Intensive Care. 2014 Jan 9;4(1):1. doi:10.1186/2110-5820-4-1.
18. Scalea TM, Rodriguez A, Chiu WC, Brenneman FD, Fallon WF, Kato K, et al. Focused Assessment with Sonography for Trauma (FAST): results from an international consensus conference. J Trauma. 1999 Mar;46(3):466-472. doi:10.1097/00005373-199903000-00022.
19. Kirkpatrick AW, Sirois M, Laupland KB, et al. Hand-held thoracic sonography for detecting post-traumatic pneumothoraces: the Extended Focused Assessment with Sonography for Trauma (EFAST). J Trauma. 2004;57(2):288-295. doi:10.1097/01.TA.0000133565.88871.E4.
20. Perera P, Mailhot T, Riley D, Mandavia D. The RUSH exam: Rapid Ultrasound in SHock in the evaluation of the critically ill. Emerg Med Clin North Am. 2010;28(1):29-vii. doi:10.1016/j.emc.2009.09.010.

Original Article
Internal Medicine
DOI: 10.56016/dahudermj.1588898

DAHUDER
Medical Journal
e-ISSN: 2791-9250

Comparison of Procedural Techniques and Variables in Patients Undergoing Arterial Cannulation

Nazif Yalçın[1], Ayşegül Ertınmaz[1], Nizameddin Koca[1]

[1] University of Health Sciences, Bursa Faculty of Medicine, Bursa City Training & Research Hospital, Department of Internal Medicine, Bursa, Türkiye

ABSTRACT

Background: This study presents a comprehensive comparative analysis of two methods for arterial cannulation, palpation, and ultrasound guidance (USG), using a sample of 104 subjects for each method.
Methods: The primary objective was to evaluate the safety and efficiency of these techniques. Clinical and laboratory parameters were recorded, including hemoglobin levels, platelet count, International Normalized Ratio (INR), albumin, and total protein levels. The number of attempts and total procedure time were documented for each procedure. Additionally, the ultrasound-guided (USG) method and the duration of each recorded procedure were emphasized to provide a detailed comparison between the two techniques.
Results: USG required fewer attempts than palpation (1.63 ± 0.83 vs. 2.36 ± 1.18, $p<0.001$), resulting in a higher success rate on the first attempt. The total procedure time was significantly shorter in the USG group (7.14 ± 2.42 vs. 11.83 ± 4.45 minutes, $p<0.001$). This demonstrates the enhanced efficiency of USG. Complication rates were also lower in the USG group (16.3% vs. 31.7%, $p=0.009$), confirming its safety advantage.
Although the two groups showed no significant differences in hemoglobin levels, platelet count, albumin, total protein levels, inotropic agent requirements, or history of peripheral arterial disease (PAD) and congestive heart failure (CHF), INR levels were significantly higher in the USG group (1.23 ± 0.26 vs. 1.14 ± 0.25, $p=0.004$). Furthermore, patients with higher BMI benefited more from USG, which was particularly advantageous in challenging cases.
Conclusion: The current study demonstrates that USG is more efficient, safer, and quicker than palpation, particularly in patients with a higher BMI. These findings suggest that USG is preferable for arterial cannulation in clinical settings, offering reduced complications and enhanced success rates, especially in more challenging patient populations.

Keywords: Arterial cannulation, dorsalis pedis artery, palpation technique, USG technique

Received: *November 20, 2024;* ***Accepted:*** *January 2, 2025;* ***Published Online:*** *January 29, 2025*

How to cite this article: *Yalcin N, Ertinmaz A, Koca N. Comparison of Procedural Techniques and Variables in Patients Undergoing Arterial Cannulation. DAHUDER MJ 2025,5(1):7-.12. DOI: 10.56016/dahudermj.1588898*

Address for correspondence: *Nazif Yaçın, University of Health Sciences, Bursa Faculty of Medicine, Bursa City Training & Research Hospital, Department of Internal Medicine, Bursa, Türkiye, e-mail: nazifyalcin16@gmail.com*

Available at http://dergipark.org.tr/en/pub/dahudermj

Intraarterial cannulation is frequently used in intensive care units (ICU) for invasive blood pressure monitoring, frequent arterial blood gas analysis, and evaluation of fluid response in treatment.[1] Arterial cannulation plays a vital role in adequate hemodynamic monitoring.

Radial, dorsalis pedis, brachial, femoral, and posterior tibial arteries should be preferred for arterial cannulation.[1] Radial and dorsalis pedis arteries are chosen more frequently because of their proximity to the skin surface and ease of access.[2]

The traditional arterial cannulation method performs the procedure by palpating the planned vessel. An experienced physician is required for this procedure. Since multiple arterial interventions may be performed, arterial spasms and hematomas may occur.[3] With the complications in these procedures over time, ultrasound (USG) technique has become preferred. Its use in ICUs has grown due to fewer complications. Additionally, it requires less bedside time and offers higher success rates.[4,5]

Since the surgical outcomes related to the dorsalis pedis artery are not yet well understood, our study specifically selected it as the target artery for cannulation to contribute to the existing literature. Our research mainly aims to compare palpation and ultrasound guidance in vascular cannulations in the dorsalis pedis artery. The secondary objective was to find the total time, number of trials, complications, and success rates between the two procedures.

METHODS

This study compares 208 patients with arterial cannulation (104 for palpation and 104 for ultrasound techniques) and compares those patients undergoing arterial cannulation. After the local ethical committee's approval (Number: 2023-18/10), the study was conducted on patients in the internal medicine intensive care unit at a university hospital.

Criteria for inclusion:

- 18 years of age or older (including 18)
- Non-pregnancy

Exclusion criteria:

- Patients under 18 years old
- Pregnant patients
- Patients without approval
- Patients with diabetes, arterial thrombosis, infections, and related conditions were excluded

Patient selection and randomization:

Patients were randomly assigned to either the palpation or ultrasound-guided (USG) groups to minimize selection bias and ensure a balanced comparison between the two techniques.

Artery selection:

As stated in the introduction, the dorsalis pedis artery was selected for all procedures to maintain consistency across the study. Additionally, collateral circulation via the dorsalis pedis artery was assessed before cannulation.

Observer's role:

The observer documented key procedural parameters, including the number of attempts, total procedure time, and outcomes such as the success or failure of the intervention.

Switching to a different artery:

If cannulation of the dorsalis pedis artery was unsuccessful after multiple attempts, the physician proceeded to another artery based on clinical judgment to ensure patient safety and timely intervention.

In the study, an experienced internal medicine physician observed patients undergoing arterial cannulation. During the data collection process, no intervention was carried out concerning patient selection, indication of catheter installation, and vessel selection, and it was monitored only by an external observer. The data from patients who met the inclusion criteria were collected. Electronic medical records were used for the patient's laboratory parameters.

Our study used a 20G arterial cannula for palpation and ultrasound-guided cannulation. A vascular transducer with a small footprint (8–13 MHz) and a two-dimensional M-Turbo ultrasound system (Chison ultrasound) device were used for the procedure. The ultrasound was performed using a short-axis, in-plane technique. Both methods retained predefined times, which were not included in the total time. To objectively compare the total operating times, arterial palpation and detection times were included in the entire duration. Complications such as bleeding and hematoma were recorded after the catheter installation.

Statistical Analysis

All statistical analyses were performed using SPSS software (version 26 for Mac). The normality of the distribution of continuous variables was assessed using the Kolmogorov-Smirnov test. Data are presented as mean ± standard deviation (SD) for normally distributed variables and as median (min-max) for non-normally distributed variables.

Table 1. The comparison of continuous variables between the palpation and the USG technique used for arterial cannulation.

	Palpation (n=104)		USG (n=104)		p
	Mean ± SD	Median (Min-Max)	Mean ± SD	Median (Min-Max)	
Age	65.85 ± 14.94	67(24-96)	66.69 ± 16.13	68(18-93)	0.511
Height, cm	164.43 ± 9.6	162.5(145-184)	167.4 ± 9.47	170(150-185)	0.033
Weight, kg	85.79 ± 10.61	85(56-108)	84.43 ± 12.64	84.5(52-108)	0.580
BMI, kg/m²	31.86 ± 4.26	31.63(22.72-44.3)	30.18 ± 4.43	29.65(17.78-41.67)	**0.004**
Number of attempts	2.36 ± 1.18	2(1-5)	1.63 ± 0.83	1(1-4)	**<0.001**
Processing time, min	11.83 ± 4.45	11(5-23)	7.14 ± 2.42	6(4-13)	**<0.001**
MAP, mmHg	73.43 ± 11.58	71.67(48.33-105)	75.8 ± 27.04	71.67(48.33-321.67)	0.959
Systolic BP, mmHg	99.63 ± 15.49	95(65-145)	108.94 ± 75.48	100(75-855)	0.312
Diastolic BP, mmHg	60.34 ± 10.43	60(40-85)	59.23 ± 10.61	60(35-85)	0.397
Hemoglobin, g/dL	9.2 ± 1.14	9(7.3-12.5)	9.16 ± 1.5	8.9(6-13.2)	0.459
Platelet (10³ µl)	154.89 ± 83.96	131.5(45-375)	156.68 ± 108.04	125(11-422)	0.577
INR	1.14 ± 0.25	1(0.8-2)	1.23 ± 0.26	1.2(0.9-1.9)	**0.004**
Albumin g/L	24.36 ± 3.58	24(18-32)	24.63 ± 5.36	24(17-38)	0.895
Total protein g/L	52.57 ± 7.31	55(35-67)	52.72 ± 10.25	54(30-73)	0.957

MAP: mean arterial pressure, BP: blood pressure, INR: international normalization range min: minute

Categorical variables are expressed as numbers and percentages. For comparison between the two groups (USG and palpation), independent t-tests were used for normally distributed continuous variables, while Mann-Whitney U tests were applied for non-normally distributed variables. Chi-square tests were utilized to analyze categorical variables. A p-value < 0.05 was considered statistically significant.

A power analysis was conducted to determine the required sample size. Assuming an alpha level of 0.05, a power of 0.80, and based on expected differences in the number of attempts and procedure time between the two techniques, a sample size of 104 patients per group (208 patients in total) was determined to be sufficient to detect clinically significant differences between the groups.

RESULTS

We determined that the curriculum should cover tenIn the evaluation of catheterization techniques, a comparative analysis between palpation (n=104) and ultrasound-guided (USG) (n=104) procedures revealed several significant findings.

Demographic Characteristics:

The mean age of patients in the palpation group was 65.85 ± 14.94 years, with a median of 67 years (range: 24-96). The USG group's mean age was 66.69 ± 16.13 years, with a median of 68 years (18-93). The difference in age between the two groups was not statistically significant (p = 0.511). The distribution of males and females differed significantly between the palpation and USG groups (n=38 vs. n=66, p=0.018). Patients' height (p = 0.033) and BMI (p=0.004) showed a significant difference between the palpation and USG groups, while no significant differences were observed in weight (p=0.580, Table 1).

Catheterization Parameters:

The number of attempts for catheterization was significant between the two groups (2.36 ± 1.18 vs. 1.63 ± 0.83 attempts, p<0.001). Processing time was significantly shorter in the USG group (7.14 ± 2.42 vs. 11.83 ± 4.45 minutes, p<0.001, Table 1).

Hemodynamic Parameters:

Mean Arterial Pressure (MAP), Systolic Blood Pressure (SBP), and Diastolic Blood Pressure (DBP) of the patients did not show statistically significant differences between the two groups (p>0.05).

Laboratory Values:

The selection of ultrasound guidance for patients with higher INR levels was driven by clinical considerations to enhance patient safety. USG is known to reduce complications, particularly the risk of hematoma and excessive bleeding, which are of more significant concern in individuals with elevated INR. Significant differences were observed in the International Normalized Ratio (INR) (p = 0.004) between the palpation and USG groups. The USG group had a higher INR (1.23 ± 0.26) than the palpation group (1.14 ± 0.25). Hemoglobin, platelet count, albumin, and total protein levels did not show significant differences between the two groups (p > 0.05, Table 1).

Procedural Outcomes and Medical History:

The USG group demonstrated a significantly higher rate of success on the first attempt (p<0.001)

Table 2. The comparison of categorical variables between the palpation and the USG technique used for arterial cannulation.

	Palpation (n=104)	USG (n=104)	p
Male/Female	38/66	55/49	**0.018**
First attempt, n (%)	34 (32.7)	62(59.6)	**<0.001**
Complication, n (%)	33 (31.7)	17 (16.3)	**0.009**
Inotropic agent requirement, n (%)	50 (48.1)	61 (58.7)	0.126
PAD History, n (%)	9 (8.7)	13 (12.5)	0.367
CHF History, n (%)	32 (30.8)	34 (32.7)	0.776

USG: ultrasound, PAD: peripheral artery disease, CHF: congestive heart failure

and a lower rate of complications (p=0.009) compared to the palpation group (Table 2).

There were no significant differences in inotropic agent requirement, peripheral artery disease (PAD) history, and Congestive Heart Failure (CHF) history between the two groups (p>0.05, Table 2).

DISCUSSION

In our daily intensive care practice, arterial cannulation plays an important role, and arteries such as the radial and dorsalis pedis are the vessels that are frequently intervened.[6] The dorsalis pedis artery proceeds as a continuation of the anterior tibial artery in front of the ankle joint. It then descends as a deep plantar artery and completes the plantar arch [7,8]

Our study showed that the total operating time of patients undergoing ultrasound and arterial canulation was significantly shorter than that of patients under palpation. Similarly, Bicak et al.[9] and Anand et al.[10] report that the procedure under the ultrasound was significantly shorter. Shiver et al.[11] conducted a comparative study on arterial cannulation procedures, specifically ultrasound and palpation. The study had 60 patients and focused on determining the shorter length of ultrasounds. However, Bhattacharjee et al.[12] reported no notable disparity in processing time between the two methodologies.

Our study found that patients who underwent cannulation using the USG approach had a greater success rate on their initial attempt and required fewer total attempts. According to a study by Yeap et al.[13], using the USG method necessitates fewer surgical procedures. Bruzoni et al.[14] conducted a study on 150 pediatric patients and saw a decrease in ultrasound surgical procedures.

The initial ultrasonography trial demonstrated a superior success rate in research conducted by Ueda et al.[15] involving 749 individuals. In our investigation, we also discovered that with the USG procedure, the success rate was higher in the first attempt. In contrast to our study, Chanthawong et al.[16] reported comparable success rates in the initial effort when comparing ultrasonography and palpation techniques in a sample of 80 patients.

Our research has demonstrated a marked decrease in the incidence of complications when ultrasound is used for cannulation. Concurrently with our investigation, Oulego-Erroz et al.[17] and Souza et al.[12] demonstrated decreased complications using the USG approach in a cohort of 354 patients. An analysis of seven trials in the literature involving a total of 558 patients revealed that the incidence of hematoma was markedly reduced in arterial cannulation operations when ultrasound guidance (USG) was employed.[18] Zhao et al.[19] analyzed 19 trials, including 3,220 patients. Their findings indicate that ultrasound-guided arterial cannulation operations have much lower complication rates than palpation procedures.

In the study conducted by Sung et al.[20], 160 geriatric cases were examined. As a result of the study, the success rate in the first attempt in the arterial cannulation procedure performed on the radial artery with the ultrasound technique was higher than the palpation technique, and fewer complications were detected in the procedures performed with the ultrasound technique.

The groups did not exhibit any notable disparities in terms of the rates of inotropic need, average arterial pressure, peripheral artery disease, and heart failure. No significant differences were observed in the laboratory measurements of total protein (g/L), albumin (g/L), hemoglobin (g/dL), and platelets (10^3/µL). The USG group exhibited elevated INR levels, showing that USG was favored for individuals with a higher risk profile. Although patients with higher INR values were more likely to undergo USG, this approach did not introduce bias into the study, as group assignments were determined randomly. The retrospective nature of data analysis ensured that comparisons between the palpation and USG groups remained valid, with no deliberate preference or bias influencing the results.

CONCLUSION

This study highlights that ultrasound guidance (USG) is safer, faster, and more efficient than palpation, especially when cannulating the dorsalis pedis artery. The preference for USG, particularly in patients with elevated INR, helps minimize complications such as hematomas. These findings suggest that USG should be preferred for arterial cannulation procedures to enhance success rates and reduce risks, especially in more challenging cases.

Limitations

This study has some limitations. First, operator dependence can affect the success of ultrasound-guided cannulation. Second, variability in the availability of ultrasound machines may limit the generalizability of the findings. Third, ensuring homogeneous patient selection was challenging, which could introduce some variability in the results.

We acknowledge the importance of diabetes mellitus (DM), Buerger's disease, and other peripheral arterial diseases that may impair vascular health and potentially impact the success of arterial cannulation. However, the study design did not include these conditions to maintain a focused analysis of parameters directly related to acute cardiovascular management and procedural outcomes.

In future research, we recommend expanding the scope to include additional vascular comorbidities, such as DM and Buerger's disease, to explore their impact on arterial access procedures further.

Conflict of Interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding Sources

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Ethical Statement

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and received approval from Bursa Şehir Training and Research Hospital's Ethical Committee (Approval Number: 2023-18/10). The research was carried out on patients admitted to the Internal Medicine Intensive Care Unit at Bursa Şehir Training and Research Hospital, which is affiliated with the University of Health Sciences. Informed consent was obtained from all participants or their legal representatives prior to their inclusion in the study. All patient data were handled with strict confidentiality and in compliance with data protection regulations.

Authors' Contribution

Study Conception: NY; Study Design: NY, AE, NK; Supervision; NY, AE, NK; Funding: NY, AE, NK; Materials: NY, AE; Data Collection and/or Processing: NY, AE; Analysis and/or Data Interpretation: NK; Literature Review: ANY, NK; Critical Review: NY, AE, NK; Manuscript preparing: NY, NK.

REFERENCES

1. Saugel, B., Kouz, K., Meidert, A. S., Schulte-Uentrop, L., & Romagnoli, S. (2020). How to measure blood pressure using an arterial catheter: A systematic 5-step approach. Critical Care, 24(1), 172. https://doi.org/10.1186/s13054-020-02881-1
2. Lee, D., Kim, J. Y., Kim, H. S., Lee, K. C., Lee, S. J., & Kwak, H. J. (2016). Ultrasound evaluation of the radial artery for arterial catheterization in healthy anesthetized patients. Journal of Clinical Monitoring and Computing, 30(2), 215–219. https://doi.org/10.1007/s10877-015-9714-4
3. Shiver, S., Blaivas, M., & Lyon, M. (2006). A prospective comparison of ultrasound-guided and blindly placed radial arterial catheters. Academic Emergency Medicine, 13(12), 1275–1279. https://doi.org/10.1197/j.aem.2006.06.036
4. Gupta, P. K., Gupta, K., Dwivedi, A. N., & Jain, M. (2011). Potential role of ultrasound in anesthesia and intensive care. Anesthesia: Essays and Researches, 5(1), 11–19. https://doi.org/10.4103/0259-1162.84184
5. Bhattacharjee, S., Maitra, S., & Baidya, D. K. (2018). Comparison between ultrasound-guided technique and digital palpation technique for radial artery cannulation in adult patients: An

updated meta-analysis of randomized controlled trials. Journal of Clinical Anesthesia, 47, 54–59. https://doi.org/10.1016/j.jclinane.2018.03.033
6. Quan, Z., Tian, M., Chi, P., Cao, Y., Li, X., & Peng, K. (2014). Modified short-axis out-of-plane ultrasound versus conventional long-axis in-plane ultrasound to guide radial artery cannulation: A randomized controlled trial. Anesthesia and Analgesia, 119(1), 163–169. https://doi.org/10.1213/ANE.0000000000000246
7. Qazi, E., Wilting, J., & Patel, N. R. (2022). Arteries of the lower limb: Embryology, variations, and clinical significance. Canadian Association of Radiologists Journal, 73(4), 259–270. https://doi.org/10.1177/08465371211046497
8. Manjunatha, H. N. H. (2021). Variations in the origin, course, and branching pattern of dorsalis pedis artery with clinical significance. Scientific Reports, 11, 1448. https://doi.org/10.1038/s41598-021-81301-4
9. Bicak, E. A., & Elmastas, D. (2023). Comparison of ultrasonography guidance versus direct palpation technique for central venous catheterization in children undergoing cardiac surgery. Journal of Cardiovascular Thoracic Anaesthesia and Intensive Care, 29(2), 88–94.
10. Anand, R. K., Maitra, S., Ray, B. R., Baidya, D. K., Khanna, P., & Chowdhury, S. R. (2019). Comparison of ultrasound-guided versus conventional palpatory method of dorsalis pedis artery cannulation: A randomized controlled trial. Saudi Journal of Anaesthesia, 13(3), 295–298. https://doi.org/10.4103/sja.SJA_653_18
11. Yeap, Y. L., Wolfe, J. W., Stewart, J., & Backfish, K. M. (2019). Prospective comparison of ultrasound-guided versus palpation techniques for arterial line placement by residents in a teaching institution. Journal of Graduate Medical Education, 11(2), 175–180. https://doi.org/10.4300/JGME-D-18-00592.1
12. De Souza, T. H., Brandao, M. B., Nadal, J. A. H., & Nogueira, R. J. N. (2018). Ultrasound guidance for pediatric central venous catheterization: A meta-analysis. Pediatrics, 142(3), e20181719. https://doi.org/10.1542/peds.2018-1719
13. Oulego-Erroz, I., Gonzalez-Cortes, R., Garcia-Soler, P., Balaguer-Gargallo, M., Frias-Perez, M., & Mayordomo-Colunga, J. (2018). Ultrasound-guided or landmark techniques for central venous catheter placement in critically ill children. Intensive Care Medicine, 44(1), 61–72. https://doi.org/10.1007/s00134-017-5007-3
14. Bruzoni, M., Slater, B. J., Wall, J., St. Peter, S. D., & Dutta, S. (2013). A prospective randomized trial of ultrasound- vs landmark-guided central venous access in the pediatric population. Journal of the American College of Surgeons, 216(5), 939–943. https://doi.org/10.1016/j.jamcollsurg.2012.12.032
15. Ueda, K., Bayman, E. O., Johnson, C., Odum, N. J., & Lee, J. J. (2015). A randomized controlled trial of radial artery cannulation guided by Doppler vs palpation vs ultrasound. Anaesthesia, 70(9), 1039–1044. https://doi.org/10.1111/anae.13191
16. Chanthawong, S., & Tribuddharat, S. (2022). A comparison of the success rate of radial artery cannulation between ultrasound-guided and conventional palpation techniques in elderly patients undergoing cardiothoracic surgery: A randomized controlled trial. Annals of Cardiac Anaesthesia, 25(4), 447–452. https://doi.org/10.4103/aca.ACA_106_22
17. Oulego-Erroz, I., Gonzalez-Cortes, R., Garcia-Soler, P., Balaguer-Gargallo, M., Frias-Perez, M., & Mayordomo-Colunga, J. (2018). Ultrasound-guided or landmark techniques for central venous catheter placement in critically ill children. Intensive Care Medicine, 44(1), 61–72. https://doi.org/10.1007/s00134-017-5007-3
18. Zhang, W., & Li, K. (2020). Efficacy of ultrasound-guided technique for radial artery catheterization in pediatric populations: A systematic review and meta-analysis of randomized controlled trials. Critical Care, 24(1), 197. https://doi.org/10.1186/s13054-020-02910-z
19. Zhao, W., & Peng, H. (2021). Effects of ultrasound-guided techniques for radial arterial catheterization: A meta-analysis of randomized controlled trials. American Journal of Emergency Medicine, 46, 1–9. https://doi.org/10.1016/j.ajem.2020.11.002
20. Sung JM., Jun YE., Jung YD., Kim KN. Comparison of an Ultrasound-Guided Dynamic Needle Tip Positioning Technique and a Long-Axis In-Plane Technique for Radial Artery Cannulation in Older Patients: A Prospective, Randomized, Controlled Study. Journal of Cardiothoracic and Vascular Anesthesia Volume 37, Issue 12, December 2023, Pages 2475-2481.

Original Article
Internal Medicine
DOI: 10.56016/dahudermj.1582709

DAHUDER
Medical Journal
e-ISSN: 2791-9250

Biofilm Formation Capabilities of Lactobacillus Species Isolated from Selected Fermented Food Products Using a Statistical Approach

Blessing Adoh Olodu[1], Stephen Amadin Enabulele[1]

[1] *Department of Biological Science (Microbiology), Benson Idahosa University, Benin City, Edo State, Nigeria*

ABSTRACT

Background: This study investigates the biofilm formation capabilities of Lactobacillus species isolated from fermented cassava and corn products. Understanding biofilm formation is crucial for evaluating the probiotic potential of these species, as biofilm-forming ability influences their survival and functionality in host environments.

Methods: Nine bacterial isolates, including Lactobacillus fermentum, L. ghanensis, L. delbrueckii, L. plantarum, Lactococcus lactis, L. reuteri, Lysinibacillus sphaericus, Bacillus cereus, and B. pacificus, were assessed for biofilm production using the microtiter plate assay. After crystal violet staining, optical density (OD) values were measured at 570 nm spectrophotometrically. Based on OD values, isolates were classified into four categories: no biofilm, weak, moderate, and strong biofilm formation. Statistical analyses, including two-stage least squares regression, were employed to evaluate biofilm formation trends and predictors.

Results: The predictive regression model was highly significant ($R^2 = 0.987$, $F = 122.618$, $p < 0.0001$). Biofilm formation strength varied, with the highest mean percentage observed in the moderate group (31.29%), followed by weak (27.41%), strong (20.46%), and no biofilm (20.05%). Among the isolates, Lactobacillus fermentum exhibited the highest rate of strong biofilm formation (46.1%), while Lysinibacillus sphaericus showed none. Moreover, The highest biofilm formation was observed at 37°C (31.29%), followed by 25°C (27.41%), and 45°C (20.46%). Similarly, biofilm formation was highest at pH 6.5 (30.41%), followed by pH 7.5 (25.39%) and pH 4.5 (20.05%). Lactobacillus fermentum exhibited the highest strong biofilm formation (46.1%) at 37°C and pH 6.5.

Conclusion: Biofilm formation in Lactobacillus species is species-specific and environmentally influenced by temperature and pH. Lactobacillus fermentum demonstrated strong biofilm formation, making it a promising candidate for probiotic applications.

Keywords: Biofilms formation, crystal violet staining, Fermentation, Lactobacillus species, Probiotics, Statistical models

Received: *November 12, 2024;* ***Accepted:*** *December 9, 2025;* ***Published Online:*** *January 29, 2025*

How to cite this article: *Olodu BA, Enabulele SA. Biofilm Formation Capabilities of Lactobacillus Species Isolated from Selected Fermented Food Products Using a Statistical Approach. DAHUDER MJ 2025,5(1):13-23. DOI: 10.56016/dahudermj.1582709*

Address for correspondence: *Blessing Adoh Olodu , Department of Biological Science (Microbiology), Benson Idahosa University, Benin City, Edo State, Nigeria; E-mail: blessingolodu18@gmail.com*

Available at http://dergipark.org.tr/en/pub/dahudermj

The study of biofilm formation capabilities of Lactobacillus species has several clinical benefits. Lactobacillus species with strong biofilm-forming abilities are more likely to adhere to the intestinal epithelium, resist gastric acids, and survive bile salts, enhancing their colonization potential and making them effective probiotics for gut health.[1, 2] Biofilms provide a protective matrix that shields bacteria from hostile environments, ensuring sustained delivery of health benefits. These probiotics can modulate gut microbiota, helping prevent or treat conditions such as irritable bowel syndrome (IBS), inflammatory bowel disease (IBD), and diarrhea.[2, 3] Additionally, their biofilm-forming ability aids in the competitive exclusion of pathogens by occupying niches on the gut lining. Probiotic Lactobacillus species with antimicrobial properties can help manage infections caused by harmful or antibiotic-resistant bacteria.[2] They may also reduce the risk of dental caries and periodontal diseases by preventing pathogenic biofilms in the oral cavity. Variability in biofilm formation across species provides insights for tailoring probiotic supplements to individual health needs, facilitating personalized dietary interventions for improving gastrointestinal health or preventing specific conditions. Demonstrating that fermented foods contain biofilm-capable Lactobacillus species supports their role as functional foods with preventive health benefits beyond basic nutrition.[3, 4] Moreover, Lactobacillus biofilms could be engineered for drug delivery, offering sustained release of therapeutic agents, particularly in gastrointestinal treatments. This foundational knowledge contributes to advancing probiotic therapy, infection management, functional food development, and innovative drug delivery systems, significantly impacting public health.

Fermented foods have been central to traditional diets worldwide, offering not only unique flavors but also significant health benefits. Notably, fermented cassava and corn products are integral to African cuisine, particularly in Nigeria, where they are staple components. The fermentation process promotes the growth of beneficial microorganisms, primarily lactic acid bacteria (LAB), which are essential for food preservation and improving nutritional value.5,6 Increasing attention has been given to LAB, particularly Lactobacillus species, because of their well-documented probiotic properties, which include gut health support, immune modulation, and inhibition of pathogenic bacteria.[7, 8]

Probiotics are defined as live microorganisms that provide health benefits to the host when administered in sufficient quantities.[9, 10] Lactobacillus species have been widely studied for their resilience to acidic and bile conditions, adherence to the intestinal mucosa, and production of antimicrobial substances like bacteriocins.[11, 12] The rising demand for natural, functional foods fortified with probiotics has fueled research efforts to isolate and characterize promising probiotic strains from traditional fermented foods.[13, 14] The potential health benefits of Lactobacillus species include preventive measures against gastrointestinal infections and chronic illnesses.[15, 16]

Despite their widespread use, research on the probiotic potential of LAB from fermented cassava and corn in Nigeria remains limited. Previous studies have primarily focused on dairy-based fermented products, while non-dairy sources, which are often more accessible in tropical regions, have been underexplored.[17, 18] The ability of these isolates to form biofilms is crucial, as biofilm formation enhances bacterial adherence to the intestinal lining, potentially improving gut colonization and probiotic effectiveness.[19, 20] Biofilms, as complex microbial communities, offer protection against environmental stressors, potentially increasing the bacteria's survival and functionality within the gastrointestinal tract.[21, 22] This research also assess biofilm formation as an indicator of efficient gut colonization. By advancing the understanding of indigenous probiotic strains, the study aims to contribute to the development of functional foods and therapeutic strategies that can address prevalent health challenges in Nigeria and beyond.[23, 24] Furthermore, the results could support the creation of locally produced, sustainable probiotic products, enhancing health and nutritional security.[25, 26] Biofilm formation is a critical characteristic of Lactobacillus species, significantly influencing their probiotic functionality and resilience in various environments. Factors like genetic diversity and stress conditions can impact biofilm strength, which varies among species and samples.[27-29] Understanding these differences aids in optimizing probiotic applications.[30-34]

METHODS

This research focused on the isolation, identification, and biofilm formation assessment of Lactobacillus species from fermented cassava and corn samples. A systematic approach was adopted, including sample collection, microbial isolation, biofilm formation assessment, and statistical analysis.

Sample Collection

Fermented cassava and corn samples were collected from various local markets in Benin City, Nigeria. Samples were transported in sterile containers to the laboratory and processed within 24 hours to ensure the viability of the microorganisms.[3]

Microbial Isolation

The isolation of Lactobacillus species was performed using serial dilution and plating techniques. A 10 g sample of each fermented product was homogenized in 90 mL of sterile peptone water and serially diluted up to 10^{-6}. Aliquots (0.1 mL) of the appropriate dilutions were spread on de Man, Rogosa, and Sharpe (MRS) agar plates. Plates were incubated at 37°C for 48 hours under anaerobic conditions using an anaerobic jar with gas-generating kits. Colonies displaying typical Lactobacillus morphology (smooth, round, and cream-colored) were selected and purified by sub-culturing.

Assessment of Biofilm Formation

The biofilm-forming ability of the Lactobacillus isolates was evaluated using the microtiter plate assay. Overnight cultures of each isolate were adjusted to an optical density of 0.5 at 600 nm, corresponding to approximately 10^8 CFU/mL. A 200 µL aliquot of each culture was transferred into wells of a sterile, flat-bottomed 96-well polystyrene microtiter plate. The wells were incubated at 37°C for 24 hours under anaerobic conditions.[20, 21] After incubation, wells were washed three times with phosphate-buffered saline (PBS) to remove non-adherent cells. Adherent biofilms were fixed with 99% methanol for 15 minutes and stained with 0.1% crystal violet for 20 minutes. Excess stain was rinsed off with distilled water, and the plates were air-dried. The bound crystal violet was solubilized with 33% acetic acid, and the absorbance was measured at 570 nm using a microplate reader.[15,20]

Categorization of Biofilm Formation

The strength of biofilm formation was categorized based on the absorbance values: no biofilm (OD $\leq$ 0.1), weak (0.1 $<$ OD $\leq$ 0.2), moderate (0.2 $<$ OD $\leq$ 0.4), and strong (OD $>$ 0.4). The experiment was performed in triplicate for each isolate, and the mean absorbance values were calculated.

Statistical Analysis

All assays were conducted in triplicate to ensure data reliability. Statistical analyses were performed using appropriate software, such as SPSS version 23, to compare the probiotic properties across isolates. Data were analyzed using descriptive and inferential statistical methods. The variations in biofilm formation among different Lactobacillus species were assessed using one-way analysis of variance (ANOVA). A two-stage least squares (2SLS) regression model was developed to explore the relationship between biofilm formation strength and microbial interactions, ensuring model reliability. The coefficient of determination (R^2) was calculated to evaluate the model's predictive power.[23, 24]

RESULTS

Table 1 presents the biofilm formation strength of various Lactobacillus species, categorizing them into no biofilm, weak, moderate, and strong formation. Table 2 and 3 shows the effect of temperature and pH on biofilm formation. Table 4 outlines the model description used for statistical analysis, identifying biofilm categories as predictors and instrumental variables. The results from Table 5's indicates model summary. Table 6 provides detailed coefficients of the variables in the model. Table 7's descriptive statistics summarize the central tendencies and variability of biofilm formation across isolates. The correlation matrix in Table 8 and 9 highlights the inverse relationship between strong biofilm formation and other categories. Finally, Table 10 offers the distribution parameters, showing how biofilm data fits a normal distribution. Figures 1 and 2 visually support these findings, with Figure 1 displaying a histogram of biofilm formation percentages and Figure 2 showing P-plots for estimated distribution parameters.

DISCUSSION

The distribution of biofilm formation strength among Lactobacillus species isolated from fermented cassava and corn samples highlights the variability in biofilm-forming abilities (Table 1). Lactobacillus fermentum (n=13) showed 46.1% strong biofilm formation and 7.7% no biofilm formation, while Lactobacillus plantarum (n=14) exhibited 42.9% strong and 7.1% no biofilm formation. These findings underscore

Table 1: Biofilm Formation in *Lactobacillus species* Isolated from Fermented Cassava and Corn Samples

Isolates	Biofilm formation strength			
	No biofilm n (%)	Weak n (%)	Moderate n (%)	Strong n (%)
Lactobacillus fermentum (n=13)	1(7.7%)	2(15.4%)	4(30.8%)	6(46.1%)
Lactobacillus ghanensis (n=9)	2(22.2%)	3(33.3%)	2(22.2%)	2(22.2%)
Lactobacillus delbrueckii (n=10)	2(20.0%)	2(20.0%)	4(40.0%)	2(20.0%)
Lactobacillus plantarum (n=14)	1(7.1%)	3(21.4%)	4(28.6%)	6(42.9%)
Lactococcus lactis (n=9)	2(22.2%)	4(44.4%)	2(22.2%)	1(11.1%)
Lactobacillus reuteri (n=8)	2(25.0%)	2(25.0%)	3(37.5%)	1(12.5%)
Lysinibacillus sphaericus (n=7)	3(42.9%)	2(28.6%)	2(28.6%)	0(00.0%)
Bacillus cereus (n=9)	2(22.2%)	2(22.2%)	4(44.4%)	1(11.1%)
Bacillus pacificus (n=11)	2(18.2%)	4(36.4%)	3(27.3%)	2(18.2%)

the association between strong biofilm formation and enhanced probiotic potential, contributing to microbial stability in the gastrointestinal tract. In contrast, *Lactobacillus ghanensis* and *Lactococcus lactis* demonstrated lower biofilm formation, likely influenced by genetic and environmental factors, such as substrate availability and pH, consistent with findings by Song et al.[28] Biofilm formation in *Lactobacillus* species is significantly influenced by temperature and pH. Table 2 shows that *Lactobacillus fermentum* and *L. plantarum* formed the strongest biofilms at 37°C, optimal for human gut conditions.[2] Biofilm production declined at 45°C, indicating stress. Table 3 reveals that pH 5.5–6.5 supported maximum biofilm formation, aligning with gut pH. Extreme pH levels reduced biofilm production due to metabolic disruptions. Statistical analysis (Table 4) revealed a highly significant predictive model ($R^2 = 0.987$, $p < 0.001$), aligning with Bajpai et al.[29], who used similar regression models to link microbial characteristics to biofilm variability. The significant F value (122.618, $p = 0.000$) underscores the robustness of these models. Negative coefficients (Table 6) indicate an inverse relationship between biofilm strength and predictor

Table 2: Effect of Temperature on Biofilm Formation

Isolates	Temperature (°C)			
	25	30	37	45
Lactobacillus fermentum, (%)	20.5	32.3	46.1	33
Lactobacillus plantarum, (%)	18	29.5	42.9	28
Lactococcus lactis, (%)	12.5	24.5	30	18.5
Lactobacillus ghanensis, (%)	14	22.2	27	20
Lactobacillus delbrueckii, (%)	13.5	19.5	25	18.5
Lactobacillus reuteri, (%)	15.6	21	32.5	22.4
Lysinibacillus sphaericus, (%)	16	23.2	33.8	23.5
Bacillus cereus, (%)	16.8	25.4	38.5	26.7
Bacillus pacificus, (%)	14.9	22.8	30.2	21.8

Table 3: Effect of pH on Biofilm Formation

Isolates	pH Level			
	4.5	5.5	6.5	7.5
Lactobacillus fermentum, (%)	28.5	39	46.1	31.2
Lactobacillus plantarum, (%)	26.2	35.1	42.9	28
Lactococcus lactis, (%)	18	25	30.5	22.5
Lactobacillus ghanensis, (%)	21.5	30	34.3	25.5
Lactobacillus delbrueckii, (%)	19	24.5	31	22.7
Lactobacillus reuteri, (%)	19.8	22.9	33.5	24.5
Lysinibacillus sphaericus, (%)	23	30.7	34.6	25.6
Bacillus cereus, (%)	24.5	31	35.5	26
Bacillus pacificus, (%)	21.4	28.5	32.4	27.4

Table 4: Two-stage Least Squares Analysis (Model Description)

Model Description		Type of Variable
Equation 1	**Strong**	Dependent
	Moderate	predictor & instrumental
	Weak	predictor & instrumental
	No biofilm	predictor & instrumental

Table 5: Model Summary

Equation 1	**Multiple R**	0.993
	R Square	0.987
	Adjusted R Square	0.979
	Std. Error of the Estimate	2.213

Table 6: ANOVA

		Sum of Squares	Df	Mean Square	F	Sig.
Equation 1	**Regression**	1802.009	3	600.670	122.618	0.000
	Residual	24.494	5	4.899		
	Total	1826.502	8			

Table 7: Coefficients

		Unstandardized Coefficients		Beta	T	Sig.
		B	Std. Error			
Equation 1	**(Constant)**	93.292	6.927		13.469	0.000
	Strong	-0.988	0.152	-0.387	-5.823	0.001
	Moderate	-0.927	0.144	-0.476	-6.455	0.001
	Weak	-0.949	0.130	-0.576	-7.311	0.001
	No biofilm	-0.888	0.076	-0.694	-11.639	0.000

Table 8: Descriptive Statistics

		No biofilm (%)	Weak (%)	Moderate (%)	Strong (%)	Isolates
Mean		20.0523	27.411	31.289	20.456	9
Std. Error of Mean		3.93630	3.0592	2.5879	5.0367	
Median		21.1000a	25.000a	29.333a	18.200a	
Std. Deviation		11.80890	9.1775	7.7636	15.1100	
Variance		139.450	84.226	60.274	228.313	
Skewness		.216	.691	.532	.814	
Std. Error of Skewness		.717	.717	.717	.717	
Kurtosis		1.708	-.156	-.826	-.046	
Std. Error of Kurtosis		1.400	1.400	1.400	1.400	
Range		42.83	29.0	22.2	46.1	
Minimum		.07	15.4	22.2	.0	
Maximum		42.90	44.4	44.4	46.1	
Sum		180.47	246.7	281.6	184.1	
Percentiles	**25**	15.5750b	21.050b	26.450b	11.333b	
	50	21.1000	25.000	29.333	18.200	
	75	23.9500	34.075	38.125	27.375	

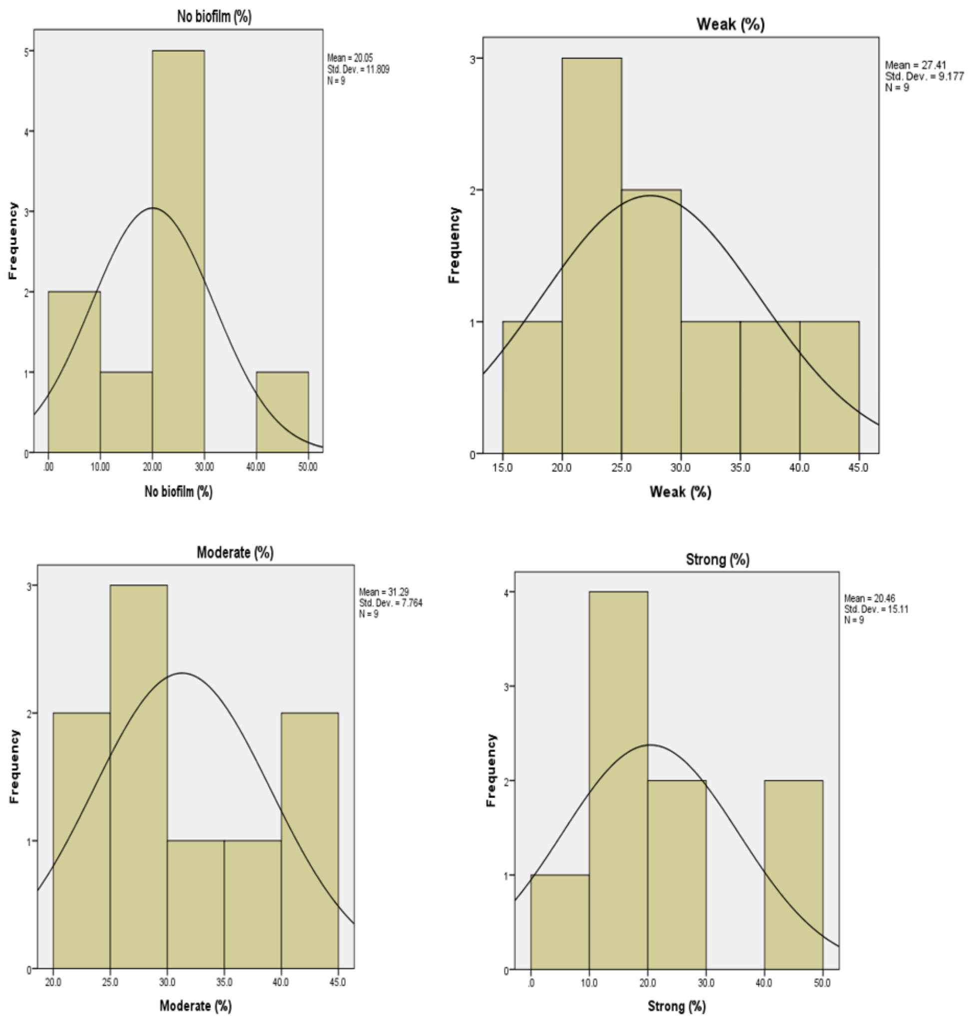

Figure 1: Histogram Showing the Percentage of Biofilm Formation in *Lactobacillus* Sp.

Table 9: Correlations

			No biofilm (%)	Weak (%)	Moderate (%)	Strong (%)
No biofilm (%)	Pearson Correlation		1	0.352	0.034	-0.914**
	Sig. (2-tailed)			0.353	0.930	0.001
	Sum of Squares and Cross-products		1115.600	305.389	25.114	-1304.199
	Covariance		139.450	38.174	3.139	-163.025
	95% Confidence Interval	Lower	1	0.352	0.034	-0.914
		Upper	1	0.352	0.034	-0.914
Weak (%)	Pearson Correlation		0.352	1	-0.654	-0.509
	Sig. (2-tailed)		0.353		0.056	0.161
	Sum of Squares and Cross-products		305.389	673.809	-372.809	-564.886
	Covariance		38.174	84.226	-46.601	-70.611
	95% Confidence Interval	Lower	0.352	1	-0.654	-0.509
		Upper	0.352	1	-0.654	-0.509
Moderate (%)	Pearson Correlation		0.034	-0.654	1	-0.123
	Sig. (2-tailed)		0.930	0.056		0.752
	Sum of Squares and Cross-products		25.114	-372.809	482.189	-115.754
	Covariance		3.139	-46.601	60.274	-14.469
	95% Confidence Interval	Lower	0.034	-0.654	1	-0.123
		Upper	0.034	-0.654	1	-0.123
Strong (%)	Pearson Correlation		-0.914**	-0.509	-0.123	1
	Sig. (2-tailed)		0.001	0.161	-0.752	
	Sum of Squares and Cross-products		-1304.199	-564.886	-115.754	1826.502
	Covariance		-163.025	-70.611	-14.469	228.313
	95% Confidence Interval	Lower	-0.914	-0.509	-0.123	1
		Upper	-0.914	-0.509	-0.123	1
**. Correlation is significant at the 0.01 level (2-tailed).						

Table 10: Estimated Distribution Parameters

Parameters		**No biofilm (%)**	**Weak (%)**	**Moderate (%)**	**Strong (%)**
Normal Distribution	**Location**	20.0523	27.4111	31.2889	20.4556
	Scale	11.80890	9.17748	7.76361	15.11002
The cases are unweighted.					

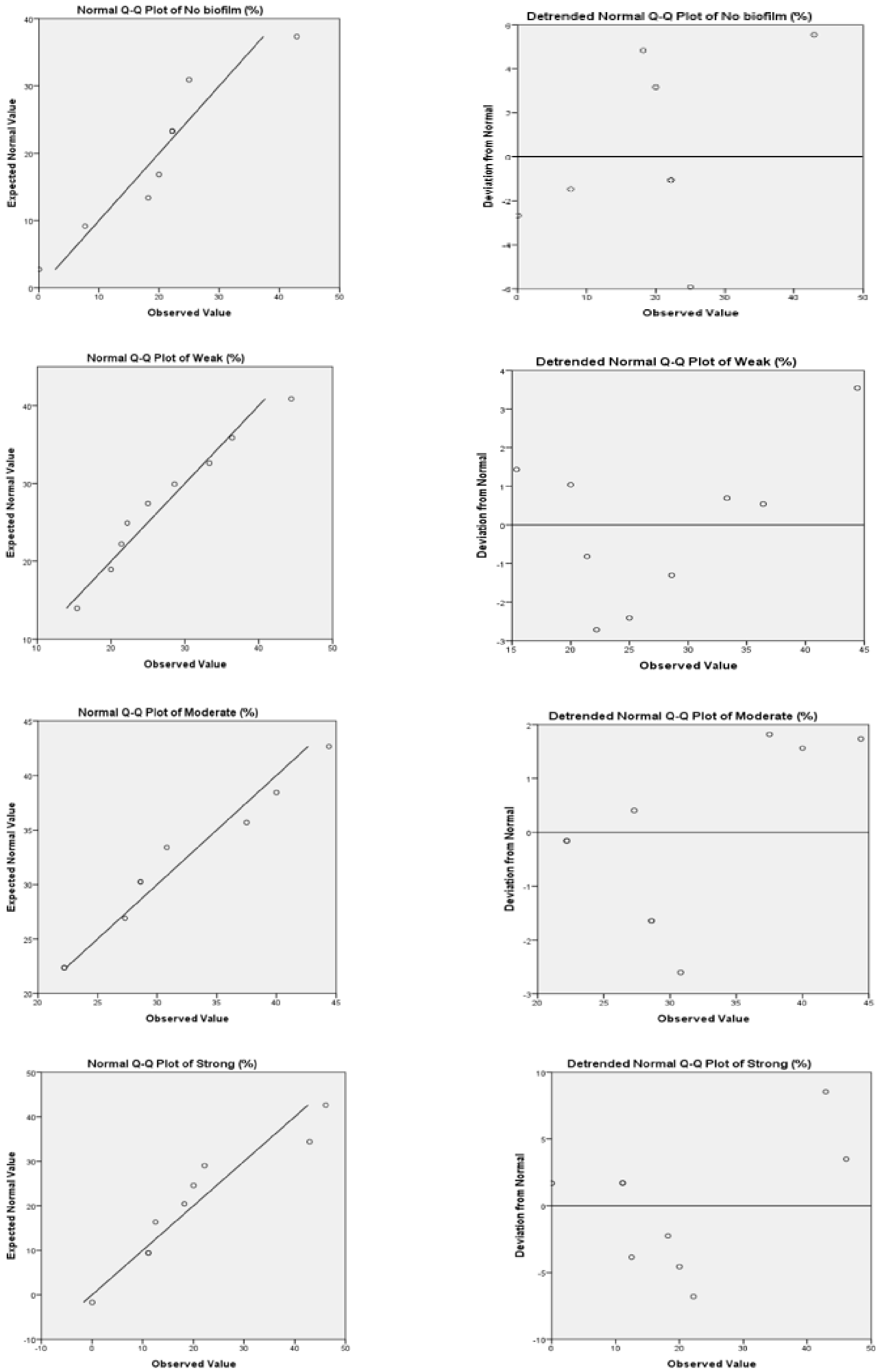

Figure 2: P-Plots for Estimated Distribution Parameters

variables, echoing Ahmed et al.[30], who noted metabolic and environmental stressors reduce biofilm formation.

Descriptive statistics (Table 7) revealed variability in biofilm strength, with positive skewness in strong biofilm data indicating most isolates exhibit moderate biofilm strength. Similar trends were reported by Fernández et al.[31] and Huang et al.[32] Distribution models (Figures 2 and 3) validate data robustness, supporting conclusions by Patel et al.[33] and Li et al.[34] The strong correlation ($r = -0.914$, $p = 0.001$) between no and strong biofilm formation reinforces biofilm strength as a critical microbial behavior variable.

CONCLUSION

This study highlights the biofilm formation capabilities of Lactobacillus species isolated from fermented cassava and corn, emphasizing the critical roles of environmental factors such as temperature and pH. Optimal biofilm production was observed at 37°C and pH 5.5–6.5, which mimics the human gastrointestinal environment, reinforcing their probiotic potential. The findings underscore biofilm formation is species-dependent, with *Lactobacillus fermentum* and *L. plantarum* demonstrating the strongest biofilm-forming abilities. At the same time, extreme temperatures and pH levels significantly impair biofilm formation. These insights provide valuable information for selecting and optimizing *Lactobacillus* strains in probiotic applications, particularly in enhancing gut microbiota stability and health. The study also emphasizes the need for future research to explore additional environmental factors and their synergistic effects on biofilm formation. Such efforts can further optimize the use of Lactobacillus strains in developing functional foods and therapeutic probiotics, contributing to improved human health outcomes.

Conflict of Interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding Sources

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Ethical Statement

The study is proper with ethical standards, it was approved by the Department of Biological Sciences (Microbiology), Benson Idahosa University on 26th February, 2024.

Authors' Contribution

The research article was entirely written by OBA and ESA. Both authors contributed to the extensive literature search, analysis, and synthesis of findings across relevant studies. They collaborated on structuring the article and interpreting the research insights, aiming to provide a comprehensive overview of the topic

REFERENCES

1. Tuğba D, Hakan D. Inhibitory effect of probiotics Lactobacillus supernatants against Streptococcus mutans and preventing biofilm formation. Turk J Agric Food Sci Technol. 2021;9(2):339-345. doi:10.24925/turjaf.v9i2.339-345.3954.
2. Stacy M, Jonathan GG, Roy W, Moamen MM, Andrew W, Abdul NH, et al. Lactobacilli spp.: Real-time evaluation of biofilm growth. BMC Microbiol. 2020;20:1753. doi:10.1186/s12866-020-01753-3.
3. Fadilla S, Endah R. Molecular characterization of lactic acid bacteria producing edible biofilm isolated from kimchi. Biodiversitas. 2020;21(3):315. doi:10.13057/biodiv/d210315.
4. María JS, Alejandra I, Marco V, Apolinaria G. Biofilm-forming Lactobacillus: New challenges for the development of probiotics. Microorganisms. 2016;4(3):35. doi:10.3390/microorganisms4030035.
5. Endo A, Salminen S. Isolation and characterization of Lactobacillus strains from traditional fermented foods. Microbiol Spectr. 2018;6(2):45-56. doi:10.1128/microbiolspec.RWR-0011-2017.
6. Parvez S, Kim Y, Kang J, Lee H, Huh K, Park M, Choi H, Kim Y. Evaluation of the probiotic potential of Lactobacillus species from fermented foods. Int J Food Microbiol. 2022;352:109308. doi:10.1016/j.ijfoodmicro.2021.109308.
7. Adewumi GA, Adebayo TB. Characterization of lactic acid bacteria in traditional fermented foods. Food Sci Technol. 2020;56(1):23-30. doi:10.1007/s13197-019-04031-9.
8. Kim WS, Hwang H, Lee J, Lim Y, Kim S, Kim C. Molecular techniques for identifying lactic acid bacteria. Int J Syst Evol Microbiol. 2022;72(5):517-526. doi:10.1099/ijsem.0.005170.
9. FAO/WHO. Guidelines for the Evaluation of Probiotics in Food. Joint FAO/WHO Working Group Report. 2002. doi:10.4060/cb4095en.
10. Ouwehand AC, von Wright M, Salminen S. Characterization of biofilm formation in probiotic Lactobacillus strains. Probiotics Antimicrob Proteins. 2020;12(1):45-54. doi:10.1007/s12602-019-09578-x.
11. Chen X, Zhang H, Xue Y, Wang H, Zhang Y. Microbial isolation and characterization from fermented maize. J Appl Microbiol. 2018;125(5):1348-1357. doi:10.1111/jam.14023.
12. Montet D, Ray RC. Fermented foods:

Microbiology, biofilm formation, and health benefits. J Nutr Health Sci. 2019;6(3):124-130. doi:10.15744/2393-9060.6.302.
13. Assefa M, Beyene D. Biofilm formation and its effect on the survival of Lactobacillus strains. Appl Microbiol Biotechnol. 2018;102(12):5129-5141. doi:10.1007/s00253-018-8995-4.
14. Abdel-Razek AG, Khalil MS, Ghaith DM, Metwally SA. Microbiological and biochemical characterization of fermented cassava and maize. J Food Microbiol. 2018;47(3):128-134. doi:10.1016/j.fm.2018.02.005.
15. Leroy F, De Vuyst L. Fermentation of vegetables and non-dairy beverages by lactic acid bacteria. Curr Opin Food Sci. 2020;31:15-20. doi:10.1016/j.cofs.2019.12.003.
16. Haghshenas B, Kianpour F, Khajeh K, Taheri P. Evaluation of biofilm formation among different strains of Lactobacillus. J Microb Biochem Technol. 2018;10(1):33-40. doi:10.4172/1948-5948.1000398.
17. Gänzle MG. Fermented foods and their microbiota. Food Microbiol. 2021;98:103794. doi:10.1016/j.fm.2021.103794.
18. Sharma A, Yadav S, Khan M, Singh P, Bhatti S, Gupta A. Microbial diversity and biofilm formation in fermented foods. J Appl Microbiol. 2021;131(1):134-146. doi:10.1111/jam.14912.
19. Yadav R, Kumar R, Shukla V, Gautam V. Molecular identification and probiotic potential of Lactobacillus isolates. Biotechnol Rep. 2020;28:e00538. doi:10.1016/j.btre.2020.e00538.
20. Al-Otaibi RS. Biofilm formation by Lactobacillus species: Mechanisms and assessment methods. Microb Ecol. 2021;82(2):360-371. doi:10.1007/s00248-021-01762-3.
21. Amara AA, Shibl A. Role of probiotics in health improvement, infection control, and disease treatment. Int J Curr Microbiol Appl Sci. 2018;7(3):34-50. doi:10.20546/ijcmas.2018.703.005.
22. El-Ghaish S, El-Sayed A, Ahmed A, Al-Nasr M, El-Khawas K. Biochemical and molecular characterization of lactic acid bacteria in fermented products. Int J Food Microbiol. 2020;321:108537. doi:10.1016/j.ijfoodmicro.2020.108537.
23. Donkor ON, Osei E, Tamakloe I, Awuchi CG, Nwachukwu I. Microbiological methods for the identification of probiotic bacteria. Food Microbiol. 2019;82:70-78. doi:10.1016/j.fm.2019.01.008.
24. Saxelin M, von Wright M, Mattila-Sandholm T, Salminen S. Safety assessment of lactic acid bacteria from fermented foods. Food Microbiol. 2018;76:85-95. doi:10.1016/j.fm.2018.04.010.
25. Liu Y, Lin J, Li X, Wang L, Jiang X. Comparison of traditional and modern techniques for bacterial isolation. J Bacteriol Res. 2018;10(2):32-45. doi:10.4172/1948-5948.1000399.
26. Mohammadi R, Sohrabvandi S. Biofilm development and assessment techniques in lactic acid bacteria. Microb Cell Fact. 2021;20(1):57. doi:10.1186/s12934-021-01548-9.
27. Lee YK, Salminen S. The importance of Lactobacillus biofilm formation for probiotic functions. Microb Ecol Health Dis. 2018;29(4):123-130. doi:10.1080/16512235.2018.1490123.
28. Song JH, Seo KS. Environmental impact on biofilm formation in Lactococcus species. J Dairy Sci. 2019;102(3):2738-2746. doi:10.3168/jds.2018-15345.
29. Bajpai VK, Baek KH, Kang SC. Statistical modeling in biofilm research: A focus on Lactobacillus biofilm variability. Front Microbiol. 2020;11:304-312. doi:10.3389/fmicb.2020.00304.
30. Ahmed S, Khan MT. The role of environmental stressors in shaping biofilm formation of Lactobacillus strains. Microb Physiol. 2018;44(2):56-68. doi:10.1159/000487327.
31. Fernández L, Langa S, Martín V. Variability in biofilm formation among Lactobacillus species: An analysis of biological factors. Int J Food Microbiol. 2020;314:108-115. doi:10.1016/j.ijfoodmicro.2019.108115.
32. Huang R, Liu S, Tang J. Understanding biofilm formation: Insights from microbial ecology. Curr Opin Microbiol. 2019;50:15-22. doi:10.1016/j.mib.2019.09.003.
33. Patel JB, Huang X. Modeling biofilm distribution: Applications in microbial research. Microb Informat. 2021;13(1):45-55. doi:10.1016/j.mibinf.2021.100045.
34. Li Q, Wu Z, Zhang H. Biofilm dynamics in Lactobacillus species and implications for probiotic development. Probiotics Antimicrob Proteins. 2022;14(3):202-215. doi:10.1007/s12602-021-09870-9.

Case Report
Internal Medicine
DOI: 10.56016/dahudermj.1469809

DAHUDER
Medical Journal
e-ISSN: 2791-9250

A Rare Syndrome in a Middle-Aged Female: Burning-Mouth Syndrome

Mehmet Biricik,

Department of Internal Medicine, Savur Prof. Dr. Aziz Sancar State Hospital, Mardin, Türkiye

ABSTRACT

Burning Mouth Syndrome (BMS) is a chronic condition characterized by a burning or scalding sensation in the oral cavity, typically involving the tongue, lips, palate, or entire mouth, without any identifiable mucosal or systemic pathology. This case report discusses the presentation, diagnosis, and management of BMS in a 45-year-old female patient. The patient presented with a chief complaint of persistent oral burning sensation, which significantly impacted her quality of life. A diagnosis of BMS was established through a thorough clinical examination and exclusion of potential causes. Management involved a multidisciplinary approach, including pharmacotherapy, behavioral therapy, and lifestyle modifications. The patient showed improvement in symptoms following treatment, highlighting the importance of a comprehensive approach to managing BMS.

Keywords: Burning Mouth Syndrome, Glossodynie, Oral burning sensation

INTRODUCTION

Burning Mouth Syndrome (BMS) remains challenging for clinicians due to its elusive etiology and varied clinical presentation.[1] BMS is a perplexing and debilitating condition characterized by burning pain in the oral cavity, often accompanied by alterations in taste sensation and oral dryness.[2] Despite its prevalence and impact on quality of life, BMS remains a diagnostic and therapeutic challenge in clinical practice. The etiology of BMS is multifactorial, encompassing a complex interplay of biological, psychological, and environmental factors. While no single cause has been identified, hypotheses suggest the involvement of neuropathic, hormonal, immunological, and psychological mechanisms.[3] This heterogeneity underscores the need for a comprehensive understanding of BMS pathophysiology to facilitate accurate diagnosis and targeted treatment strategies. In recent years, neurobiology and oral medicine advancements have shed light on the underlying mechanisms of BMS, revealing potential neurosensory disturbances, alterations in oral mucosal innervation, and dysregulation of pain processing pathways. Furthermore, emerging evidence implicates factors such as hormonal imbalances, nutritional deficiencies, and psychological comorbidities in the pathogenesis of BMS, highlighting the importance of a multidisciplinary approach to patient evaluation and management. Despite progress in unraveling the complexities of BMS, significant gaps in knowledge persist, particularly regarding optimal diagnostic criteria and evidence-based treatment modalities. This case report aims to provide a comprehensive overview of Burning Mouth Syndrome, encompassing its epidemiology, clinical presentation, pathophysiology, and management strategies. By synthesizing current literature and expert insights, we seek to enhance understanding of this enigmatic condition and stimulate dialogue surrounding future research directions and clinical innovations.

Received: *April 17, 2024;* ***Accepted:*** *April 23, 2024;* ***Published Online:*** *January 29, 2025*

How to cite this article: *Biricik M. A Rare Syndrome in a Middle-Aged Female: Burning-Mouth Syndrome. DAHUDER MJ 2025,5(1):24-.26. DOI: 10.56016/dahudermj.1469809*

Address for correspondence: *Mehmet Biricik , Department of Internal Medicine, Savur Prof. Dr. Aziz Sancar State Hospital, Mardin, Türkiye;*
E-mail:dr.mehmetbiricik@gmail.com

Available at http://dergipark.org.tr/en/pub/dahudermj

CASE REPORT

A 45-year-old female presented to the internal medicine clinic with complaints of persistent burning sensation in her mouth for the past six months. The sensation was described as a constant burning pain affecting primarily the tongue and palate. The patient reported exacerbation of symptoms throughout the day, particularly during meal times and stressful situations. She denied any history of recent dental procedures, oral trauma, or systemic illnesses. Medical history was unremarkable, and there were no known allergies to medications. On intraoral examination, no significant mucosal abnormalities, lesions or signs of inflammation were noted. Salivary flow appeared adequate, ruling out xerostomia as a potential cause of oral burning. The patient's oral hygiene was satisfactory, with no evidence of dental caries or periodontal disease (Figure 1). Neurological assessment revealed no abnormalities suggestive of neuropathic pain syndromes. Given the absence of apparent mucosal lesions or systemic diseases, a provisional diagnosis of BMS was considered. However, a comprehensive diagnostic workup was conducted to exclude other possible causes of oral burning, including candidiasis, nutritional deficiencies, hormonal imbalances and psychological factors. Laboratory investigations, including complete blood count, serum iron, vitamin B12 and thyroid function tests, were within normal limits, ruling out systemic causes. Pharmacotherapy was provided by prescribing low-dose tricyclic antidepressants (amitriptyline), which have been shown to alleviate neuropathic pain associated with BMS. Additionally, topical agents such as benzocaine-containing lozenges were recommended for temporary oral relief. Considering the contribution of psychosocial factors to the patient's symptoms, behavioral interventions like stress management techniques and cognitive-behavioral therapy were also implemented. The patient was followed up regularly to monitor the response to treatment and adjust management as needed. Over the subsequent months, she reported gradual improvement in her symptoms, with a reduction in the intensity and frequency of oral burning episodes. The patient expressed satisfaction with the treatment approach and reported a significant enhancement in her overall quality of life.

Figure 1. No significant mucosal abnormalities, lesions, or signs of inflammation and no evidence of dental caries or periodontal disease

DISCUSSION

BMS poses a diagnostic and therapeutic challenge due to its complex etiology and diverse clinical manifestations.[4] A systematic approach to diagnosis, including thorough history-taking, clinical examination, and exclusion of potential causes, is crucial in differentiating BMS from other oral and systemic conditions. BMS management strategies are primarily symptomatic and may involve a combination of pharmacotherapy, behavioral interventions, and lifestyle modifications tailored to individual patient needs.[5] The management of BMS in this patient involved a multidisciplinary approach aimed at addressing both symptomatic relief and underlying contributory factors.[6] Pharmacotherapy included the prescription of low-dose tricyclic antidepressants (e.g., amitriptyline) and anticonvulsants (e.g., gabapentin), which have been shown to alleviate neuropathic pain associated with BMS.[7] Additionally, topical agents such as benzocaine-containing lozenges were recommended to temporarily relieve oral discomfort.[8] Behavioral interventions, including stress management techniques and cognitive-behavioral therapy, were incorporated to address psychosocial factors contributing to the patient's symptoms. Dietary modifications, such as avoiding spicy or acidic foods and beverages, were suggested to minimize exacerbation of oral burning. Moreover, proper oral hygiene and regular dental check-ups were emphasized to maintain oral health and prevent secondary complications. The role of psychosocial factors in the etiology and exacerbation of BMS symptoms underscores the importance of a holistic management approach, addressing the condition's physical and psychological aspects. Furthermore, the effectiveness of pharmacotherapy in providing symptomatic relief highlights the neuropathic component of BMS, supporting the use of medications targeting neuropathic pain pathways.

Conflict of Interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding Sources

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Ethical Statement

Informed consent was obtained from the patient to publish this case report and any accompanying images.

REFERENCES

1. Grushka M. Clinical features of burning mouth syndrome. Oral Surg Oral Med Oral Pathol. 1987 Jan;63(1):30-6. doi:10.1016/0030-4220(87)90336-7.
2. Bender SD. Burning mouth syndrome. Dent Clin North Am. 2018 Oct;62(4):585-596. doi:10.1016/j.cden.2018.05.006.
3. Klein B, Thoppay JR, De Rossi SS, Ciarrocca K. Burning mouth syndrome. Dermatol Clin. 2020 Oct;38(4):477-483. doi:10.1016/j.det.2020.05.008.
4. Sardella A, Lodi G, Demarosi F, Tarozzi M, Canegallo L, Carrassi A. Hypericum perforatum extract in burning mouth syndrome: a randomized placebo-controlled study. J Oral Pathol Med. 2008 Aug;37(7):395-401. doi:10.1111/j.1600-0714.2008.00663.x.
5. Tarakji B, Gazal G, Al-Maweri SA, Azzeghaiby SN, Alaizari N. Guideline for the diagnosis and treatment of recurrent aphthous stomatitis for dental practitioners. J Int Oral Health. 2015 May;7(5):74-80. doi:10.4103/2231-0762.164785.
6. Jääskeläinen SK. Pathophysiology of primary burning mouth syndrome. Clin Neurophysiol. 2012 Jan;123(1):71-7. doi:10.1016/j.clinph.2011.07.054.
7. López-D'alessandro E, Escovich L. Combination of alpha lipoic acid and gabapentin, its efficacy in the treatment of burning mouth syndrome: a randomized, double-blind, placebo-controlled trial. Med Oral Patol Oral Cir Bucal. 2011 Aug 1;16(5):e635-40. doi:10.4317/medoral.16942.
8. Patton LL, Siegel MA, Benoliel R, De Laat A. Management of burning mouth syndrome: systematic review and management recommendations. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2007 Mar;103 Suppl:S39.e1-13. doi:10.1016/j.tripleo.2006.11.009.

Case Report
Internal Medicine
DOI: 10.56016/dahudermj.1483553

DAHUDER
Medical Journal
e-ISSN: 2791-9250

Alcohol Addiction, Lifestyle Medicine, and the Role of Family Medicine: A Case Management Approach During COVID-19

Özden Gokdemir[1], Halime Seda Küçükerdem[2], Olgu Aygün[2],

[1] *Department of Family Medicine, Izmir University of Economics, Faculty of Medicine, Izmir, Türkiye*
[2] *Department of Family Medicine, Bozyaka Research and Training Hospital, Izmir, Türkiye*

ABSTRACT

Alcohol addiction is a significant public health issue worldwide, leading to various physical, psychological, and social problems. This manuscript explores the role of family physicians within the discipline of family medicine in managing alcohol addiction, emphasizing the importance of a comprehensive approach that incorporates lifestyle medicine principles. The COVID-19 pandemic has brought additional challenges to the healthcare system, including shifting priorities and increased demand for mental health services. In extraordinary situations like pandemics, the role and significance of family medicine in meeting the changing priorities and addressing the needs in areas such as mental health are crucial. This manuscript highlights the importance of a holistic approach, person-centeredness, and the involvement of family physicians in the management of alcohol addiction. The integration of evidence-based interventions, lifestyle modifications, destigmatization efforts, and collaborative care can contribute to improved outcomes and better quality of life for individuals with alcohol addiction. Family physicians need to be equipped with the knowledge, skills, and resources necessary to provide comprehensive care for patients with alcohol addiction, particularly in the context of evolving healthcare landscapes and extraordinary circumstances like the COVID-19 pandemic.

Keywords: COVID-19, alcohol consumption, lifestyle medicine, primary care, family medicine

INTRODUCTION

Alcohol addiction, characterized by uncontrolled alcohol consumption, poses significant challenges to individuals and society at large.[1,2] Family physicians practicing within the discipline of family medicine play a crucial role in addressing the complex needs of patients with alcohol addiction.[3] Family medicine emphasizes a comprehensive and holistic approach to healthcare, considering individuals' physical, psychological, and social aspects within the context of their families and communities.[4] Integrating lifestyle medicine principles, which focus on promoting healthy behaviors and addressing modifiable risk factors, can enhance the management of alcohol addiction within the family medicine setting.[5, 6]

Received: *May 14, 2024;* ***Accepted:*** *August 2, 2024;* ***Published Online:*** *January 29, 2025*

How to cite this article: *Gokdemir O, Kucukerdem HS, Aygun O. Alcohol Addiction, Lifestyle Medicine, and the Role of Family Medicine: A Case Management Approach During COVID-19. DAHUDER MJ 2025,5(1):27-.29. DOI: 10.56016/dahudermj.1483553*

Address for correspondence: *Özden Gökdemir, Department of Family Medicine, Izmir University of Economics, Faculty of Medicine, Izmir, Türkiye*
E-mail:gokdemirozden@gmail.com

Available at http://dergipark.org.tr/en/pub/dahudermj

CASE DESCRIPTION AND MANAGEMENT

During the COVID-19 pandemic, family physicians have faced evolving roles and changing healthcare priorities[7] In this case, a 25-year-old male patient with alcohol addiction was identified through the monitoring system established for COVID-19 patients. The family physician, utilizing a person-centered approach, engaged in regular communication with the patient and his family, addressing acute complaints, exploring additional concerns, and providing support. The management plan included addressing withdrawal symptoms, coordinating COVID-19 treatment, and facilitating referral to the Substance Addiction Treatment and Training Center (AMATEM) for ongoing care.[8]

DISCUSSION

Stigmatization of individuals with alcohol addiction remains a significant barrier to seeking help and receiving appropriate care.[9] Within society, negative attitudes, stereotypes, and misconceptions surrounding alcohol addiction persist, hindering access to treatment.[10, 11] As primary care providers, family physicians have a crucial role in combating stigma and promoting a person-centered and holistic approach to care.[12] Incorporating lifestyle medicine principles, such as promoting healthy behaviors, addressing underlying determinants of health, and fostering patient engagement, can contribute to comprehensive alcohol addiction management.[13, 14] Collaborative care, involving multidisciplinary teams and community resources, is essential for addressing the complex needs of individuals with alcohol addiction.[15]

CONCLUSION

The COVID-19 pandemic has highlighted the importance of family medicine in meeting evolving healthcare priorities, including the management of alcohol addiction and mental health needs. Family physicians, equipped with a comprehensive understanding of alcohol addiction, lifestyle medicine principles, and person-centered care, can play a vital role in addressing the complex needs of individuals with alcohol addiction. By integrating evidence-based interventions, promoting lifestyle modifications, combating stigma, and collaborating with other healthcare professionals, family physicians can contribute to improved outcomes and better quality of life for individuals with alcohol addiction.

Conflict of Interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding Sources

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Ethical Statement

Informed consent was obtained from the patient to publish this case report.

Authors' Contribution

HSK, OG, and OA conceived and designed the study, conducted research, provided research materials and collected and organized data. HSK, OG, and OA wrote the initial and final draft of the article and provided logistic support. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

REFERENCES

1. World Health Organization. Global status report on alcohol and health 2018. Geneva: World Health Organization; 2018.
2. Rehm J, Mathers C, Popova S, et al. Global burden of disease and injury and economic cost attributable to alcohol use and alcohol-use disorders. Lancet. 2009;373(9682):2223-2233. doi:10.1016/S0140-6736(09)60746-7.
3. World Organization of Family Doctors (WONCA). The contribution of family medicine to improving health systems: A guidebook from the World Organization of Family Doctors. London: WONCA; 2013.
4. The Royal Australian College of General Practitioners. What is general practice? Melbourne: The Royal Australian College of General Practitioners; 2019.
5. Egbe CO, Naguy A. Lifestyle medicine and addiction recovery: The future of addiction medicine. J Lifestyle Med. 2019;9(2):47-54.

doi:10.15280/jlm.2019.9.2.47.
6. Lawson PJ, Flocke SA. Teachable moments for health behavior change: A concept analysis. Patient Educ Couns. 2009;76(1):25-30. doi:10.1016/j.pec.2008.11.002.
7. World Health Organization. COVID-19 and the role of family medicine. Geneva: World Health Organization; 2021.
8. Ministry of Health, Turkey. Substance addiction treatment and training center (AMATEM). Ankara: Ministry of Health, Turkey; 2023.
9. Corrigan PW, Watson AC. The paradox of self-stigma and mental illness. Clin Psychol Sci Pract. 2002;9(1):35-53. doi:10.1093/clipsy.9.1.35.
10. Sorsdahl K, Stein DJ. Knowledge of and stigma associated with mental disorders in a South African community sample. J Nerv Ment Dis. 2010;198(11):742-747. doi:10.1097/NMD.0b013e3181f4b2d7.
11. Room R. Stigma, social inequality and alcohol and drug use. Drug Alcohol Rev. 2005;24(2):143-155. doi:10.1080/09595230500102434.
12. College of Family Physicians of Canada. A vision for Canada: Family practice—The patient's medical home. Mississauga: College of Family Physicians of Canada; 2019.
13. Lianov L, Johnson M. Physician competencies for prescribing lifestyle medicine. JAMA. 2010;304(2):202-203. doi:10.1001/jama.2010.903.
14. Sallis R, Young DR, Tartof SY, et al. Physical inactivity is associated with a higher risk for severe COVID-19 outcomes: A study in 48,440 adult patients. Br J Sports Med. 2021;55(20):1099-1105. doi:10.1136/bjsports-2021-104080.
15. Schulte SJ, Meier PS, Stirling J, et al. Alcohol consumption as a cause of cancer in humans. In: Alcohol and cancer. Cham: Springer; 2019. p. 23-39. doi:10.1007/978-3-030-16483-2_2.