p-ISSN 2301-9123 | e-ISSN 2460-5441

Global Medical and Health Communication

Published by:
UPT Publikasi Ilmiah
Universitas Islam Bandung

APR 2024 VOL. 12 NO. 1

Global Medical and Health Communication

Editorial Team

Editorial Address
Jalan Hariangbanga No. 2, Tamansari, Bandung 40116, West Java, Indonesia
Phone/fax: (022) 4321213
E-mail: gmhc.unisba@gmail.com
Website: https://ejournal.unisba.ac.id/index.php/gmhc

Accredited by:
Ministry of Research, Technology and Higher Education of the Republic of Indonesia (Kemenristekdikti) Number: 30/E/KPT/2019, 11th November 2019

This journal is indexed on:

Managed by:
Faculty of Medicine, Universitas Islam Bandung

Published by:
UPT Publikasi Ilmiah Universitas Islam Bandung

Publish Every 4 Months
April, August, December

Global Medical and Health Communication

pISSN 2301-9123 | eISSN 2460-5441

Volume 12 Number 1, April 2024

TABLE OF CONTENTS

RESEARCH ARTICLES

AUTHOR GUIDELINES

Global Medical and Health Communication is a journal that publishes medical and health scientific articles published every 4 (four) months. Articles are original research that needs to be disseminated and written in English.

The submitted manuscript must be an article that has never been published, and the author must ensure that all co-authors have agreed by signing a statement on the seal. For original research, we accept the study which is last then 7 (seven) years when the manuscript is submitted. The manuscript is an original article free from plagiarism. When the article is published in another journal then in the next journal, the article will be disallowed.

All articles will be discussed by experts in the field of scholarly concern (peer reviewer) and will be edited by the editor. The editor reserves the right to add or subtract sentences, both abstracts, and scripts without changing the meaning. Manuscripts that are accepted for publication will become the property of the publisher. It is not allowed to be published in other media. The needed revised manuscripts will be returned to the author. Research articles must be approved by the health research ethics committee or consider the ethical aspects of research accounted for.

Article Writing

Typed the article in Microsoft Word format with paper size A4 (21.0×29.7 cm), 4 cm left and top margin, 3 cm down and right, not back and forth. The font is black Georgia with 12 pt size, typed justified except for a title with a spacing of two spaces. Typing a new paragraph 6 taps from the left edge of the line, unless the first paragraph is not typed indented. In one manuscript only in English. Typed italic the untranslatable terms in a foreign language or regional language. It is recommended to use a professional translator who understands the health field or software such as Grammarly in writing English manuscripts. The maximum script length is 20 pages (including images, tables, and photos). Each page is numbered typed on the bottom right page, sequentially starting from the title page to the last page.

Table title is the typed center, font size 11 pt, bold, initial letter of each word written with a capital letter, except conjunctions. The titles are numbered and written on top of the table. Example: Table 3 *Neisseria gonorrhoeae* Resistance to 8 Types of Antimicrobials in 20 Specimens. Table, no vertical dividing line, and there are only three horizontal borderlines. Created tables in sequence two spaces from the text. Table descriptions and abbreviations are placed in the table description, not on the table title.

Typed center figure title with 11 pt font size, bold, numbered according to the appearance in the text and typed under the image. The source of the cited image and or table should be added to references if it is not the author's work.

Figures (graphs, diagrams, and photos) and tables besides being written in place, are also made separately on other text pages with sufficient sharpness and darkness. A maximum number of tables and or images are 6 (six) pieces. Figures are sent in black and white or colored format when required, uploaded to the Supplementary File(s) are in high-resolution jpeg, jpg, or png formats.

Write correspondence as to the footnote on the first page containing the full name of the author with degrees/academic degrees, institution, address, mobile phone, and e-mail.

Content and Format Articles

The article contains results of original research in the field of basic medical or applied, and health. The article format consists of Title, Introduction, Methods, Results, Discussion, Conclusion(s), Conflict of Interest, Acknowledgments, and References.

Articles Title

Maximum article title consists of 12 words (choose words and terms that are dense meaning and able to characterize the entire contents of the script). Typed with bold fonts, size 12 pt, one space, the initial letter of each word is written in capital letters (except the conjunctive), and center. The ownership row consists of 2 elements, the author name and origin institution. The author's name written with the initial fonts is capital and bold, size 11 pt, one space, and center. Institution name written with the initial fonts is capital, size 10 pt, one space, and center.

Abstract

The abstract is typed using 12 pt font size and one space. The abstract is written in one paragraph, one space, a maximum of 250 words, and should describe the entire contents of the article. The abstract should be suitable for the format of introduction, methods (contain method, place, and time of the study), results, discussion, and conclusion. Abstract be equipped with keywords consisting of 3–5 words.

Introduction

The introduction begins with the general background of the study in a brief maximum of one paragraph. Then, load the State of the Art (a brief review of literature or previous studies, 1–2 paragraphs) to justify/strengthen the statement of novelty or significance or scientific contribution or originality of this article and try to have references to articles from journals of the last 10 years that strengthen the justification for originality or contributions.

Before writing the purpose of the study, there must be a clear and explicit Gap Analysis or statement of gaps (originality) or a statement of the contribution of novelty (novelty statement), or the unique difference of this research compared to previous studies, also in

terms of the importance of whether or not the research was conducted.

Methods
Methods contain the material under study, and the way described briefly by the order of operation as well as the location and time of the study. Explain statistical methods in detail. Consideration of ethical issues is included. If the protocol has been approved then the ethical clearance/approval letter number and the health research ethics committee must be written.

Results
The result is the core of scientific writing. This section presents data and information that will be used as the basis of the conclusion and is even expected to get a new theory. In results, listed the tables and or images, graphics, photos to explain and abbreviate the description should be given; numbered according to their appearance in the text. Results of the study and discussion should be written separately.

Discussion
Discussion of the article reveals, explains, and discusses the results of the study with an analysis by the research design, interpretation, and explanation of its synthesis. Also, the results obtained are compared with the results of previous research of others. Suggestions are also written here.

Conclusion(s)
The conclusion is submitted by the results obtained by the researcher and written briefly and clearly in two or three sentences in one paragraph.

Conflict of Interest
All authors must make a formal statement at the time of submission indicating any potential conflict of interest that might constitute an embarrassment to any of the authors if it were not to be declared and were to emerge after publication. Such conflicts might include but are not limited to, shareholding in or receipt of a grant or consultancy fee from a company whose product features in the submitted manuscript or which manufactures a competing product.

Acknowledgment
Acknowledgments should be provided to research contributors without writing a degree.

References
Authors are recommended to use reference management software for citation and reference writing, such as Mendeley and EndNote.

References are written by the Vancouver system's writing rules, given the sequence number corresponding to appearing in the article. List all author names if no more than six people; when more than six authors write the first six authors followed by et al. The references cited in the article are the most important references. The minimum referral number of 20 (twenty) and maximum of 30 (thirty) copies of the most recent 10 (ten) years of journal article/book publishing. Reference should be sought from 80% primary literature and 20% secondary literature. Avoid referral in the form of personal communication except for the information that is not possible from a public source. Include source name, date of communication, written permission, and confirmation of the accuracy of the source of communication.

Example How to Write References
Journals
Theodoridou K, Vasilopoulou VA, Katsiaflaka A, Theodoridou MN, Roka V, Rachiotis G, et al. Association of treatment for bacterial meningitis with the development of sequelae. Intern J Infect Dis. 2013;17(9):e707–13.
Zhang B, Kunde D, Tristram S. *Haemophilus haemolyticus* is infrequently misidentified as *Haemophilus influenzae* in diagnostic specimens in Australia. Diagn Microbiol Infect Dis. 2014;80(4): 272–3.

Books and Other Monographs
Editor as Author
Nriagu J, editor. Encyclopedia of environmental health. Michigan: Elsevier BV; 2011.

Organization as Author
World Health Organization. Guideline: neonatal vitamin A supplementation. Geneva: WHO Press; 2011.

Chapter in Book
Miller LG. Community-associated methicillin resistant *Staphylococcus aureus*. In: Weber JT, editor. Antimicrobial resistance. Beyond the breakpoint. Basel: Karger; 2010. p. 1–20.

Conference Proceeding
Nicholai T. Homeopathy. Proceedings of the Workshop Alternative Medicines; 2011 November 30; Brussels Belgium. Brussels: ENVI; 2011.

Journal Article from Internet
King P. *Haemophilus influenzae* and the lung (*Haemophilus* and the lung). Clin Transl Med. 2012;1:10 [cited 2015 August 15]. Available from: https://clintransmed.springeropen.com/articles/10.1186/2001-1326-1-10.

Authors
Written equipped in the covering letter, containing the full name (with degrees/academic degrees), the area of expertise, institution, address, mobile phone, and e-mail.

Supplementary File(s)
In the Supplementary Files, upload the following document:
- ethics and plagiarism statement;
- scan results of ethical approval/clearance letters from the Health Research Ethics Committee;
- copyright statement
- pictures (graphs, diagrams, and photos) at a manuscript in high-resolution jpeg, jpg, or png format.

Article Submission
Submit article and correspondence with the editorial board online. Register at https://ejournal.unisba.ac.id/index.php/gmhc and follow the guidelines.

Manuscripts submitted not in accordance will be rejected.

Editorial Board of
Global Medical and Health Communication
Faculty of Medicine, Universitas Islam Bandung
Jalan Hariangbanga No. 2, Tamansari,
Bandung 40116, West Java, Indonesia

Global Medical and Health Communication

Online submission: https://ejournal.unisba.ac.id/index.php/gmhc
DOI: https://doi.org/10.29313/gmhc.v12i1.12788

GMHC. 2024;12(1):1–11
pISSN 2301-9123 | eISSN 2460-5441

RESEARCH ARTICLE

AI-SPOT: a Novel Artificial Intelligence-enabled Sport Optimization Tracker to Enhance Performance and Prevent Injury in Elite Footballers

Aaron Chen Angus,[1] Dinesh Sirisena[2]
[1]School of Sports, Health and Leisure, Republic Polytechnic, Singapore,
[2]Department of Sports and Exercise Medicine, Khoo Teck Puat Hospital, Singapore

Abstract

This study introduces AI-SPOT, a novel artificial intelligence tool for optimizing performance and preventing injuries in elite footballers. Data were collected from four Singapore Premiere League clubs and the National Team, encompassing 68 male footballers over two seasons (2021–2022). The comprehensive dataset included diverse metrics, injury records, and automated live match data from established databases. AI-SPOT employs Python's scikit-learn for predictive analytics, using techniques like logistic regression and XGBoost, and was further developed with TensorFlow. Its effectiveness in injury prediction and performance assessment was validated with extensive local and international data sources. The system's potential for broader sports applications was underscored by user experience assessments, indicating a significant shift towards AI-driven strategies in sports management. Despite its reliance on high-quality, sport-specific data, AI-SPOT's adaptability highlights its role as a transformative tool in sports analytics, paving the way for advanced, data-driven approaches in sports management and strategy formulation.

Keywords: Artificial intelligence, data-driven decision making, machine learning, sport medicine

Introduction

Elite football clubs channel substantial resources into player recruitment, training, and sustenance. While detrimental to on-field performance, player injuries also pose considerable financial implications. Contemporary football sees a burgeoning inclination towards adopting data-driven decision-making mechanisms such as player performance enhancement and injury prevention. Integrating artificial intelligence (AI) offers promising prospects in predicting player injuries and ascertaining their value.

In elite football echelons, the frequency of injuries remains alarmingly elevated. Muscle strains, notably hamstring strains, are the most commonplace, succeeded by ligament sprains and injuries to the meniscus or cartilage.[1,2] Training load, about both volume and intensity, is a significant determinant for these injuries.[3,4] The aftermath of such injuries transcends mere player health. The absence of crucial players may culminate in match losses, which have a cascading effect on league standings and can instigate substantial economic setbacks.[5] Chronic injuries can exacerbate player downtime, leading to a dip in match-day earnings, a drop in player asset value, and escalated medical expenditures.[6] The consequential losses impact diverse aspects, from league standings and ticket revenue to sponsorships and player market evaluations.[5,7]

Historically, elite football clubs' determinations regarding player recruitment and participation in pivotal matches hinged on the understanding of coaches and scouts. Yet, data analytics proffers a more grounded viewpoint. Tools designed to gauge player value, epitomized by the expected goals (xG) metric, have garnered extensive traction in contemporary times.[8,9] The xG paradigm gauges shot quality predicated on various determinants, affording coaches a lucid understanding of player output.[10,11] The infusion of such data-centric instruments enables clubs to adopt enlightened choices, potentially amplifying football standards at both club and national tiers.[12,13]

The realm of sports analytics has witnessed rapid strides in the potentialities of AI. Cutting-

Received: 15 October 2023; Revised: 21 November 2023; Accepted: 22 December 2023; Published: 30 April 2024

Correspondence: Aaron Chen Angus. School of Sports, Health and Leisure, Republic Polytechnic. 9 Woodlands Avenue 9, Singapore 738964. E-mail: aaron_chen_angus@rp.edu.sg

edge algorithms now hold the prowess to forecast a player's imminent performance trajectory and their susceptibility to injuries.[14] Training these algorithms on expansive datasets augments their precision.[15] Envisioning a consolidated framework, spearheaded by AI, materializes as the potential panacea for clubs striving to hone player output while concurrently curtailing injury risks.[16] Contemporary algorithms cater to athlete surveillance and prognosticate injury vulnerabilities by tracking players' physical exertions juxtaposed against benchmarked metrics.[17] Furthermore, the pervasive xG model in football analytics evaluates shot quality drawing on diverse parameters, encompassing shot positioning, the anatomical region utilized, and the nature of the assist.[8] The present discourse seeks to refine these algorithms by capitalizing on an exhaustive dataset representing elite football talent.

This study aims to develop AI-SPOT, an advanced artificial intelligence tool designed for optimizing performance and injury prevention in elite footballers. It focuses on enhancing injury prediction algorithms and evaluating athlete performance using extensive data from top-tier football players. The objectives include implementing machine learning techniques for efficient athlete load management, resource allocation, and real-time tactical decision-making. The research intends to contribute to sports medicine, sports science, and performance analytics, showcasing the efficacy of AI in professional sports.

Methods

The study cohort comprised 68 male elite footballers systematically selected from the Singapore Premiere League (SPL) and the Singapore National Football Team. These subjects actively participated in the SPL's two consecutive competitive seasons (2021–2022). The inclusion criteria mandated active involvement in the team lineup for the respective seasons, ensuring all participants met the rigorous health and fitness standards for elite-level national football. Participant demographics included an age range of 18 to 33 years, with a mean age of 25.4 years. Bodyweight varied between 75 and 98 kilograms (mean: 87.5 kg), and height ranged from 175 cm to 190 cm, averaging 178 cm. These physical attributes and performance metrics were categorized and analyzed in alignment with established industry practices.[18] The selection process was stringent, focusing on athletes who represented the pinnacle of their profession in terms of skill and performance and met the comprehensive physical and health criteria characteristic of top-tier footballers. This rigorous selection ensured the reliability and relevance of the data collected for this study.

A comprehensive dataset was curated for each subject throughout the two SPL seasons. The parameters included various aspects of training load data,[19] summarised in Table 1.

Injury data was systematically collected from the sports medicine departments of the respective football clubs, encompassing the following data summarised in Table 2.

To maintain confidentiality, measures were implemented to anonymize participants, ensuring the absence of any identifiable information. In line with ethical research practices, subjects participated voluntarily, retaining the right to withdraw at any point without repercussions. Additionally, participants provided informed consent by standard ethical research procedures on human subjects.[20,21]

The research methodology, including the informed consent form, received approval from both the Institutional Review Board of Republic Polytechnic and the Football Association of Singapore's Medical Board (ethics approval reference code: HSR-SHL-F-2021-021).[20,21]

Performance analysis and player value data were primarily sourced from the InStat Analytics Database, Wyscout Database (courtesy of the Football Association of Singapore), and a custom Python-based web scraper extracting public match and player data. The exported XML file from the InStat platform needed minimal preprocessing, primarily structural adjustments.[22]

While data was readily available, it was evident that football clubs varied in their interpretation of the Wyscout and HUDL InStat datasets. Established methodologies typically involve video analytics, subsequently validated via the InStat platform.[23] The overarching goal of this research was to harness machine learning for faster, more efficient team play analyses, complementing conventional video analytics.

Advanced Python libraries facilitated extensive data wrangling of football match data. Cross-drill analyses were conducted during the exploratory data analysis (EDA) phase, harnessing

Table 1 Athlete Load Data Fields

Field No.	Field Name	Data Type
1	Date of record	Date
2	Day type (match, training, rest)	Nvarchar(50)
3	Athlete ID (masked name)	Nvarchar(255)
4	Position (goalkeeper, defender, midfielder, forward)	Nvarchar(50)
5	Gender	Char(1)
6	Date of birth	Date
7	Nationality	Nvarchar(100)
8	Ethnicity	Nvarchar(100)
9	Height	Decimal(5,2)
10	Weight	Decimal(5,2)
11	Body fat %	Decimal(5,2)
12	Lean mass	Decimal(7,2)
13	Basal metabolic rate	Int
14	Resting heart rate	Int
15	Maximum heart rate	Int
16	Average heart rate	Int
17	VO_2max	Decimal(6,2)
18	Blood lactate	Decimal(5,2)
19	Energy intake	Decimal(8,2)
20	Energy expenditure	Decimal(8,2)
21	Energy deficit	Decimal(8,2)
22	Hydration	Decimal(5,2)
23	Maximum speed	Decimal(5,2)
24	Average speed	Decimal(5,2)
25	Total distance	Decimal(8,2)
26	Vertical jump test score	Decimal(5,2)
27	Yo-yo test score	Decimal(5,2)
28	Sit and reach the test score	Decimal(5,2)
29	Perceived tissue damage (soreness)	Nvarchar(255)
30	Perceived effort (RPE)	Decimal(4,2)

visualizations to discern underlying patterns, trends, and potential outliers. Such outliers, once verified with sport science experts and deemed incongruent, were excluded, ensuring a more robust machine learning model.[24]

We are utilizing Python libraries, including sci-kit-learn, and the model-building phase encompasses feature reduction and model selection.

Feature reduction, a vital machine learning process, entails optimizing the number of features for improved learning outcomes. It can be achieved by removing redundant or irrelevant features in the early EDA stages or during modeling for better generalization and accuracy.[25] Principal component analysis (PCA) is vital for reducing dimensions in machine learning, especially with complex datasets like our project. PCA is used in this study to transform data into uncorrelated variables, simplifying the dataset and maintaining key information, thus aiding in efficient analysis and enhanced interpretability of intricate data.[26]

Classification models, either simple or complex, were employed to predict potential injuries. While simpler models, like decision trees, are resource-efficient and beneficial in certain situations, complex models like the extreme gradient boosting tree model offer nuanced parameter tuning for enhanced accuracy in high-dimensional datasets.[27] Model efficacy was evaluated using key machine learning

Table 2 Injury Record

Data Point	Data Field Type
Date of record	Date
Athlete ID (masked name)	Nvarchar(100)
Type of injury reported (based on list) □ Immunodeficiency (flu symptoms) □ Fever □ Tendon/muscle stiffness □ Tendon/muscle strain □ Tendon/muscle tear □ Ankle sprain □ Knee injury □ Quad, hamstring, groin strain □ Hip pointers □ Shoulder dislocation □ Acromioclavicular sprain □ Wrist and hand injury □ Meniscal damage □ Bone fracture □ Muscle atrophy □ Cartilage degeneration □ Concussion □ Others: _____	Nvarchar(100)
Number of days of medical certificate	Int
Missed match (date of match)	Date

metrics: accuracy score, receiving operator characteristics-area under the curve (ROC-AUC), precision, recall, and f1-score.[28,29]

Results

This study undertook an intensive exploration of multi-dimensional data derived from a league comprising 380 matches, averaging 1,800 events per match, encompassing 352 distinct action types. Specific actions, such as failed shot saves, goal kicks, and penalty kicks were discerned to bear a heightened likelihood of influencing game outcomes. Yet, their inherent randomness limits their tactical exploitability. As the focus shifted towards tactical actions and amenability to manipulation, constraints imposed by machine learning model assumptions arose, especially concerning logistic regression, which mandates feature independence and a degree of linearity.

A pivotal step in the data wrangling phase, feature engineering was employed to ensure the dataset aptly supported our project objectives. Important relationships derived from the raw data include a high correlation between passes and shots, an inverse moderate correlation between duels and passes, and a significant correlation between shots and game outcomes. We recognized a clear differentiation in the number of shots and passes between stronger and weaker teams. Additionally, midfielders emerged as the most frequently substituted player role. We categorized team actions into three sections: defending pitch, midfield, and attacking pitch, anticipating these divisions to offer insights into team strategies and player performance.

The initial model design was to craft distinct models for various teams, given the unique characteristics within each team's data. A challenge was ensuring the models' robustness, especially considering each team only had a sample size of 38 games per season. The data presented discrepancies in accuracy rates, with some models reflecting high accuracy for stronger or weaker teams, likely influenced by imbalanced data.

In a 7-fold cross-validated study on stratified data, a top-performing team in the 2022 SPL

Season resonated best with the Gaussian Naïve Bayes classifier, while a lower-tier team aligned more with the random forest classifier. These models, however, showed considerable variance when trained and tested over 10,000 iterations due to the limited sample size.

To enhance the model, data augmentation techniques like the synthetic minority oversampling technique (SMOTE), adaptive synthetic sampling (ADASYN), and deep learning neural networks were employed. However, the conventional augmentation methods, such as SMOTE and ADASYN, were ineffective. The conditional transformative generative adversarial networks (CTGANs) model, a variant of GANs tailored for tabular data, was introduced. Despite some instances of optimism, the generated synthetic data often needed to mirror real-world data, leading to potential inaccuracies.

PCA was leveraged to decipher the high-dimensional data. The initial PCA showcased that actions predominantly in the attacking pitch area play a pivotal role in match outcomes. Post-feature selection, a more refined dataset was

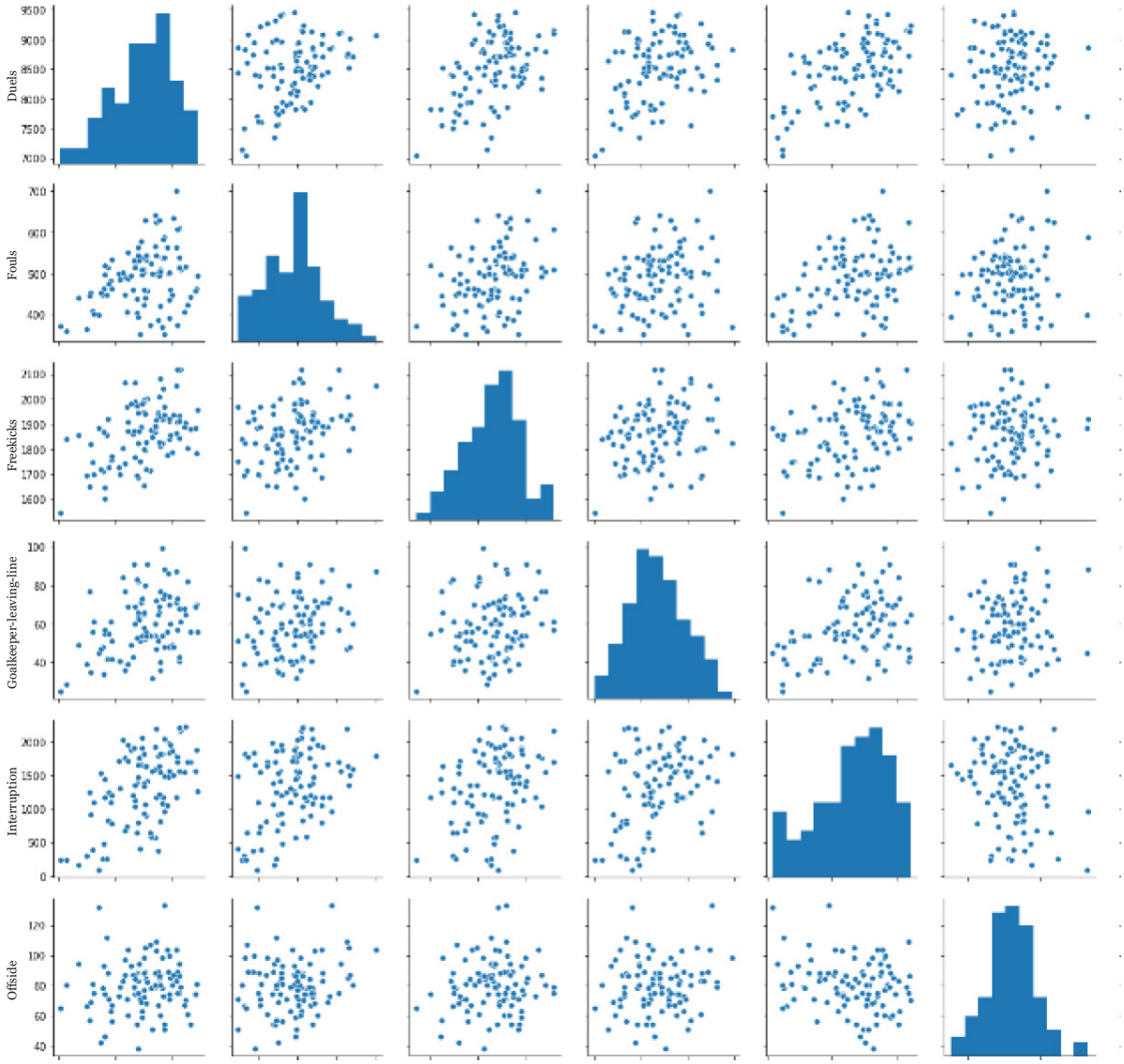

Figure 1 Pairs Plot Sample from PCA to Visualise Feature Relationships

Note: The pairs plot from PCA allows the identification of critical features for dimensionality reduction based on the comprehensive dataset used in this study by displaying correlations between feature pairs in machine learning model building

employed for a second PCA, where the primary component accounted for over 40% of the data variance, emphasizing the significance of midfield action and passing networks (Figure 1).

The iterative approach in this study led to a model that emphasizes frequently occurring and impactful actions. Simplifying the dataset is anticipated to yield more robust results, especially considering the limited sample size. The final design targets three pivotal actions across the three pitch areas: passes, duels, and shots. League-wide data will be employed for model training instead of individual team data.

Subsequent feature selection was streamlined by leveraging model fitting to pinpoint pivotal features. The logistic regression model, with its commendable accuracy of 83%, provided a reliable metric for feature importance. The gradient boosting classifier displayed a marginally superior accuracy, suggesting its potential to yield even more refined outcomes with hyperparameter tuning, and this was subsequently adopted for the model's development. The performance metrics for the various (Table 3 and Table 4).

The Shapley additive explanation (SHAP) method is rooted in cooperative game theory and has been adapted to measure feature importance in machine learning. Distinguishing from other models, SHAP offers localized feature importance evaluations, making it more adaptable to dynamic situations such as individual football matches where data from one game might vary considerably.

Our analyses revealed insightful patterns. In a swamp plot generated from logistic regression using the SHAP explanation, the most significant feature was 'team1 accurate shots'. A higher value for this feature correlates with a more significant positive impact on match outcomes. Contrastingly, the 'team1 pass non-accurate in the attack pitch' feature, although holding a mix of high values, demonstrated varied effects on the game, underscoring the unique nature of each football match. Comparative analyses of various models (like random forest and XGB classifiers) using SHAP yielded consistent results on feature importance. However, the magnitude of SHAP values varied, with tree models typically showing smaller values. Among the models evaluated, logistic regression emerged superior due to its rapid training speed, high predictive accuracy (74–78%), and substantial SHAP values. The XGB classifier, although slightly more accurate in prediction, was more time-consuming and exhibited minimal SHAP values. Given these findings, this study designated the logistic regression model for this system, but other models remain relevant for future data comparisons.

For player evaluation, leveraging the SHAP values from the logistic regression, we calculated the feature importance for individual games and extended this to assess player contributions. We sought to represent intangible match aspects like team morale, synergy, and skill through statistical evaluations. By leveraging SHAP values, we distilled these concepts into measurable actions on the field. We introduced two new metrics for player evaluation: 'player value', derived from the product of action count and its corresponding SHAP value, and a normalized metric accounting

Table 3 Performance Metrics for Classifiers Used for Model Design

Classifier	Accuracy	Log Loss	Recall	ROC_AUC
LogisticRegression	80.246914	0.410564	0.792952	0.891807
KNeighborsClassifier	62.55144	3.724202	0.572687	0.661635
SVC	53.292181	0.65454	0	0.616978
DecisionTreeClassifier	72.222222	9.594105	0.722467	0.722237
RandomForestClassifier	81.069959	0.459312	0.753304	0.897428
XGBClassifier	83.950617	0.448677	0.837004	0.909889
AdaBoostClassifier	82.304527	0.666443	0.792952	0.906077
GradientBoostingClassifier	82.098765	0.397874	0.814978	0.901944
GaussianNB	75.925926	1.443781	0.784141	0.83555
LinearDiscriminantAnalysis	84.156379	0.372274	0.845815	0.913476
QuadraticDiscriminantAnalysis	61.522634	10.989866	0.77533	0.633664
CatBoostClassifier	81.481481	0.38089	0.819383	0.910074

Table 4 Top Features in Feature Engineering

Coefficient	Features
0.727745	Shot Shot Opportunity Accurate
0.384252	Home Ground
0.35633	Pass Cross Assist Accurate
0.325931	Offside
0.249253	Pass Simple pass Assist Accurate
0.213237	Shot Shot Counter attack Opportunity Accurate
0.19711	Free Kick Throw in Not accurate
0.194009	Pass Simple pass Interception Not accurate
0.186302	Pass Smart pass Assist Accurate
0.183734	Duel Air duel Counter attack Accurate
−0.167229	Others on the ball Acceleration Not accurate
−0.180898	Duel Ground attacking duel Interception Accurate
−0.182379	Duel Ground attacking duel Counter attack Not accurate
−0.215683	Pass Cross Key pass Accurate
−0.24314	Pass Cross Accurate
−0.257963	Pass Simple pass Key pass Accurate
−0.298885	Pass Simple pass Dangerous ball lost Not accurate
−0.347183	Free Kick Free kick cross Not accurate
−0.370614	Save attempt Reflexes Accurate
−1.438092	Save attempt Reflexes Not accurate

for play duration, obtained by dividing the player value by the total minutes played on the pitch (Figure 2 and Figure 3).

The model was deployed to a client-based functional application developed using TensorFlow and hosted on a cloud for beta testing with the participating football clubs. This product is named AI-SPOT, which is short for Artificial Intelligence-enabled Sports Performance and Optimisation Tracker. Some sample screens in this paper use English Premiere League data run on this system to demonstrate and generate predictive outcomes (as the Singapore Premiere League data is classified and provided only for model building). A sample workflow in the system is shown in Figure 4.

Discussion

This study leveraged advanced machine learning to enhance football team management, specifically XGBoost and logistic regression classifiers. This approach addressed critical aspects such as athlete load, injury prediction, match performance, and player valuation. Demonstrating robustness and accuracy, the model's effectiveness was affirmed using diverse datasets, including those from the Singaporean football teams and the extensive English Premier League data, thereby showcasing its potential for broad application in sports analytics.

Utilizing TensorFlow, AI-SPOT was developed into a functional platform, prioritizing robust data security and an intuitive user interface refined through beta tests with various football teams. This development process ensured the platform's adaptability to the specific needs of team managers and coaches and accommodated the dynamic nature of football data.

AI-SPOT's success in football demonstrates its potential for broader applications in sports, marking a shift from traditional methods to data-driven strategies. Utilizing AI for predictive analytics, this approach could significantly enhance the quality and performance across various sports disciplines, not limited to football. The adaptability of the system's algorithms allows for recalibration to suit both team-based and individual sports, indicating a new era of technology-driven sports performance, injury prevention, and strategic decision-making.

In this study, AI-SPOT has demonstrated

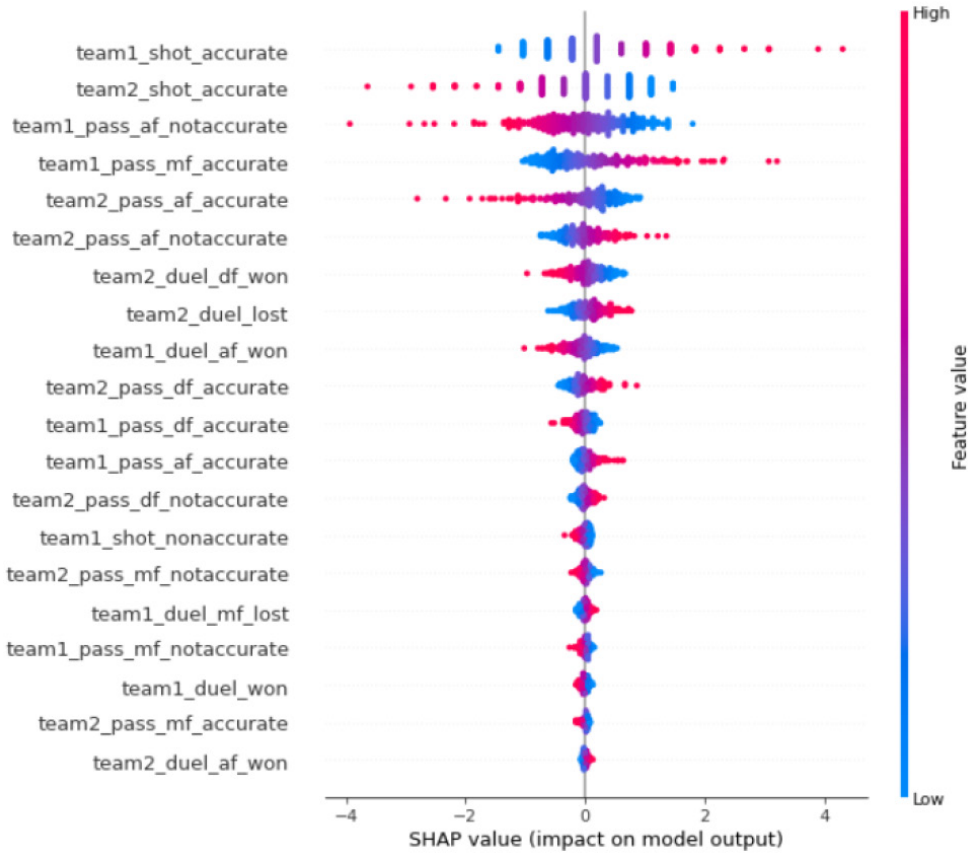

Figure 2 Swamp Plot Sample Using Logistic Regression for SHAP Values

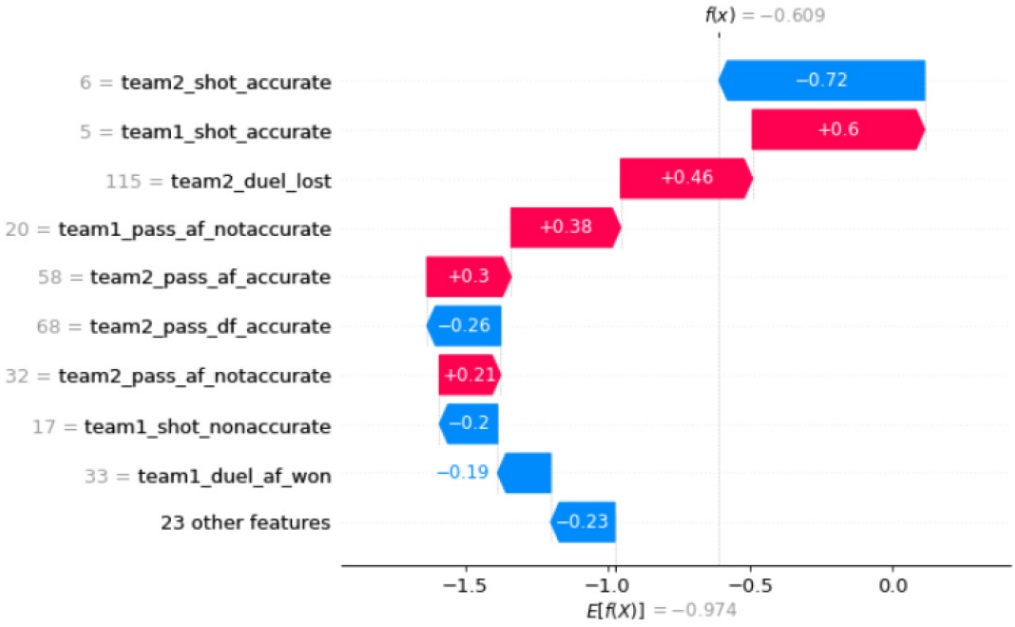

Figure 3 Waterfall Plot on Sample Match Trained on Logistic Regression

Note: The plot shows a function f(x) on the prediction probability of the game. At a negative value, the model predicts the playing team is unlikely to win the game. The blue and red ribbons represent features causing negative and positive impacts on the game outcome

Figure 4 Sample Workflow of the AI-SPOT System Using EPL Data

Note: SPOT system's workflow using EPL data showcases the systematic visualization process for predictive analytics, which aids in evaluating team performance indicators for tactical decision-making

significant advancements in sports analytics and injury prevention, yet it also encounters limitations. Compared to previous methods, AI-SPOT's advanced machine learning algorithms integration offers more accurate injury prediction and performance assessment, addressing gaps identified in earlier research. However, its reliance on extensive, high-quality data from professional leagues may limit applicability in lower-tier or amateur sports settings. Additionally, while AI-SPOT shows promise in enhancing decision-making, translating its insights into practical coaching strategies requires further exploration. These considerations suggest areas for ongoing research and development, emphasizing the need for adaptable, versatile tools in sports analytics.

Conclusions

This study harnessed advanced machine learning techniques to optimize football team management by integrating athlete load, injury prediction, match performance, and player valuation using the XGBoost and Logistic Regression classifiers, resulting in a robust and accurate model. The successful transition from model development to real-world application culminated in AI-SPOT, a functional platform powered by TensorFlow that holds promise for broader applications in sports beyond football, emphasizing the potential of data-driven decision-making in sports management and performance optimization.

Conflict of Interest

None declared.

Acknowledgment

The authors would like to express their appreciation for the support from the Football Association of Singapore (FAS) as well as Singapore Premiere League Teams who have actively supported this study, Hougang United, Lion City Sailors, Geylang United and Tampines Rovers football clubs.

References

1. López-Valenciano A, Ruiz-Pérez I, Garcia-Gómez A, Vera-Garcia FJ, De Ste Croix M, Myer GD, Ayala F. Epidemiology of injuries in professional football: a systematic review and meta-analysis. Br J Sports Med. 2020;54(12):711–8.
2. Della Villa F, Buckthorpe M, Grassi A, Nabiuzzi A, Tosarelli F, Zaffagnini S, et al. Systematic video analysis of ACL injuries in professional male football (soccer): injury mechanisms, situational patterns and biomechanics study on 134 consecutive cases. Br J Sports Med. 2020;54(24):1423–32.
3. Gabbett TJ. The training-injury prevention paradox: should athletes be training smarter and harder? Br J Sports Med. 2016;50(5):273–80.
4. Windt J, Zumbo BD, Sporer B, MacDonald K, Gabbett TJ. Why do workload spikes cause injuries, and which athletes are at higher risk? Mediators and moderators in workload–injury investigations. Br J Sports Med. 2017;51(13):993–4.
5. Dellal A, Lago-Peñas C, Rey E, Chamari K, Orhant E. The effects of a congested fixture period on physical performance, technical activity and injury rate during matches in a professional soccer team. Br J Sports Med. 2015;49(6):390–4.
6. Rössler R, Junge A, Chomiak J, Dvorak J, Faude O. Soccer injuries in players aged 7 to 12 years: a descriptive epidemiological study over 2 seasons. Am J Sports Med. 2016;44(2):309–17.
7. Lee EC, Fragala MS, Kavouras SA, Queen RM, Pryor JL, Casa DJ. Biomarkers in sports and exercise: tracking health, performance, and recovery in athletes. J Strength Cond Res. 2017;31(10):2920–37.
8. Liu H, Hopkins W, Gómez MA, Molinuevo JS. Inter-operator reliability of live football match statistics from OPTA Sportsdata. Int J Perf Anal Sport. 2020;13(3):803–21.
9. Jha D, Rauniyar A, Johansen HD, et al. Video analytics in elite soccer: a distributed computing perspective. Proc IEEE Sens Array Multichannel Signal Process Workshop. 2022;2022:221–5.
10. Fernandez-Navarro J, Fradua L, Zubillaga A, McRobert AP. Influence of contextual variables on styles of play in soccer. Int J Perf Anal Sport. 2018;18(3):423–36.
11. van Maarseveen MJJ, Oudejans RRD, Mann DL, Savelsbergh GJP. Perceptual-cognitive skill and the in situ performance of soccer players. Q J Exp Psychol (Hove). 2018;71(2):455–70.

12. Rein R, Memmert D. Big data and tactical analysis in elite soccer: future challenges and opportunities for sports science. Springerplus. 2016;5(1):1410.
13. Tenga A, Sigmundstad E. Characteristics of goal-scoring possessions in open play: comparing the top, in-between and bottom teams from professional soccer league. Int J Perf Anal Sport. 2011;11(3):545–52.
14. Bittencourt NFN, Meeuwisse WH, Mendonça LD, Nettel-Aguirre A, Ocarino JM, Fonseca ST. Complex systems approach for sports injuries: moving from risk factor identification to injury pattern recognition—narrative review and new concept. Br J Sports Med. 2016;50(21):1309–14.
15. Gonçalves B, Coutinho D, Travassos B, Brito J, Figueiredo P. Match analysis of soccer refereeing using spatiotemporal data: a case study. Sensors (Basel). 2021;21(7):2541.
16. Sarmento H. From traditional scouting to a data-driven approach: soccer analytics in the era of big data. J Hum Sport Exerc. 2020;15(3):678–88.
17. Gabbett TJ. Debunking the myths about training load, injury and performance: empirical evidence, hot topics and recommendations for practitioners. Br J Sports Med. 2020;54(1):58–66.
18. Smith J. Elite football player characteristics and performance metrics: an analysis. Sports Med. 2020;50:1231–42.
19. Djaoui L, Haddad M, Chamari K, Dellal A. Monitoring training load and fatigue in soccer players with physiological markers. Physiol Behav. 2017;181:86–94.
20. Wiesing U, Parsa-Parsi R. The World Medical Association launches a Revision of the Declaration of Geneva. Bioethics. 2016;30(3):140.
21. Bjärsholm D, Gerrevall P, Linnér S, Peterson T, Schenker K. Ethical considerations in researchingsportandsocialentrepreneurship. Eur J Sport Sci. 2018;15(3):216–33.
22. Ngiam KY, Khor IW. Big data and machine learning algorithms for health-care . Lancet Oncol. 2019;20(5):e262–73.
23. Kubayi A. Analysis of goal scoring patterns in the 2018 FIFA World Cup. J Hum Kinet. 2020;71:205–10.
24. Berrar D. Data wrangling and exploratory data analysis in bioinformatics. Front Genet. 2020;11:512036.
25. Cai W, Yang Z, Wang Z, Wang Y. A new compound fault feature extraction method based on multipoint kurtosis and variational mode decomposition. Entropy (Basel). 2018;20(7):521.
26. Martin RK, Pareek A, Krych AJ, Maradit Kremers H, Engebretsen L. Machine learning in sports medicine: need for improvement. J ISAKOS. 2021;6(1):1–2.
27. Marynowicz J, Lango M, Horna D, Kikut K, Konefał M, Chmura P, et al. Within-subject principal component analysis of external training load and intensity measures in youth soccer training. J Strength Cond Res. 2023;37(12):2411–6.
28. Chen T, Guestrin C. XGBoost: a scalable tree boosting system. In: KDD '16: Proceedings of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining; 2016 August 13–17; San Francisco, CA, USA. San Francisco, CA, USA: Association for Computing Machinery, Inc.; 2016. p. 785–94.
29. Rico-González M, Pino-Ortega J, Méndez A, Clemente FM, Baca A. Machine learning application in soccer: a systematic review. Biol Sport. 2023;40(1):249–63.

Global Medical and Health Communication

Online submission: https://ejournal.unisba.ac.id/index.php/gmhc
DOI: https://doi.org/10.29313/gmhc.v12i1.11789

GMHC. 2024;12(1):12–17
pISSN 2301-9123 | eISSN 2460-5441

RESEARCH ARTICLE

The Relationship Level of Self-medication Knowledge with Rationality of Drug Use in Adolescents

Muhammad Cariefzi Zahdffa Kusuma,[1] Meiyanti Meiyanti[2]

[1]Faculty of Medicine, Universitas Trisakti, West Jakarta, Indonesia,
[2]Department of Pharmacology and Medical Pharmacy, Faculty of Medicine, Universitas Trisakti, West Jakarta, Indonesia

Abstract

Currently, self-medication in Indonesian adolescents has a high prevalence. The problem with self-medication is the accuracy of drug use in adolescents, resulting in irrational treatment. The purpose of this study was to analyze the relationship between the level of knowledge of self-medication and the rational use of gastritis drugs in adolescents. This observational study has a cross-sectional design and a sample size of 91 students. The research was conducted from April to June 2021 in Jakarta. The nonrandom sampling method was used for the selection of research samples. Research data were obtained through interviews and questionnaires. Calculate the sample size using the infinite and finite population formula with a prevalence of 23.8. Inclusion criteria subjects aged 15–19 years who had complaints in the upper gastrointestinal tract and signed informed consent. Exclusion criteria are students taking gastritis treatment based on prescriptions from doctors or according to doctor's recommendations. Data analysis using SPSS 23.0 and correlation test using the chi-square test with a significance value of $p<0.05$. The results showed that 33% of respondents had good self-medication knowledge, and as many as 60% had irrational gastritis treatment behavior. The results of bivariate analysis obtained there is a significant relationship between the level of knowledge of self-medication and the rational treatment of gastritis with a value of $p=0.000$ ($p<0.05$). This study concludes that there is a relationship between knowledge of self-medication and the rational use of drugs..

Keywords: Adolescents, medicine, rationality, self-medication

Introduction

Self-medication is an attempt by someone to treat themselves without a prescription from a doctor.[1] Based on the 2017–2019 national socioeconomic survey by the Statistics Indonesia, it was found that there was an increase in the average number of self-medications in Indonesia every year. In 2017, the number of people practicing self-medication was 69.43%; in 2018, it was 70.74%; and in 2019, it was 71.46%, with an average increase of 1% each year.[2] Gastritis (stomach inflammation) is a health problem in the digestive system with a high incidence rate. According to the 2018 Health Profile, gastritis is among the top 10 diseases of hospitalizations in Indonesia with 30,154 cases (4.9%). The incidence of gastritis is relatively high, with a prevalence of 274,396 cases in 258,704,900 people.[3] The study by Tauran and Lameky[4] showed a relationship between diet and the incidence and recurrence of gastritis. Previous studies obtained the results of several types of over-the-counter drugs often used for gastritis self-medication, including antacids, histamine two receptor antagonists, proton pump inhibitors, and sucralfate.[5]

Several factors, including commercial marketing of drugs, treatment experience, economic conditions, social conditions, psychological conditions, education, and educational history, influence the choice of self-medication.[1] Various problems often arise in the implementation of self-medication, such as a lack of understanding and knowledge about the proper and rational use of a drug, excessive use of drugs, and lack of knowledge about proper storage and disposal of drugs.[6] According to data from Statistics Indonesia in 2019, 73.63% of self-medication practitioners belonged to adolescents aged 15–19 years; this figure exceeded the average number of self-medication practitioners in Indonesia, 71.46%.[2] Adolescence is a transitional

Received: 23 April 2023; Revised: 12 February 2024; Accepted: 23 February 2024; Published: 30 April 2024

Correspondence: Meiyanti, dr., Sp.F.K. Department of Pharmacology and Medical Pharmacy, Faculty of Medicine, Universitas Trisakti. Jln. Kyai Tapa No. 260, West Jakarta 11440, Special Capital Region of Jakarta, Indonesia. E-mail: meiyanti@trisakti.ac.id

period when a person develops self-identity and still cannot understand complex concepts, the relationship between actions and consequences, or how much control they have or can have to make decisions related to their health.[7]

A study in Medan showed that 68.75% of the population had good knowledge about the use of gastritis drugs and selection attitudes, and there was a significant relationship between drug knowledge and self-medication for ulcer disease in the village.[8] Different results were obtained in another study; this study concluded that the level of knowledge of self-medication does not influence the rationality of drug use. The level of knowledge about the rationality of self-medication is influenced by the level of knowledge influenced by the latest education and occupation, and there is no significant relationship between knowledge and self-medication between the rationality of drug use with sociodemographic factors such as age, gender, education level, and occupation.[9]

The rationality of gastritis treatment is critical in the current field of public health; the high prevalence of the disease with the rational use of drugs has an impact on the success of treatment and can prevent or reduce side effects and unwanted effects from the use of drugs. The results of the research are still conflicting between self-medication knowledge and treatment rationality, encouraging researchers to examine the relationship between self-medication knowledge and the rationality of gastritis drug treatment in adolescents.

Methods

This research study design used an observational analytic method with a cross-sectional approach. The research was located at Senior High School (*Sekolah Menengah Atas Negeri*, SMAN) 28 Jakarta because the research location is easily accessible to researchers in conditions of imposing social distancing; the research was conducted from April to June 2021. The research sample was taken using the consecutive nonrandom sampling technique. Calculate the sample size using the infinite and finite population formula at 95% reliability, a prevalence of 23.8%, and accuracy of measurement accuracy of 0.05. Respondents who participated in this study were 91 students aged 15–19 years who had complaints in the upper gastrointestinal tract, were willing to participate, and signed informed consent. Exclusion criteria are students who are taking gastritis treatment based on prescriptions and have a history of using gastritis drugs from doctors or according to doctor's recommendations. Data collection was carried out by filling in the consent form and questionnaire sheet containing sociodemographic data (age, gender, parent's education level, family economic level), a self-medication knowledge level questionnaire consisting of 12 questions, and a gastritis drug use rationality questionnaire composed of 10 questions. A pilot test of the questionnaire was conducted on ten students to test the validity and reliability, obtaining a value of r=0.361 and Cronbach's alpha 0.68. Bivariate data analysis of the relationship between the level of knowledge of self-medication and rationality of treatment using the chi-square test on SPSS for Windows version 23.0 software with a significance level of 95%. This research has passed the ethical review from the Faculty of Medicine, Trisakti University, with No. 46/KER-FK/2/2021.

Results

Based on Table 1, the average age was 16.2 years, with 60 (66%) subjects being female. Most of the subjects' parents' education (64%) is included in the higher education category, with parental income 62 (68%) above the regional minimum wage (*upah minimum regional*, UMR). Based on the knowledge of self-medication, 31 (34%) have a moderate level of expertise, and the knowledge of good and not good self-medication, 30 (33%). Based on the drug rationality category, it was found that most of the 55 (60%) used drugs irrationally. The type of drug most widely used for treating gastritis is antacid at 81%, followed by second-order proton pump inhibitor (PPI) medications at 10% and sucralfate drugs at 9%.

Based on Table 2, out of 91 subjects, 31 subjects with moderate self-medication knowledge had irrational drug use 21 (68%), while subjects with a good knowledge level of 30 subjects had 21 (70%) rational drug use. From the results of bivariate chi-square analysis, the relationship between knowledge of self-medication and drug rationality was found to be p=0.000. Meanwhile, based on demographic data on gender and parental income, from the results of bivariate chi-square analysis, it was found that there was no significant relationship between these demographic data and drug rationality with p-values of 0.140 and 0.110,

Table 1 Subject Characteristics

Variables	Mean±SD	n=91 (%)
Age (year)	16.2±0.7	
Gender		
Male		31 (34)
Female		60 (66)
Parental education		
Low		33 (36)
High		58 (64)
Parents' income		
≤UMR		29 (32)
>UMR		62 (68)
Self-medication knowledge		
Good		30 (33)
Moderate		31 (34)
Poor		30 (33)
Rationality of medication		
Yes		36 (40)
No		55 (60)
Type of drug		
Antacid		74(81)
Sucralfate		8 (9)
Proton pump inhibitor		9 (10)
Self-medication		
Yes		32 (35)
No		59 (65)

Note: UMR: regional minimum wage

respectively. A total of 58 subjects had parents with a high level of education; in this group, 30 (52%) were categorized as irrational drug use, but in the low education level group, as many as 33 subjects obtained 76% of this group used irrational drugs. The results of the chi-square bivariate analysis showed that parental education is significantly related to drug rationality with a value of p=0.024.

Discussion

The prevalence of self-medication in this study was 35%, which is lower than that of gastritis self-medication in other countries. The systematic literature review and meta-analysis results showed that more than 50% of adolescents take medicine without consulting a doctor.[10] Some of the factors causing the high rate of self-medication are due to the easy access to the drugs needed, especially over-the-counter drugs, and limited over-the-counter drugs without any standardization of over-the-counter drug sales. The location and geographical conditions of the residence affect access to self-medication, and limited transportation and health facilities will increase the prevalence of self-medication.[11,12] Another factor causing the high prevalence of self-medication is the pharmacist's role as a drug seller is very active compared to the pharmacist's role as a health service provider.[7,10] People practice self-medication because of the high cost of treatment, limited health insurance coverage, previous experience with the disease, lack of trust in health workers, avoiding loss of work time, and avoiding long waiting times to consult a doctor.[13,14]

Antacid is the type of drug most widely

Table 2 Self-medication Knowledge, Gender, Education, and

Variables	Yes (n=36)	No (n=55)	Total (n=91)	p
Self-medication knowledge				
Good	21	9	30	0.000*
Moderate	10	21	31	
Poor	5	25	30	
Gender				
Male	9	22	31	0.14
Female	27	33	60	
Parental education				
Low	8	25	33	0.024*
High	28	30	58	
Parents' income				
≤UMR	8	21	32	0.11
>UMR	28	34	59	

Note: *p<0.05, UMR: regional minimum wage

consumed to treat gastritis complaints. The results of this study are no different from previous studies; antacids ranked first in self-medication; this is because antacid class drugs are a class of over-the-counter drugs, easily available at relatively affordable prices so that they become the drug of choice, especially among adolescents.[15] The results of this study show that there is no significant relationship between gender and the rationality of drug use. The same thing was also obtained by other researchers before; a study by Albati et al. concluded no relationship exists between gender and self-medication behavior in adolescents aged 13–18 years.[7] Other researchers concluded that sociodemographic factors such as age, gender, occupation, and level of occupational knowledge were significantly related to self-medication behavior.[16] Other researchers concluded that there was a relationship between gender and rationality of drug use. This is because women are more actively involved in the health of family members than men. In addition, mothers tend to provide stocks of certain drugs at home. Women have a higher level of socialization to exchange health information and medicines used; this can affect the rationality of self-medication.[17]

This study shows a significant relationship between parental education level and self-medication rationality. Similar research results obtained by previous studies say that the higher the parent's education, the better the level of parental self-medication knowledge. The role of parents, especially mothers, is vital in the development of children, starting from physical, mental, psychosocial, and spiritual development; besides that, mothers also play a central role in determining health care or selecting medicines to be used in the household. The level of public knowledge will affect the behavior of drug use.[18]

Various factors cause the use of drugs to be irrational, including a low level of knowledge so that advertisements and drug promotions easily tempt it, limitations to seeking drug information through social media or the internet from trusted sources, reluctance to read the information on medicinal products consumed, especially indications and how to use drugs. When doing self-medication, knowledge of drug selection according to the disease and how to use it will have an impact on safe and rational self-medication. It will not have an impact on the emergence of adverse effects from drug use or waste of medical expenses.[16,19,20]

Based on the characteristics of education level, other studies found that people with low education levels correlated with low knowledge of self-medication, so this group usually chose to see a doctor rather than do self-medication. The higher a person's education, the more likely they are to do self-medication because they can seek medical advice and drug information through mass media and the internet from reliable reference sources.[21]

The results of this study showed no significant relationship between the economic level and rationality of drug use. In contrast to the study in China, it was concluded that low-income groups tend to self-medicate using limited over-the-counter drugs compared to prescription drugs. This may be due to the high cost of medication.[22] Economic level is usually aligned with education level. High education and high economic level groups usually have higher health care, more accessible access to health facilities, and tend to have health insurance.

This study found that the level of knowledge of self-medication was significantly related to the rationality of drug use. The results of a survey conducted by Lee et al.[23] said that respondents with low levels of self-medication knowledge, poor health behaviors such as smoking, and alcohol consumption tend to carry out irrational self-medication practices such as adolescents who consume alcohol and smoking are related, and more likely to carry out irrational self-medication practices. According to indications, the level of education and knowledge about the disease and drugs affects the rationality of treatment. Various means can be used to obtain drug information, and consultation with pharmacists in pharmacies can improve treatment rationality. Alternative, practical, cheap, and effective treatment is the reason for the increasing prevalence of self-medication continuing to increase.[8,24] Knowledge about drugs can be obtained through drug packaging, which contains information on active ingredients, dosage, how to use, duration of use, and side effects of the drug. In contrast to other researchers, it is said that the living environment, community conditions, and the active role of pharmacists or other health workers affect the rationality of self-medication even though the knowledge of self-medication is still low.

Poor self-medication behavior is feared to trigger irrational drug use behavior, especially if the culture has been embedded in a person's

mindset in determining how to use drugs, which will have a terrible impact when the person becomes a parent and repeats the same way in determining the use and selection of drugs for their children which can trigger irrational drug use behavior from generation to generation.[8,14,25,26] Holistic coordination and cooperation between the government, food and drug regulatory agencies, pharmacies, and community behavior and awareness are needed to improve the rational use of self-medication. The limitations of this study are that the research location was only carried out in one high school, and several variables such as habit history and diet that affect the degree of disease were not examined in this study.

Conclusion

There is a relationship between the level of knowledge of self-medication and parental education and the rationality of gastritis treatment in adolescents.

Conflict of Interest

The authors do not have any conflict of interest to declare.

Acknowledgment

The authors would like to thank the principal, teachers, and administrative staff of SMAN 28 Jakarta and all research subjects willing to participate in this study.

References

1. Jajuli M, Sinuraya RK. Artikel tinjauan: faktor-faktor yang mempengaruhi dan risiko pengobatan swamedikasi. Farmaka. 2018;16(1):48–53.
2. Kementerian Kesehatan Republik Indonesia. Profil kesehatan Indonesia tahun 2019. Jakarta: Kementerian Kesehatan Republik Indonesia; 2020.
3. Badan Penelitian dan Pengembangan Kesehatan, Kementerian Kesehatan Republik Indonesia. Laporan nasional Riskesdas 2018. Jakarta: Lembaga Penerbit Badan Penelitian dan Pengembangan Kesehatan; 2019.
4. Tauran I, Lameky VY. Pola makan dan kekambuhan gastritis pada mahasiswa di Akademi Keperawatan Rumkit Tk III Dr. J. A. Latumeten Kota Ambon. GHS. 2022;7(1):36–40.
5. Untari EK, Nurbaeti SN, Nansy E. Kajian perilaku swamedikasi penderita tukak peptik yang mengunjungi apotek di Kota Pontianak. J Farm Klin Indones. 2013;2(3):112–20.
6. Sholiha S, Fadholah A, Artanti LO. Tingkat pengetahuan pasien dan rasionalitas swamedikasi di apotek Kecamatan Colomadu. Pharmasipha. 2019;3(2):38–48.
7. Albatti TH, Alawwad S, Aldueb R, Alhoqail R, Almutairi R. The self-medication use among adolescents aged between 13–18 years old; prevalence and behavior, Riyadh – Kingdom of Saudi Arabia, from 2014–2015. Int J Pediatr Adolesc Med. 2017;4(1):19–25.
8. Andarwati R. Hubungan pengetahuan melalui iklan obat (maag) terhadap sikap pemilihan obat untuk swamedikasi pengobatan maag pada masyarakat di dusun V Desa Binjai Baru Kecamatan Talawi. J Ilm PANNMED. 2016;10(3):314–6.
9. Harahap NA, Khairunissa K, Tanuwijaya J. Patient knowledge and rationality of self-medication in three pharmacies in Panyabungan city, Indonesia. JSFK. 2017;3(2):186–92.
10. Gualano MR, Bert F, Passi S, Stillo M, Galis V, Manzoli L, et al. Use of self-medication among adolescents: a systematic review and meta-analysis. Eur J Public Health. 2015;25(3):444–50.
11. Kifle ZD, Mekuria AB, Anteneh DA, Enyew EF. Self-medication practice and associated factors among private health sciences students in Gondar town, North West Ethiopia. A cross-sectional study. Inquiry. 2021;58:469580211005188.
12. Saha A, Marma KKS, Rashid A, Tarannum N, Das S, Chowdhury T, et al. Risk factors associated with self-medication among the indigenous communities of Chittagong Hill Tracts, Bangladesh. PLoS One. 2022;17(6):e0269622.
13. Khalifeh MM, Moore ND, Salameh PR. Self-medication misuse in the Middle East: a systematic literature review. Pharmacol Res Perspect. 2017;5(4):e00323.
14. Azhar MIM, Gunasekaran K, Kadirvelu A, Gurtu S, Sadasivan S, Kshatriya BM. Self-medication : awareness and attitude among Malaysian urban population. IJCRIMPH.

2013;5(6):436–43.
15. Lady F. Ketepatan swamedikasi maag pada pelajar sekolah menengah atas negeri non kesehatan di Kecamatan Pontianak Selatan periode 2019. Jmfarmasi [Internet]. 2019;4(1):40773. Available from: https://jurnal.untan.ac.id/index.php/jmfarmasi/article/view/40773.
16. Kristina SA, Prabandari YS, Sudjaswadi R. Perilaku pengobatan sendiri yang rasional pada masyarakat. BKM. 2007;23(4):176–83.
17. Maipauw G, Meiyanti. Determinants of self-medication rationality in pharmacy visitors. IJMBS. 2021;5(6):122–7.
18. Bimantara L, Rakhmawati E. Hubungan tingkat pendidikan terhadap tingkat pengetahuan orangtua dalam swamedikasi demam pada anak menggunakan obat parasetamol. Java Health J. 2017;4(2):266.
19. Husna HI, Dipahayu D. Pengaruh pengetahuan masyarakat terhadap rasionalitas penggunaan analgesik oral non steroid anti-inflamatory drug golongan non selective COX-1 dan COX-2 secara swamedikasi. J Pharm Sci. 2017;2(2):24–9.
20. Malik AA, Becerra MC, Lash TL, Cranmer LM, Omer SB, Fuad J, et al. Risk factors for adverse events in household contacts prescribed preventive treatment for drug-resistant tuberculosis exposure. Clin Infect Dis. 2021;72(10):1709–15.
21. Suherman H, Febrina D. Pengaruh faktor usia, jenis kelamin, dan pengetahuan terhadap swamedikasi obat. Viva Medika. 2019;10(2):94–108.
22. Chang J, Wang Q, Fang Y. Socioeconomic differences in self-medication among middle-aged and older people: data from the China health and retirement longitudinal study. BMJ Open. 2017;7(12):e017306.
23. Lee CH, Chang FC, Hsu SD, Chi HY, Huang LJ, Yeh MK. Inappropriate self-medication among adolescents and its association with lower medication literacy and substance use. PLoS One. 2017;12(12):e0189199.
24. Handayani DT, Sudarso S, Kusuma AM. Swamedikasi pada mahasiswa kesehatan dan non kesehatan. J Manaj Pelayanan Farm. 2013;3(3):197–202.
25. Wibawa MA, Jaluri PDC, Fakhruddin F. Gambaran tingkat pengetahuan pasien gastritis terhadap swamedikasi dan rasionalitas obat di apotek Kelurahan Mendawai Kota Pangkalan Bun. J Borneo Cendekia. 2020;4(1):97–107.
26. Zulkarni R, Yosmar R, Octafiani I. Hubungan pengetahuan pasien terhadap rasionalitas swamedikasi di beberapa apotek Kecamatan Lubuk Basung. J Sporta Saintika. 2019;4(2):1–9.

Global Medical and Health Communication

Online submission: https://ejournal.unisba.ac.id/index.php/gmhc
DOI: https://doi.org/10.29313/gmhc.v12i1.12158

GMHC. 2024;12(1):18–25
pISSN 2301-9123 | eISSN 2460-5441

RESEARCH ARTICLE

Patient Safety Incident Reporting Challenges in Indonesian Private Hospitals

Ekorini Listiowati,[1] Merita Arini,[1] Mochamad Iqbal Nurmansyah,[2] Emma Rachmawati,[3] Agus Samsudin[4]

[1]Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta, Bantul, Indonesia,
[2]Faculty of Health Sciences, Universitas Islam Negeri Syarif Hidayatullah Jakarta, South Tangerang, Indonesia,
[3]Faculty of Health Sciences, Universitas Muhammadiyah Prof. Dr. Hamka, South Jakarta, Indonesia,
[4]Faculty of Economics, Social and Humanities, Universitas Aisyiyah Yogyakarta, Sleman, Indonesia

Abstract

Reporting patient safety incidents is essential in improving learning and patient safety. It is necessary to identify reporting challenges to improve the reporting process's success. This study assessed the challenges of patient incident reporting and learning systems in Indonesian private hospitals. This qualitative participatory action research is used. In October 2022, data was collected using a videoconferencing application. This study included 34 quality improvement and patient safety team members from 22 private hospitals. In this study, inductive analysis was used. The challenges of patient safety incident reporting are examined in six categories in this study: reporting environment, reporting rules and content, analysis and investigation, governance, action and learning, and patient and family engagement. The challenges mostly come from reporting environment components such as reporting difficulty and ignorance, a lack of time for analysis, the fear of making a mistake in the reporting process, and insufficient management support. Multiple challenges were encountered in different patient safety incident components. A positive environment for reporting patient safety incidents needs a multifaceted approach, including increased hospital leadership commitment and policies and procedures.

Keywords: Incident reporting, Indonesia, patient safety, private hospitals

Introduction

High-quality health care is predicated on patient safety.[1] The emergence of this issue results from the increasing complexity of healthcare systems and the resulting increase in patient harm in healthcare facilities.[2] Unsafe care likely ranks among the top 10 causes of death and disability worldwide.[3] Moreover, conditions are worse in low- and middle-income countries, where an estimated 134 million adverse events due to unsafe care occur in hospitals, leading to 2.6 million deaths. It also has an economic impact; the WHO estimates that 20–40% of all healthcare expenditures worldwide are wasted due to substandard care.[4,5] Data collected from 2015 to 2019 in Indonesia shows that patient safety incidents continue to increase, whereas in 2019, incidents reached 7,465 cases.[6] By increasing opportunities to learn from errors, reporting incidents protects patients from preventable harm.[7] Reporting systems can provide warnings, identify significant problems, and explain their root causes. They play an essential role in raising awareness and fostering a culture of safety.[8] Utilizing incident reporting systems for authentic learning to achieve sustainable risk reductions and improvements in patient safety is needed.[9]

The Indonesian patient safety incident reporting system appeared ineffective due to its inability to collect adequate national incident reporting data and its lack of transparency; these shortcomings impeded national-level learning.[10] Another study revealed that hospital-related factors included a lack of understanding, knowledge, and responsibility for incident reporting, a lack of leadership and institutional culture, and the perception of incident reporting as an additional burden.[11] Another study revealed a lack of knowledge, socialization, or training as practical barriers to incident reporting and fear of reporting as cultural barriers.[12] The Indonesian

Received: 22 June 2023; Revised: 6 December 2023; Accepted: 23 February 2023; Published: 30 April 2024

Correspondence: Ekorini Listiowati. Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta. Jln. Brawijaya, Tamantirto, Kasihan, Bantul 55183, Special Region of Yogyakarta, Indonesia. E-mail: ekorini_santosa@umy.ac.id

government must urgently improve the system by implementing specific regulations and establishing a robust infrastructure at all levels to support incident reporting.[13]

In 2020, the WHO launched patient safety incident reporting and learning systems, whereas the guideline includes a self-assessment that can be used for patient safety incident reporting.[9] The tool is created for exploration and discussion to identify, strengthen, and develop system gaps. The tool identifies patient safety incident reporting and learning systems in the hospital by exploring six big themes, i.e., (1) environment for reporting, (2) reporting rules and content, (3) analysis and investigation, (4) governance, (5) action and learning, and (6) patient and family engagement.[9] As the guidance had already been released when this study was conducted, it was unnecessary to utilize it. This study evaluated Indonesian private hospitals' patient incident reporting and learning systems.

Methods

This research used a qualitative participatory action research approach to explore patient safety incident reporting and learning system challenges. It was a self-reflective inquiry that researchers and participants undertake so they can understand and improve upon the practices in which they participate and the situations in which they find themselves.[14] Before the study, the researchers invited approximately 90 private hospitals, class C and D, members of one hospital group. Hospitals participating in this study were from provinces such as Lampung, Jakarta, West Java, Central Java, East Java, and Yogyakarta. After that, 34 participants from 22 hospitals in classes C and D were willing to participate in this study. Data was collected during October 2022.

Participants (informants) in this study were chosen using an expert sampling technique, one of the purposive sampling methods. Informants were selected based on their knowledge and experience to provide valuable insights related to the research objectives.[15] One or two informants from a hospital's quality improvement and patient safety teams could participate in this study. Those units were selected because the patient safety unit of a hospital is responsible for developing patient safety programs and recording, reporting, and analyzing incidents to build learning solutions. There was a total of 34 participants in this study.

The measurement instrument is based on reporting patient safety incidents and learning systems, including technical reports and guidance from the World Health Organization.[9] It is intended as a tool for exploration and discussion to identify, strengthen, and develop system gaps. It is not limited to health services that already have a system; those without one can also use it. In this study, six semi-structured questions are used to measure six aspects of implementation and challenges, including (1) environment for reporting, (2) reporting rules and content, (3) analysis and investigation, (4) governance, (5) action and learning, and (6) patient and family engagement.

Using a video conferencing platform, the focus group discussion was conducted since the participants came from several cities in Indonesia; hence, it was only possible to gather some participants to meet face-to-face. Participants were separated into two distinct groups. The discussion was moderated by two male researchers, MAS and MIN, and two female researchers, EL and ER. The researchers are university instructors. EL is a lecturer in family medicine and public health, ER and MIN are lecturers in the public health department, and MAS is a lecturer in the management department. The researchers are trained in qualitative research and have relevant experience in the field. The discussion lasted approximately two hours, and interview questions were designed to explore various topics, including challenges and potential strategies for enhancing patient incident reporting and learning systems. Before data collection, informants were provided with information regarding the research's background, the absence of any conflicts of interest, the study's objectives and methods, and those who agreed to participate signed a consent form. Throughout the research process, anonymity and secrecy were maintained. With number 204/EC-KEPK FKIK UMY/X/2022, the Ethics Committee of Research of the Faculty of Medicine and Health Sciences at Muhammadiyah University Yogyakarta granted ethical approval for this study. This study is reported using the consolidated criteria for reporting qualitative checklists (COREQ).[16]

The data were analyzed using thematic content analysis techniques, a method for identifying, analyzing, and reporting data patterns using Microsoft Excel software (Microsoft, Redmond, WA, 2010). Seven steps adapted from Dahlgren

and Fallsberg for the data analysis procedure, including familiarization, condensation, comparison, grouping, articulation, labeling, and contrasting, were conducted.[17] This study used a direct qualitative content analysis where the research topic was previously determined based on the research instruments that covered the six previously mentioned topics.[18] Using the inductive method, themes were then derived from the data, while EL, MA, and MIN performed cross-checks on the themes and codes throughout the analysis.

Results

There were 34 research participants, including 28 females and six males (Table). Most respondents were between 31 and 40, with the youngest 23 years old and the oldest 53 years old. Most respondents were registered nurses (n=21) with a bachelor's degree (n=18). Respondents are officers in each hospital's quality improvement and patient safety units. In addition, the results of this study are comprised of six components: (1) reporting environment; (2) regulations and reporting content; 3) analysis and investigation; (4) management; (5) action and learning; and (6) patient and family participation.

In the reporting environment, ease of report creation, time availability, motivation, and management support are discussed. The results demonstrated that hospital employees still need to comprehend how to create incident reports regarding patient safety. This makes them less motivated to produce reports.

"Due to several reasons such as negative judgment, being busy so they have to make a report later, they don't understand how to make an incident report, laziness, don't have the courage, and because they are afraid of being blamed and judged." (infection and prevention control nurse, 35 years old, female, nurse)

Regarding the motivation and awareness of reporting patient safety incidents, informants reported that health workers were hesitant to report patient safety incidents because they feared negative evaluations, such as poor performance on incidents that had occurred.

"Our colleagues still have a feeling of fear, the sense that they will later become bad for judges of performance when they later report the incident." (Head of Quality Assurance and Patient Safety, 51 years old, female, nurse)

Table Participants' Characteristics

Variables	n=34
Gender	
Male	6
Female	28
Age (years)	
≤30	8
31–40	15
>40	11
Profession	
Nurse	21
Medic (physician, dentist)	8
Others	6
Education	
Diploma	7
Bachelor	18
Master/specialist	9

In addition, the patient safety incidents that must be reported to the Ministry of Health cause the hospital to fear that it will receive an unfavorable evaluation if a patient safety incident is reported.

"It's true that our incident report also has to be reported to the Ministry of Health, but for now, we only want it to come from the hospital environment to improve quality. That's actually what I want to say. I'm not afraid, but I'm still scared that my performance will be negative." (Head of Quality Assurance and Patient Safety, 51 years old, female, nurse)

In addition, there is a problem with reporting near misses in hospitals, where reporting incidents is high but reporting undesirable events is low. This is because hospital personnel fear the negative repercussions of reporting adverse events.

"There are many reports of several incidents, such as near-miss incidents or something that doesn't cause problems like that. But if it's been an adverse event, this is Sentinel. How about this later? This problem needs to be audited or something like that, so why doesn't it feel right? This incident shouldn't happen anymore." (Head

of Quality Committee, 53 years old, female, medical doctor)

On the other hand, near-misses were not reported because the hospital staff believed that the incident had been resolved, so they did not report this type of incident.

"As for the reporting itself, in other hospitals, there may be a lot of near-miss incidents; in fact, in our case, the near-miss incidents are limited because they have been handled. So, it doesn't need to be reported, but related to adverse events, they are often reported." (Secretary of Quality Committee, 40 years old, female, nurse)

Another topic associated with the reporting environment is management support. Informants reported minimal management support for patient safety incident reporting against the sentinel criterion. This is because management is concerned that reporting sentinel events, such as the revocation of hospital permits, will result in repercussions.

"On the other hand, we feel that the directors themselves don't seem to support certain matters to be reported because there is still a feeling of fear, especially with sentinel events, so there is confusion about whether sentinel events must be reported, whether they can affect, for example, hospital license and everything." (Head of Quality Committee, 53 years old, female, medical doctor)

In addition, informants believed that management continued to think that the presence of patient safety incidents indicated subpar performance by hospital personnel. On the other hand, management is considered to be focused on humans as the cause of patient safety incidents and does not view the incident as a systemic issue. This demonstrates that management support for patient safety incident reporting remains restricted.

"So, there are still two opinions when an incident occurs. One considers that it is okay to report due to improvement. But one side of the other management staff believes that the performance in the unit is negative." (Head of Quality Assurance and Patient Safety, 51 years old, female, nurse)

In addition, informants believed that management support for implementing follow-up on patient safety incident recommendations for additional investigations remained minimal.

"For example, there was an incident, and then an analysis of the root of the problem was carried out; it turned out that the end of the problem was that there was no regulation yet, which made a regulation take quite a long time to create the regulation, so that was the obstacle." (Head of Quality Committee, 47 years old, female, nurse)

Several issues relating to the clarity of reporting criteria, training, and mechanisms for patients or their families to submit patient safety incident reports were examined regarding reporting regulations and content. Regarding the clarity of the criteria, the informant stated that the officer did not comprehend the requirements for a patient safety incident. He did not report the occurrence because he believed it was unnecessary. The informant also stated that officers had erroneously reported work safety incidents rather than patient safety.

"In general, it's easy, yes, the only drawback is to report it; this is an incident, but some of the staff don't understand that this is an incident that must be reported immediately and then immediately fill out the form on the RS SIM to report it immediately. This is what sometimes results in low incident reports." (Head of Quality Committee, 53 years old, female, medical doctor)

"But starting from near miss, no harm and adverse events, those who don't understand that. Later, we usually directly discuss things with the head of the room, who comes to report. We read the report, uh, this is included in the near miss report, because this hasn't taken any medication yet, no, it's not no harm incident, if that's the case, it's more like an injury, for example. I have several times received reports related to OSH; for example, the NSA reported it to us, then we clarified that this did not report to us." (Head of Quality Committee, 47 years old, female, nurse)

Officers had difficulty classifying the incident as a near-injury, a potential injury, or an unwelcome occurrence. This is because officers need to comprehend the criteria for each incident. In addition, informants from mental hospitals

reported that officers sometimes lacked clarity regarding whether a given incident constituted a patient safety incident or was caused by the patient's condition.

"Then, related to the Sentinel, we might be confused if we were in a psychiatric hospital. Is this because of the patient's condition? According to friends, this is sometimes not because of unexpected events but because of the patient's condition. This is what sometimes makes our colleague think that this is not a sentinel like that." (Head of Quality Assurance and Patient Safety, 51 years old, female, nurse)

The study results also indicate a need for more training and education regarding reporting patient safety incidents.

"After participating in the training, the staff earlier understood that they had already started trying to make an analysis. However, our colleague is doing the analysis, and the others could be more confident, so they are still groping around." (Secretary of Quality Committee, 37 years old, female, hospital administrator)

The final topic examined is how patients or their families submit patient safety incident reports. It has been determined that forms for reporting patient safety incidents by patients and patient families are available. The mechanism still needs to be implemented, so reporting has yet to go smoothly.

"Indeed, there is (a patient reporting mechanism), but it still needs to be implemented. We've tried to make the form, but we still need the mechanism. For the form, there is a simple form, how to report or maybe report it to the staff later, the new staff will report it, it's not very clear." (Head of Quality Committee, 47 years old, female, nurse)

The implementation of incident analysis and investigation is explained in the analysis and investigation section, and the confidentiality of reporting and the use of the patient safety incident reporting information system are discussed in the management section. The outcomes demonstrated that hospital personnel needed to comprehend the analysis of patient safety incident reporting.

"For this follow-up analysis, the unit's confidence is still low in our hospital, so they often ask us to join the quality committee. There is a sub-committee for patient safety in the next room. Usually, the person in charge indeed contacts us directly, so later in the grading, we have to guide it for discussion like that, so later they try to make it first, and then we guide." (Head of Quality Committee, 41 years old, female, medical doctor)

Additionally, it was discovered that the hospital safety unit continued to hold concurrent positions with other hospital positions. This hinders their performance of their duties, particularly regarding further analysis and investigation.

"But in terms of analysis and grading, they are still not very confident, and they still often ask the quality committee if the quality committee is still not fully functioning correctly because they still hold multiple positions; in other words, this quality committee is only for accreditation." (Secretary of Quality Committee, 37 years old, female, nurse)

On the other hand, some hospitals have conducted a thorough analysis, categorizing the causes of patient safety incidents based on their origins and involving experts, hospital administrators, and the HRD department. Concerning the confidentiality and anonymity of reporting, all informants stated that privacy and anonymity were ensured in both the printed form and the information system. Regarding ease of reporting, the study results indicate that some hospitals still use manual forms (rather than information systems) where hospital staff believe it is challenging to report patient safety incidents. Manual reporting necessitates the completion of multiple forms, which can interfere with other tasks.

"Where we report, it is still manual, so if we take it from the first discussion, their reporting is still low because too much should be written based on sheets adopted from the Ministry of Health." (Secretary of Quality Committee, 37 years old, female, nurse)

In terms of action and learning, support for staff involved in incidents is discussed. The

formulation of actions to reduce patient safety incidents was discussed in terms of involving patients and families. The Human Resources department assists personnel involved in reporting patient safety incidents. Patient participation in the reporting and analyzing of patient safety incidents has yet to be carried out optimally. In Indonesian health services, there has yet to be a culture in which patients discuss safety incidents and formulate actions to reduce patient safety incidents. In addition, the hospital is concerned that they will be held accountable if they disclose patient safety incidents to their patients.

"It has yet to be entrenched in Indonesia, so we must be careful about incidents there. Looking for the right words, so that we are good, everything is like that, more towards us not wanting incidents, no. But internally, we take lessons, we immediately take care of them, don't make omissions, but we don't convey (to the patient) the discussion yet." (Head of Quality Committee 47 years old, female, nurse)

Discussion

The study results indicate that the patient safety system faces numerous obstacles. The reporting environment presents the most barriers. According to the study results, manual reporting is one of the obstacles to reporting patient safety incidents. Manual reporting requires the creator to write down and send the file, which is not considered concise. As shown in this study, computerized reporting systems are regarded as more efficient in facilitating the reporting of patient safety incidents.[19] According to a study conducted in Brazil, computer-based reporting of patient safety incidents in hospitals can increase the number of volunteers reporting quality incidents.[20]

The study's results indicated that some staff must still comprehend patient safety incident report preparation or analysis. According to studies, medical professionals must still understand the reporting system for patient safety incidents.[21] When reporting incidents involving patient safety, inadequate training is one of the causes of confusion among healthcare workers. Similar research conducted in Indonesia indicates that training related to incident reporting is still inadequate in all hospitals, and some healthcare professionals believe that the government pays insufficient attention to reporting patient safety incidents.[11] Additionally, research conducted in South Korea indicates that there still needs to be more knowledge and skills about incident reporting, such as using tools such as root cause analysis and failure mode and effects analysis, what should be reported, and how to report.[22]

A lack of staff motivation to report patient safety incidents is one of the obstacles to accomplishing this. This is due to negative judgment in reporting patient safety incidents. The obstacles include a culture of shaming and blaming, a lack of time to report, a lack of knowledge of the reporting system, and a lack of management support.[21] The emphasis must shift from the individual to the system, with an emphasis on learning rather than punishment and disciplinary sanctions; the recent opioid epidemic is an illustration of ineffective guidelines. Unfortunately, the leading cause of underreporting is fear of sanctions.[23]

One of the barriers to reporting patient safety incidents is the need for more feedback from management regarding patient safety incidents. Due to the lack of feedback, it was also possible for reporters to become cynical about the incident reporting system, which could have a demoralizing effect and serve as a reason not to use the incident reporting system.[24] The role of leadership, the credibility and content of information, effective dissemination channels, the capacity for rapid action, and the requirement for feedback at all organizational levels are needed for healthcare organizations to learn from care delivery failures; incident reporting systems must provide effective feedback.[25]

Since only one subset of non-profit private hospitals participated in this study, it is impossible to generalize the findings to cover all hospital types in Indonesia. This study is the first to examine the reporting of patient safety incidents and the learning system by WHO recommendations. Therefore, additional research is required to assess the incident reporting and learning system in Indonesia's other types of hospitals.

Conclusions

Multiple challenges were encountered in different patient safety incident components. The reporting environment, which could have been more conducive to reporting patient safety incidents, presented the most significant challenges. The

ease of reporting and management support must be improved to improve incident reporting. Education and training should be provided for hospital staff and management to enhance their understanding of the importance of the incident reporting system and create a positive reporting environment. Moreover, this study emphasizes leadership and organization support and feedback in order to support a positive environment for incident reporting.

Conflict of Interest

All of the authors declare no conflict of interest.

Acknowledgment

We want to thank Universitas Muhammadiyah Yogyakarta for supporting this study.

References

1. Mitchell PH. Defining patient safety and quality care. In: Hughes RG, editor. Patient safety and quality: an evidence-based handbook for nurses [e-book]. Rockville: Agency for Healthcare Research and Quality; 2008 [cited 2023 May 31]: Chapter 1. Available from: https://www.ncbi.nlm.nih.gov/books/NBK2681.
2. World Health Organization. Patient safety [Internet]. Geneva: World Health Organization; 2019 [cited 2023 May 31]. Available from: https://www.who.int/news-room/fact-sheets/detail/patient-safety.
3. World Health Organization. Global action on patient safety. Geneva: World Health Organization; 2019 [cited 2023 June 3]. Available from: https://apps.who.int/gb/ebwha/pdf_files/WHA72/A72_R6-en.pdf.
4. National Academies of Sciences, Engineering, and Medicine; Health and Medicine Division; Board on Health Care Services; Board on Global Health; Committee on Improving the Quality of Health Care Globally. Crossing the global quality chasm: improving health care worldwide. Washington DC: National Academies Press; 2018.
5. Yip W, Hafez R. Improving health system efficiency: reforms for improving the efficiency of health systems: lessons from 10 country cases [Internet]. Geneva: WHO Press; 2015. Available from: https://iris.who.int/bitstream/handle/10665/185989/WHO_HIS_HGF_SR_15.1_eng.pdf.
6. Daud A. Sistem pelaporan dan pembelajaran keselamatan pasien nasional (SP2KPN) [Internet]. Jakarta Selatan: Perhimpunan Rumah Sakit Seluruh \ (PERSI): 2020 [cited 2023 Mar 15]. Available from: https://persi.or.id/wp-content/uploads/2020/08/materi_drarjaty_ereport_web060820.pdf.
7. Hegarty J, Flaherty SJ, Saab MM, Goodwin J, Walshe N, Wills T, et al. An international perspective on definitions and terminology used to describe serious reportable patient safety incidents: a systematic review. J Patient Saf. 2021;17(8):e1247–54.
8. Vincent C. Incident reporting and patient safety. BMJ. 2007;334(7584):51.
9. World Health Organization. Patient safety incident reporting and learning systems: technical report and guidance. Geneva: World Health Organization; 2020.
10. Dhamanti I, Leggat S, Barraclough S, Liao HH, Abu Bakar N. Comparison of patient safety incident reporting systems in Taiwan, Malaysia, and Indonesia. J Patient Saf. 2021;17(4):e299–305.
11. Dhamanti I, Leggat S, Barraclough S, Rachman T. Factors contributing to under-reporting patient safety incidents in Indonesia: leaders' perspectives. F1000Res. 2021;10:367.
12. Dhamanti I, Leggat S, Barraclough S. Practical and cultural barriers to reporting incidents among health workers in Indonesian public hospitals. J Multidiscip Healthc. 2020;13:351–9.
13. Dhamanti I, Leggat S, Barraclough S, Tjahjono B. Patient safety incident reporting in Indonesia: an analysis using world health organization characteristics for successful reporting. Risk Manag Health Policy. 2019;12:331–8.
14. Cornish F, Breton N, Moreno-Tabarez U, Delgado J, Rua M, de-Graft Aikins A, et al. Participatory action research. Nat Rev Methods Primers. 2023;3:34.
15. Frey BB, editor. The SAGE encyclopedia of educational research, measurement, and evaluation. Thousand Oaks: SAGE Publications, Inc.; 2018. Available from: https://methods.sagepub.com/reference/the-sage-encyclopedia-of-educational-research-measurement-and-evaluation.

16. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. Int J Qual Health Care. 2007;19(6):349–57.
17. Abeysena H. Countering practices of linguistic shame and shaming in English language teaching in Sri Lanka. PhD [dissertation]. Burwood, Australia: Deakin University; 2020. Available from: https://hdl.handle.net/10779/DRO/DU:22558498.v1.
18. Kibiswa NK. Directed qualitative content analysis (DQlCA): a tool for conflict analysis. Qual Rep. 2019;24(8):2059–79.
19. Budi SC, Sunartini S, Dewi FST, Lazuardi L, Rokhman N. Incident reporting development: PaSIR (patient safety incident reporting) system for better patient safety. J Aisyah. 2022;7(4):1097–104.
20. Capucho HC, Arnas ER, Cassiani SHDB. Patient safety: a comparison between handwritten and computerized voluntary incident reporting. Rev Gaucha Enferm. 2013;34(1):164–72.
21. Nurdin DA, Wibowo A. Barriers to reporting patient safety incident in healthcare workers: integrative literature review. JAKI. 2021;9(2):210–7.
22. Hwang JI, Lee SI, Park HA. Barriers to operating patient safety incident reporting systems in Korean general hospitals. Healthc Inform Res. 2012;18(4):279–86.
23. Brattebø G, Flaatten HK. Errors in medicine: punishment versus learning medical adverse events revisited - expanding the frame. Curr Opin Anaesthesiol. 2023;36(2):240–5.
24. Hewitt T, Chreim S, Forster A. Incident reporting systems: a comparative study of two hospital divisions. Arch Public Health. 2016;74:34.
25. Benn J, Koutantji M, Wallace L, Spurgeon P, Rejman M, Healey A, et al. Feedback from incident reporting: information and action to improve patient safety. Qual Saf Health Care. 2009;18(1):11–21.

Global Medical and Health Communication

Online submission: https://ejournal.unisba.ac.id/index.php/gmhc
DOI: https://doi.org/10.29313/gmhc.v12i1.11953

GMHC. 2024;12(1):26–30
pISSN 2301-9123 | eISSN 2460-5441

RESEARCH ARTICLE

Vitamin D Levels and Their Correlation with Predisposing Factors and Estimated Fetal Weight in Third Trimester of Pregnancy: an Observational Study

Dwiwahju Dian Indahwati,[1] Diana Krisanti Jasaputra,[2] Arief Budiono,[1] Julia Windi Gunadi,[3] Ronny Lesmana,[4,5] Steven Zerin Putra Kusmawan[6]

[1]Department of Obstetrics and Gynecology, Immanuel Hospital, Bandung, Indonesia,
[2]Department of Pharmacology, Faculty of Medicine, Universitas Kristen Maranatha, Bandung, Indonesia,
[3]Department of Physiology, Faculty of Medicine, Universitas Kristen Maranatha, Bandung, Indonesia,
[4]Department of Biomedical Sciences, Faculty of Medicine, Universitas Padjadjaran, Sumedang, Indonesia,
[5]Physiology Molecular Laboratory, Biological Activity Division, Central Laboratory, Universitas Padjadjaran, Sumedang, Indonesia, [6]Faculty of Medicine, Universitas Kristen Maranatha, Bandung, Indonesia

Abstract

Vitamin D has a broad impact on the human body, including affecting the bones and the immune system. Vitamin D deficiency in pregnant women is a risk factor in several circumstances, such as preeclampsia, gestational diabetes, premature birth, and low birth weight babies. This study aimed to determine the vitamin D levels and their relationship to predisposing factors and estimated fetal weight in the third trimester of pregnancy. Eighteen pregnant women in their third trimester of pregnancy who received antenatal care in the Obstetric Clinic of Immanuel Hospital Bandung from January to December 2022 were used as subjects of this study. The inclusion criteria are third-trimester pregnant women, healthy, while the exclusion criteria are currently taking drugs that have side effects in pregnancy or having pregnancy disorders. Blood was taken to measure vitamin D levels, fetal weight was estimated with obstetric ultrasound, and the subjects filled in questionnaires about predisposing factors. The results showed ten pregnant women (56%) had vitamin D deficiency below 20 ng/mL in their third-trimester pregnancy. We found non-significant relationships ($p>0.05$) between predisposing factors (daily consumption of vitamin D, sun exposure, maternal age), estimated fetal weight, and vitamin D levels. This study concludes that 56% of pregnant women in their third trimester of pregnancy have vitamin D deficiency with no significant relationship with its predisposing factors and estimated fetal weight.

Keywords: Daily consumption, fetal weight, maternal age, third-trimester pregnant women, vitamin D

Introduction

Vitamin D has a broad impact on the human body, including affecting the bones and the immune system.[1] Vitamin D receptors are present in almost all cells in the body. Vitamin D can enter cells and affect the cell nucleus. Vitamin D also functions as a hormone and vitamin D affects genes in the cell nucleus.[2] A deficiency of vitamin D will cause disturbances in the brain, causing insomnia, sleep apnea, anxiety, and depression.[3]

Vitamin D, which can increase the immune system against viruses, can also reduce symptoms of sinusitis. Vitamin D, which has an anti-inflammatory effect, also helps reduce inflammation in these sufferers. Every immune cell has a vitamin D receptor, which controls cytokine storms and self-defense in autoimmune and allergic diseases.[4] A deficiency of vitamin D will cause muscle cramps, which is related to calcium, which plays a role in muscle contraction.[5] A deficiency of vitamin D dramatically affects bones and teeth. A person deficient in vitamin D and calcium can not reach optimum development for the teeth and bones.[6]

Vitamin D in pregnant women plays a vital role, including maintaining the baby's health in the womb. Previous studies have shown that the incidence of vitamin D deficiency and insufficiency during pregnancy ranges from 27.0% to 91.0% in the United States, 39.0% to 65.0% in Canada, 45.0% to 100.0% in Asia,

Received: 24 May 2023; Revised: 20 December 2023; Accepted: 17 January 2023; Published: 30 April 2024

Correspondence: Diana Krisanti Jasaputra. Department of Pharmacology, Faculty of Medicine, Universitas Kristen Maranatha. Jln. Prof. drg. Surya Sumantri, M.P.H. No. 65, Bandung 40164, West Java, Indonesia. E-mail: dianakjasaputra14@gmail.com

19.0% to 96.0% in Europe, and 25.0% to 87.0% in Australia and New Zealand.[7]

Vitamin D deficiency that occurs at the age of five or when the baby is in the womb can increase the risk of experiencing bone malformations, such as abnormalities in the maxillary bone, and it becomes easy to experience scoliosis, kyphosis, lordosis, flat feet, rickettsia.[6] Without vitamin D, bones become soft (osteomalacia), and osteoporosis can occur.[6,8] Abnormalities in bones and teeth can be prevented by giving pregnant women and nursing mothers sufficient vitamin D. An observational study in Istanbul has proven that vitamin D deficiency was significantly related to daily vitamin intake and clothing style.[9] Other research found that age over 30, parity over 2, BMI, and hyperlipemia are risk factors for vitamin D deficiency in pregnant women.[10] The occurrence of early gestation age was also found to be higher in pregnant women with vitamin D deficiency.[11] But studies about the prevalence of vitamin D deficiency, its predisposing factors, and outcomes at the Obstetric Clinic of Immanuel Hospital Bandung are still limited. Therefore, this study aimed to determine whether there is a vitamin D deficiency with its correlation to predisposing factors and estimated fetal weight in third-trimester pregnant women.

Methods

This research is an analytic observational study with a transversal approach, namely a cross-sectional design. Vitamin D levels in the blood of third-trimester pregnant women were measured by examining a total of 25(OH)D using the ELISA method. The machine used for vitamin D measurement was the Abbott Architect i1000SR Immunoassay System (STEM-AIAEPO-0170-LGZ; Abbott Laboratories; USA). The kit used in the study was ARCHITECT 25-OH Vitamin D 5P02 (G95619R03-B5P02X; Abbott Laboratories, Ireland). Fetal weight is measured using obstetric ultrasonography with an ultrasound (Sonoscope S6, portable color Doppler ultrasound). This research has received ethical approval from the Health Research Ethics Committee at Immanuel Bandung Hospital with number 15/A01/EC/III/2022. This research was conducted at Immanuel Hospital Bandung from January 2022 to December 2022. The subjects of this study are third-trimester pregnant women who received antenatal care at Immanuel Hospital, Bandung. The method of sampling is consecutive sampling. The population of research subjects was obtained from the gynecology polyclinic at Immanuel Hospital with inclusion criteria for third-trimester pregnant women, healthy, and with exclusion criteria (1) currently taking drugs that have side effects in pregnancy (tetracycline, thalidomide, phenytoin), (2) have pregnancy disorders (eclampsia, preeclampsia, thyroid disorders). The sample size is calculated with the cross-sectional formula that resulted in 18 for a minimal sample size.[12]

The research procedures were as follows: (1) the researcher explained to the prospective research subjects the background, objectives, and research procedures, (2) if the prospective research subjects were willing, then the research subjects were asked to sign informed consent, (3) the research subject's blood was taken for examination of vitamin D levels in the Hospital Clinical Pathology Laboratory, (4) research subjects examined fetal weight using obstetric ultrasonography (Sonoscope S6, portable color doppler ultrasound) (5) questionnaire regarding daily consumption of vitamin D and food contains high vitamin D (fish and milk), sun exposure was given to the patients to be filled in, (6) data on the results of an examination of vitamin D levels in the blood of pregnant women, questionnaire about daily consumption of vitamin D and sun exposure, fetal weight were collected, processed, and analyzed with SPSS. The simple linear regression method is used to determine the correlation between predisposing factors, maternal age, and estimated fetal weight and vitamin D levels.

Results

The results showed that out of 18 research subjects, eight people had normal vitamin D levels (>20 ng/ml), and ten other people (56%) had vitamin D deficiency with levels below 20 ng/ml. Recommendations for normal vitamin D levels (cut off) in pregnant women are 20 ng/ml.[13] The result of vitamin D levels is shown in Figure.

Table 1 shows research results of vitamin D levels estimated fetal body weight in 18 pregnant women in the third trimester. Table 2 shows the relationship between predisposing factors (maternal age, daily consumption of vitamin D from fish, supplementation, milk, and sun

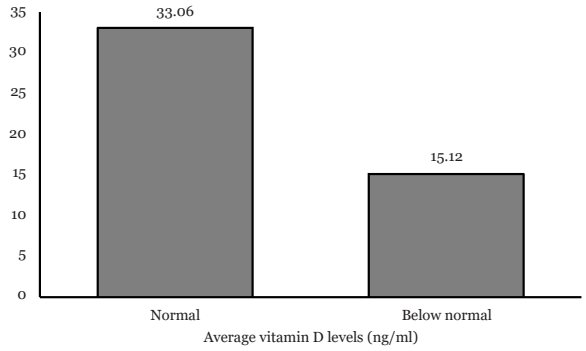

Figure Average Vitamin D Levels in Study Subjects

exposure) and vitamin D levels. The results showed a non-significant relationship between predisposing factors and vitamin D levels.

Discussion

The results showed that out of 18 pregnant women in the third trimester, 10 had vitamin D deficiency with levels below 20 ng/ml. Vitamin D deficiency in pregnant women is a risk factor in several circumstances, such as preeclampsia, gestational diabetes, premature birth, and low birth weight babies.[14] Vitamin D levels in the blood of pregnant women and fetal weight based on statistical tests conducted in this study showed no relationship between vitamin D levels in the blood of pregnant women and fetal weight. It can be seen from the $p>0.05$ value analyzed by the simple linear regression parametric method.

Table 1 Research Results of Vitamin D Levels Estimated Fetal Body Weight in 18 Pregnant Women in the Third Trimester

No.	Vitamin D Levels (ng/ml)	Estimated Fetal Body Weight (grams)
1	34.2	2,504
2	17.5	2,175
3	16.8	2,136
4	27.1	1,884
5	45.8	2,300
6	18.8	1,285
7	12.0	2,700
8	21.7	2,250
9	22.1	2,720
10	18.8	1,468
11	42.8	1,500
12	11.5	2,097
13	11.2	2,800
14	12.3	1,636
15	15.3	2,950
16	45.5	2,100
17	17.0	1,712
18	25.3	2,316

This study also gave some questionnaires to the study subjects to analyze the relationship between maternal age, daily consumption of food and drink containing high vitamin D, vitamin D supplementation, sun exposure, estimated fetal weight based on ultrasound, and vitamin D deficiency. The results found no significant relationship between those factors and vitamin D levels. According to a previous study, high vitamin D levels were found in populations that consume a lot of fish oil, tuna, salmon, and eggs and people exposed to sunlight in the arm and leg area.[15] Vitamin D in pregnancy is also related to the development of the fetus; if there is a deficiency or insufficiency of vitamin D in the mother, it will directly affect the fetus in the womb. During pregnancy, the mother needs 4–5 times the 1,25(OH)2D, calcitriol, and calcium to develop fetal bone.[14] The need for daily vitamin D in pregnant women is the same as the need for vitamin D in non-pregnant women with an age interval of 0–50 years, which is 200 IU/day.[13]

Fetal weight growth is associated with increased maternal calcium mobilization to fetal, especially in bone mineralization. In the growth and development of intrauterine pregnancy, the fetus depends on maternal nutrition, calcium levels, and 25(OH)D in the maternal.[14] Vitamin D deficiency can also be influenced by ethnicity, vitamin D supplementation, body mass index, seasonality, and boundary differences that are used as a reference to determine vitamin D deficiency in certain studies.[1,10,16,17]

Vitamin D deficiency is defined as serum levels of 25-hydroxy vitamin D less than 20 ng/ml, and vitamin D insufficiency is defined as serum levels of 25-hydroxy vitamin D 20–30 ng/ml.[13,18] The best biomarker for diagnosing vitamin D deficiency is measuring 25-hydroxy vitamin D. Vitamin D deficiency can be caused in several cases, such as decreased food intake or absorption and insufficient sun exposure. Sun exposure is the largest source of vitamin D that can be absorbed through the skin by 50–90%.

Table 2 Relationship between Predisposing Factors and Vitamin D Levels

Predisposing Factors	Vitamin D Levels		Total (n=18)	p
	Normal (n=8)	Deficiency (n=10)		
Maternal age (years)				
<30	5	7	12	>0.05
≥30	3	3	6	
Eating fish				
Yes	4	5	9	>0.05
No	4	5	9	
Vitamin D3 supplementation				
Yes	7	5	12	>0.05
No	1	5	6	
Exposure to sunlight for ≥30 minutes				
Yes	8	9	17	>0.05
No	0	1	1	

Therefore, it is tough to maintain vitamin D levels if only from food sources.[19,20] Endogenous synthesis is reduced due to chronic liver disease and kidney failure, as well as increased hepatic catabolism mediated by drugs that can activate vitamin D degradation, such as nifedipine, spironolactone, and clotrimazole.[21]

Previous studies on 3,658 pregnant women showed a correlation between vitamin D levels and fetal weight.[22] Another study with a sample size of 1,491 showed that any increase in vitamin D levels of 10 nmol/l in the umbilical cord would increase the body weight of the fetus by 61 mg at a concentration of vitamin D levels less than 40 nmol/l.[23] The vitamin D3 requirement of pregnant women is 1,000–4,000 IU per day for maximum results.[24]

The strength of this study is it supported other studies that found vitamin D deficiency in pregnant women, especially in the third trimester. Late pregnancy is associated with higher calcium demands, which is associated with vitamin D status. Therefore, vitamin D is needed to ensure optimal fetal skeletal development and maternal and fetal health.

The limitations of this study are (1) the small sample size that might not be able to describe the accurate correlation between daily consumption of vitamin D, sun exposure, maternal age, and estimated fetal weight with vitamin D levels in third-trimester pregnant women; (2) vitamin D levels only examined at a one-time point at third-trimester. If the measurements were also conducted at the first and second trimesters, the results might show vitamin D modulation throughout the pregnancy process; (3) other predisposing factors and outcomes such as low socioeconomic and educational status, covered clothing style, parity, BMI, and lipid profile were not examined in this study. Those factors might correlate with vitamin D levels in pregnant women.

Further studies need to be conducted in larger sample sizes, at several time points (first, second, and third semester), and other risk factors that might be in correlation with vitamin D levels in pregnant women need to be examined.

Conclusions

This study concludes that 56% of pregnant women in their third trimester of pregnancy have vitamin D deficiency. This study also found no correlation between daily vitamin D consumption, sun exposure, maternal age, and estimated fetal weight with vitamin D levels.

Conflict of Interest

The authors declared no conflict of interest.

Acknowledgment

We would like to thank Immanuel Hospital's clinical laboratory, which has allowed us a vitamin D level examination. This study is supported

by Hibah Internal from Maranatha Christian University to DDI and AB with 034/SK/ADD/UKM/2021.

References

1. Bishop EL, Ismailova A, Dimeloe S, Hewison M, White JH. Vitamin D and immune regulation: antibacterial, antiviral, anti-inflammatory. JBMR Plus. 2021;5(1):e10405.
2. Sassi F, Tamone C, D'Amelio P. Vitamin D: nutrient, hormone, and immunomodulator. Nutrients. 2018;10(11):1656.
3. Eyles DW. Vitamin D: brain and behavior. JBMR Plus. 2021;5(1):e10419.
4. Ao T, Kikuta J, Ishii M. The effects of vitamin D on immune system and inflammatory diseases. Biomolecules. 2021;11(11):1624.
5. Gunton JE, Girgis CM. Vitamin D and muscle. Bone Rep. 2018;8:163–7.
6. Zihni Korkmaz M, Yemenoğlu H, Günaçar DN, Ustaoğlu G, Ateş Yildirim E. The effects of vitamin D deficiency on mandibular bone structure: a retrospective radiological study. Oral Radiol. 2023;39(1):67–74.
7. Woon FC, Chin YS, Ismail IH, Batterham M, Abdul Latiff AH, Gan WY, et al. Vitamin D deficiency during pregnancy and its associated factors among third-trimester Malaysian pregnant women. PLoS One. 2019;14(6):e0216439.
8. Minisola S, Colangelo L, Pepe J, Diacinti D, Cipriani C, Rao SD. Osteomalacia and vitamin D status: a clinical update 2020. JBMR Plus. 2021;5(1):e10447.
9. Özdemir AA, Ercan Gündemir Y, Küçük M, Yıldıran Sarıcı D, Elgörmüş Y, Çağ Y, et al. Vitamin D deficiency in pregnant women and their infants. J Clin Res Pediatr Endocrinol. 2018;10(1):44–50.
10. Yang C, Jing W, Ge S, Sun W. Vitamin D status and vitamin D deficiency risk factors among pregnancy of Shanghai in China. BMC Pregnancy Childbirth. 2021;21:431.
11. Chen B, Chen Y, Xu Y. Vitamin D deficiency in pregnant women: Influenced by multiple risk factors and increase the risks of spontaneous abortion and small-for-gestational-age. Medicine (Baltimore). 2021;100(41):e27505.
12. Husna MFC, Lestari PM, Syamsuri AK, Theodorus T. Accuracy tests of serum vitamin D and calcium levels in chorioamnionitis patients with preterm labor. Indones J Obstet Gynecol. 2020;8(3):137–41.
13. Gao F, Guo F, Zhang Y, Yuan Y, Chen D, Bai G. Vitamin A, D, and E levels and reference ranges for pregnant women: a cross-sectional study 2017–2019. Front Nutr. 2021;8:628902.
14. Agarwal S, Kovilam O, Agrawal DK. Vitamin D and its impact on maternal-fetal outcomes in pregnancy: a critical review. Crit Rev Food Sci Nutr. 2018;58(5):755–69.
15. Al Zarooni AAR, Nagelkerke N, Al Marzouqi FI, Al Darmaki SH. Risk factors for vitamin D deficiency in Abu Dhabi Emirati population. PLoS One. 2022;17(2):e0264064.
16. Meltzer DO, Best TJ, Zhang H, Vokes T, Arora VM, Solway J. Association of vitamin D levels, race/ethnicity, and clinical characteristics with COVID-19 test results. JAMA Netw Open. 2021;4(3):e214117.
17. Correia A, Azevedo M do S, Gondim F, Bandeira F. Ethnic aspects of vitamin D deficiency. Arq Bras Endocrinol Metabol. 2014;58(5):540–4.
18. Amrein K, Scherkl M, Hoffmann M, Neuwersch-Sommeregger S, Köstenberger M, Tmava Berisha A, et al. Vitamin D deficiency 2.0: an update on the current status worldwide. Eur J Clin Nutr. 2020;74(11):1498–513.
19. Raymond-Lezman JR, Riskin SI. Benefits and risks of sun exposure to maintain adequate vitamin D levels. Cureus. 2023;15(5):e38578.
20. Knuschke P. Sun exposure and vitamin D. Curr Probl Dermatol. 2021;55:296–315.
21. Keane JT, Elangovan H, Stokes RA, Gunton JE. Vitamin D and the liver—correlation or cause? Nutrients. 2018;10(4):496.
22. Chen YH, Fu L, Hao JH, Yu Z, Zhu P, Wang H, et al. Maternal vitamin D deficiency during pregnancy elevates the risks of early gestational age and low birth weight infants in the Chinese population. J Clin Endocrinol Metab. 2015;100(5):1912–9.
23. Zhu P, Tong SL, Hu WB, Hao JH, Tao RX, Huang K, et al. Cord blood 25-hydroxyvitamin D and fetal growth in the China-Anhui Birth Cohort study. Sci Rep. 2015;5:14930.
24. Pérez-López FR, Pilz S, Chedraui P. Vitamin D supplementation during pregnancy: an overview. Curr Opin Obstet Gynecol. 2020;32(5):316–21.

Global Medical and Health Communication

Online submission: https://ejournal.unisba.ac.id/index.php/gmhc
DOI: https://doi.org/10.29313/gmhc.v12i1.12410

GMHC. 2024;12(1):31–36
pISSN 2301-9123 | eISSN 2460-5441

RESEARCH ARTICLE

Epidemiologic Spatial Analysis of a Tuberculosis Incidence in Bandung City in 2021

Dony Septriana Rosady,[1] Nysa Ro Aina Zulfa,[2] Sony Bagja Pratama[3]

[1]Department of Bioethics and Medical Humanities, Faculty of Medicine, Universitas Islam Bandung, Bandung, Indonesia, [2]Department of Epidemiology, Faculty of Public Health, Universitas Indonesia, Depok, Indonesia, [3]Department of Urban and Rural Planning, Faculty of Science and Technology, Universitas Terbuka, Tangerang Selatan, Indonesia

Abstract

Tuberculosis (TB) is a communicable disease that is a significant cause of ill health and one of the leading causes of death worldwide. Tuberculosis remains a major global health problem. Tuberculosis infection remains one of the biggest health problems in Indonesia, which ranked second in the world on the list of countries with a high burden of TB. This is a cross-sectional study where the research displays population data, population density, and the incidence of TB in Bandung city, which is visualized in the mapping. This research analyzed the relationship between population density and the incidence of TB. The area with the highest TB incidence was the Babakan Ciparay subdistrict, with a total of 469 people and a population density of 205 people/hectare. The study has shown a strong relationship and a positive correlation between population density and the incidence of TB in Bandung city ($p<0.001$, $r=0.603$). Tuberculosis cases tend to be higher in areas with high population densities. Besides population density, other factors influence the incidence of TB in an area. House technical factors such as adequacy of windows, air ventilation, and lighting influence TB transmission. Besides that, household sanitation factors and occupancy density also impact the incidence of TB. In conclusion, subdistricts with a high population density show a high incidence of TB. There is a strong and unidirectional relationship between population density and the incidence of TB.

Keywords: Density, population, spatial, tuberculosis

Introduction

Tuberculosis (TB) is a communicable disease that is a significant cause of ill health and one of the leading causes of death worldwide.[1–5] Tuberculosis remains a major global health problem.[6] It affects approximately 10 million people worldwide and kills more than 1 million every year.[7] Tuberculosis infection remains one of the biggest health problems in Indonesia, which ranked second in the world on the list of countries with a high burden of TB.[8,9]

Tuberculosis is caused by the bacillus *Mycobacterium tuberculosis*, which is spread when people who are sick with TB expel bacteria into the air.[10–12] The disease typically affects the lungs (pulmonary TB) but can also affect other sites.[13] Appropriate TB treatment is needed so that treatment can be completed. An unexpected condition in treating TB is the presence of multidrug-resistant TB (MDR).[11,14,15] In this condition, treatment becomes more complex, and costs have the potential to be greater than it should be.

Many studies have shown that there is a relationship between various factors and the incidence of TB.[16–18] Several studies have shown that the incidence of TB is related to social factors such as population density.[16,17,19–21] Areas with a high population density are at greater risk of transmission to the community.[7,22,23]

This study aims to describe the distribution of population and population density and determine the relationship between population density and the incidence of TB. This research was conducted by visualizing distribution maps to make it easier to understand data distribution. Epidemiological spatial analysis makes it easier to read data by mapping according to population density and incidence of tuberculosis.

Received: 4 August 2023; Revised: 10 February 2024; Accepted: 2 March 2024; Published: 30 April 2024

Correspondence: Dony Septriana Rosady, MD, MBA, MSc, MPA. Department of Pharmacology, Faculty of Medicine, Universitas Islam Indonesia. Jln. Tamansari No. 22, Bandung 40116, West Java, Indonesia. E-mail: dony.septriana@unisba.ac.id

Methods

This research is cross-sectional research where the study qualitatively displays population data, population density, and the incidence of TB in Bandung, which is visualized in the mapping. This research quantitatively analyzed the relationship between population density and the incidence of TB. This research uses secondary data from the Bandung City Health Service Office and the Bandung City Population and Civil Registry Service Office for 2021.

The data was processed using ArcGIS software and then visualized as a map of the distribution of TB incidence at the sub-district level. Statistical analysis used SPSS software with the Spearman correlation technique because the independent variable data (population, area, and population density) and the dependent variable (TB incidence) were numerical data that were not normally distributed.

The research has obtained a recommendation for a research permit from the National Unity and Politics Agency of the Bandung City Government with letter number PK.03.04.05/480-BKBP/ III/2023 and the Bandung City Government Health Service Office with letter number B/ PP.06.02/6272-Dinkes/ III/2023.

Results

Bandung city is divided into 30 districts, which carry out administrative functions regarding public services to the community. The results showed that in all sub-districts in Bandung, there were patients diagnosed with TB. The highest incidence of TB was in the Babakan Ciparay sub-district, with 469 cases, followed by the Bojongloa Kaler sub-district, with 428 cases.

In a descriptive view, the incidence of TB in one area is also accompanied by a high population density. This condition needs to be analyzed using statistical analysis to see the relationship and the strength of the correlation between population density and the incidence of TB in an area.

The map of the population density distribution and the TB incidence map illustrates that areas with a high-density level tend to be accompanied by a high incidence of TB. Furthermore, statistical analysis using the non-Spearman correlation method was carried out to see the relationship and the strength of the correlation between the independent variables (population, area, and population density) and the dependent variable (TB incidence). The results of the analysis shown in Table 2.

Based on the results of the analysis (Table 2), it was found that the relationship between population density and the incidence of TB can be said to have a strong relationship ($r=0.603$) with a positive correlation coefficient and a significant relationship between the two variables ($p<0.001$).

Discussion

The study showed a strong relationship and a positive correlation between population density and the incidence of TB in Bandung city. Several studies have shown the same result that there is a relationship between population density and the high incidence of TB.[24–28]

The area with the highest TB incidence was the Babakan Ciparay sub-district, with 469 people and a population density of 205 people/hectare. The area with the second highest incidence is Bojongloa Kaler, with a total of 428 people and a population density of 405 people/hectare. There are very different densities between the sub-districts of Babakan Ciparay and Bojongloa Kaler, even though the incidence of TB is in the high group.

High population density increases the risk of transmission of infectious disease cases. Tuberculosis cases tend to be higher in areas with high population densities. Besides population density, other factors influence the incidence of TB in an area. House technical factors such as adequacy of windows, air ventilation, and lighting influence TB transmission. Besides that, household sanitation factors and occupancy density also influence the incidence of TB.[29]

Efforts to detect early detection of new cases of TB have an important role in a strategic step in eliminating TB cases. New TB cases must be handled immediately and thoroughly and seek to break the chain of transmission of TB to others. The primary health service intervention that may be carried out to reduce the risk of TB infection developing into active TB is to carry out preventive measures. Preventive interventions that can be carried out are preventing and controlling TB infection and vaccinating the bacille Calmette-Guerin (BCG) vaccine.

Disturbances in the detection and treatment of TB have an impact on those who already have TB disease. People who remain undiagnosed and

Table 1 Characteristics of Bandung Sub-districts

No.	Sub-districts	Area (ha)	Population (n)	Population Density (n/ha)	TB Case (n)
1	Andir	455.09	99,319	218	256
2	Antapani	423.05	80,375	190	169
3	Arcamanik	733.52	79,731	109	127
4	Astana Anyar	264.18	73,614	279	266
5	Babakan Ciparay	699.31	143,066	205	469
6	Bandung Kidul	510.27	61,250	120	150
7	Bandung Kulon	688.53	136,607	198	291
8	Bandung Wetan	340.99	29,042	85	64
9	Batununggal	479.14	121,639	254	341
10	Bojongloa Kaler	307.24	124,309	405	428
11	Bojongloa Kidul	482.69	87,916	182	255
12	Buahbatu	734.11	104,102	142	216
13	Cibeunying Kaler	459.64	70,808	154	151
14	Cibeunying Kidul	410.38	113,568	277	223
15	Cibiru	666.56	75,777	114	153
16	Cicendo	723.59	96,544	133	205
17	Cidadap	768.28	54,616	71	133
18	Cinambo	429.98	25,586	60	61
19	Coblong	719.22	115,256	160	337
20	Gedebage	978.30	41,738	43	75
21	Kiaracondong	568.28	131,612	232	326
22	Lengkong	579.56	71,261	123	169
23	Mandalajati	472.66	73,532	156	153
24	Panyileukan	520.45	40,584	78	66
25	Rancasari	684.33	86,465	126	147
26	Regol	475.85	80,808	170	213
27	Sukajadi	520.72	102,987	198	259
28	Sukasari	626.73	77,815	124	133
29	Sumur Bandung	344.50	37,921	110	89
30	Ujungberung	613.72	90,006	147	169

untreated have a higher risk of death compared to those who start treatment. Most people infected through increasing community transmission are at risk of becoming a source of infection. Transmission times vary greatly, ranging from weeks to decades. Therefore, disruption to diagnosis and treatment has a more rapid impact on TB mortality and a slower effect on TB incidence.

Several strategies and programs must be carried out effectively to eliminate TB. Conducting advocacy efforts to gain political support is a strategic step. The executive and legislative parties must carry out this advocacy to accelerate efforts from a regulatory perspective. Besides that, it is necessary to strengthen the decentralization of TB services to the primary service level. Exceptional funding support in the treatment of TB is also needed so that programs can run effectively. A cross-sectoral collaboration, including government, academia, business,

Table 2 Relationship of Population, Area, and Population Density to TB Incidence

Variables	p	r
Population (n)[s]	<0.001[*]	0.866
Area (ha)[s]	0.244	0.095
Population density (n/ha)[s]	<0.001[*]	0.603

Note: [s]non-parametric Spearman correlation, [*]significance

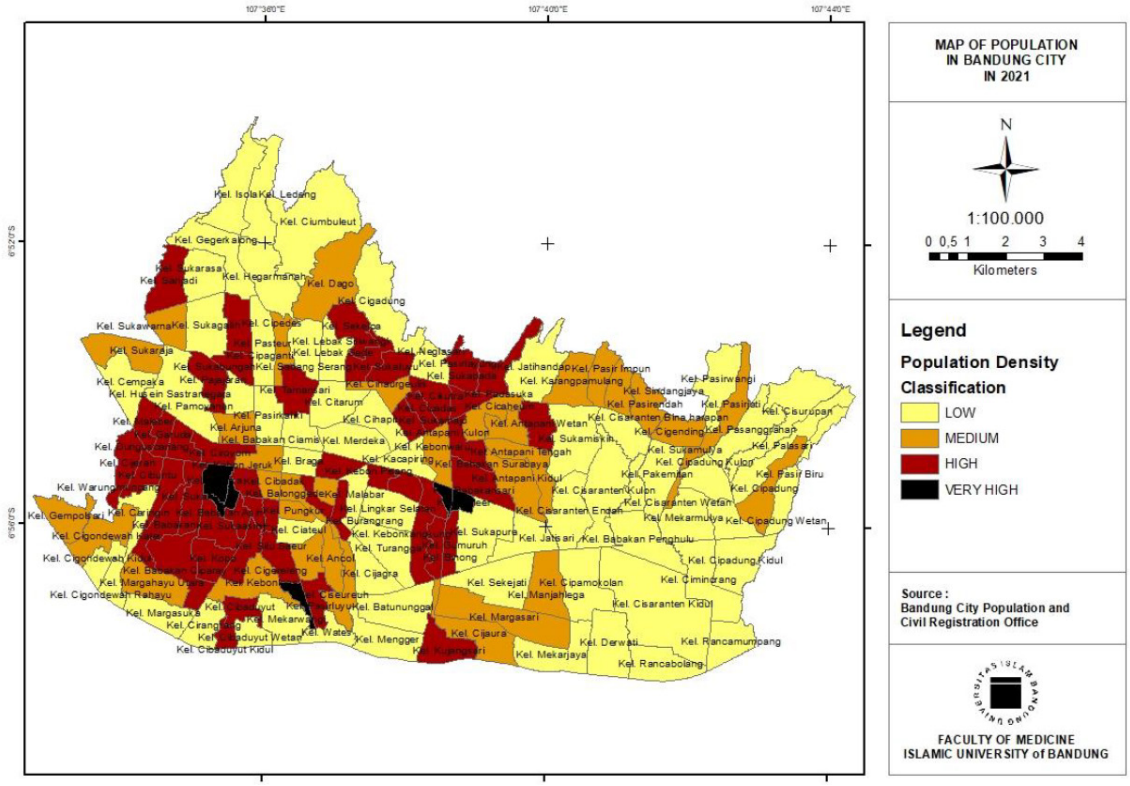

Figure 1 Map of Population Density in Bandung City Year 2021

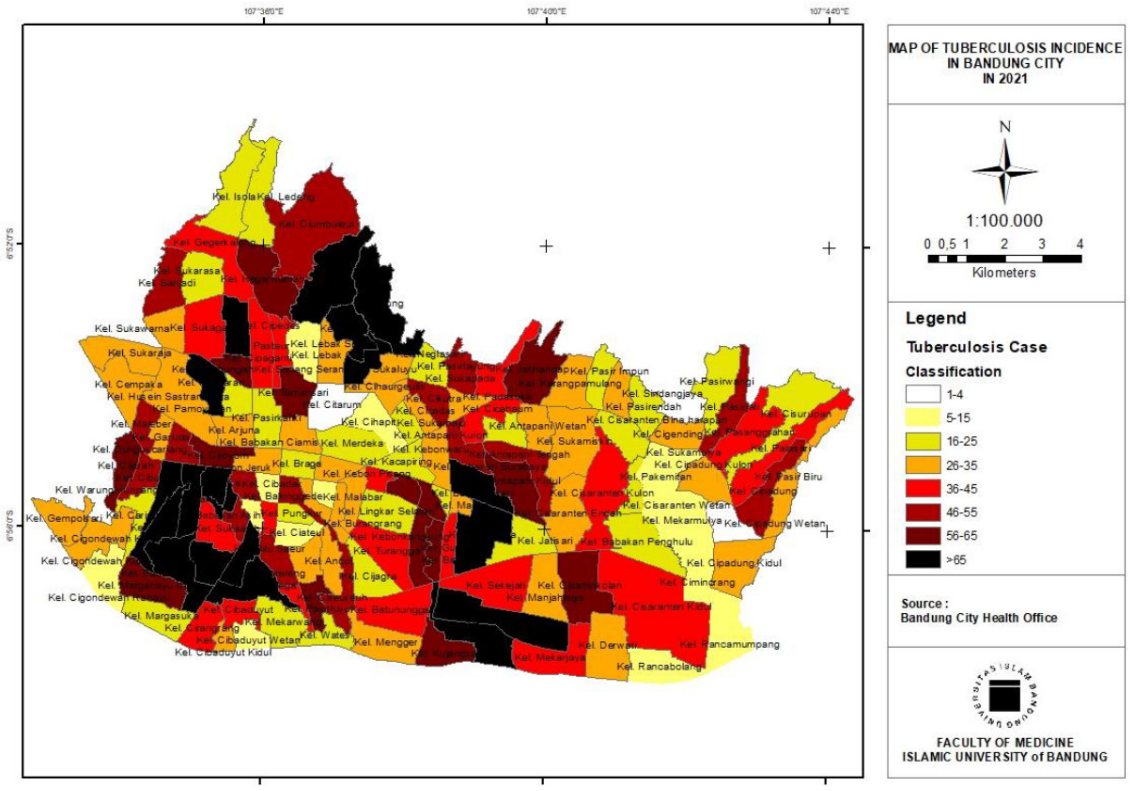

Figure 2 Map of Tuberculosis Incidence in Bandung City Year 2021

society, and the media, is required to build an effective TB control system.

Conclusion

Sub-districts with a high population density show a high incidence of TB. There is a strong and unidirectional relationship between population density and the incidence of TB.

Conflict of Interest

There is no conflict of interest in this research.

Acknowledgment

Thanks were conveyed to the Bandung City Government Health Service and the National Unity and Politics Agency.

References

1. World Health Organization. Global tuberculosis report 2022. Geneva: World Health Organization; 2022.
2. Dao TP, Hoang XHT, Nguyen DN, Huynh NQ, Pham TT, Nguyen DT, et al. A geospatial platform to support visualization, analysis, and prediction of tuberculosis notification in space and time. Front Public Health. 2022;10:973362.
3. Respati T, Sufrie A. Socio-cultural factors in the treatment of pulmonary tuberculosis: a case of Pare-Pare municipality South Sulawesi. GMHC. 2014;2(2):60–6.
4. Purbaningsih W, Rachmawati M, Triyani Y, Rahmi FS. Histopathological review of granuloma in diagnosis of tuberculosis lymphadenitis (TBL). GMHC. 2023;11(3): 171–5.
5. Triyani Y, Tejasari M, Purbaningsih W, Masria S, Respati T. The relation of acid fast bacilli with Ziehl Neelsen staining and histopathologic examination of biopsy specimens in extrapulmonary TB suspected patients. GMHC. 2020;8(2):132–9.
6. Bie S, Hu X, Zhang H, Wang K, Dou Z. Influential factors and spatial–temporal distribution of tuberculosis in mainland China. Sci Rep. 2021;11(1):6274.
7. Li M, Lu L, Jiang Q, Jiang Y, Yang C, Li J, et al. Genotypic and spatial analysis of transmission dynamics of tuberculosis in Shanghai, China: a 10-year prospective population-based surveillance study. Lancet Reg Health West Pac. 2023;38:100833.
8. Ratnasari NY, Handayani S. Tuberculosis research trends in Indonesian health scientific journals: from research design to data analysis. Kemas. 2023;18(4):483–91.
9. Lubis DM, Siregar Y, Sinaga BYM, Bangun SR. Pengaruh pemberian vitamin D terhadap gambaran foto toraks pasien tuberkulosis paru beretnis Batak. GMHC. 2017;5(1):64–9.
10. Zebua HI, Jaya IGMM. Spatial autoregressive to model tuberculosis cases in Central Java province in 2019. Cauchy. 2019;7(2):240–8.
11. Andini NLE, Oktora SI. Determinants of multidrug-resistant pulmonary tuberculosis in Indonesia: a spatial analysis perspective. J Varian. 2022;6(1):34–48.
12. Chong F, Marín D, Pérez F. Baja captación y éxito en el tratamiento para la tuberculosis en una cárcel de Ecuador. Rev Panam Salud Publica. 2019;43:e106.
13. Yang DL, Li W, Pan MH, Su HX, Li YN, Tang MY, et al. Spatial analysis and influencing factors of pulmonary tuberculosis among students in Nanning, during 2012–2018. Wang MS, editor. PLoS One. 2022;17(5):e0268472.
14. Yang C, Zhang Y, Jiang Y, Wu Z, Shen X, Warren JL, et al. Multiple epidemics of multidrug-resistant tuberculosis revealed by spatial disease mapping and whole-genome sequencing analysis in urban China. J Clin Transl Sci. 2021;5(Suppl 1):5–6.
15. Jenkins HE, Plesca V, Ciobanu A, Crudu V, Galusca I, Soltan V, et al. Assessing spatial heterogeneity of multidrug-resistant tuberculosis in a high-burden country. Eur Respir J. 2013;42(5):1291–301.
16. Tuntun M, Aminah S, Yusrizal Ch. Distribution pattern and spatial analysis of factors for tuberculosis (TB) cases in Bandar Lampung city in 2022. Bali Med J. 2022;12(1):50–8.
17. Puspita T, Suryatma A, Simarmata OS, Veridona G, Lestary H, Athena A, et al. Spatial variation of tuberculosis risk in Indonesia 2010–2019. HSJI. 2021;12(2):104–10.
18. Huang CC, Trevisi L, Becerra MC, Calderón RI, Contreras CC, Jimenez J, et al. Spatial scale of tuberculosis transmission in Lima, Peru. Proc Natl Acad Sci USA. 2022;119(45):e2207022119.

19. Sun W, Gong J, Zhou J, Zhao Y, Tan J, Ibrahim AN, et al. A spatial, social and environmental study of tuberculosis in China using statistical and GIS technology. Int J Environ Res Public Health. 2015;12(2):1425–48.
20. Shaweno D, Karmakar M, Alene KA, Ragonnet R, Clements AC, Trauer JM, et al. Methods used in the spatial analysis of tuberculosis epidemiology: a systematic review. BMC Med. 2018;16(1):193.
21. Saputra FF, Wahjuni CU, Isfandiari MA. Spatial modeling of environmental-based risk factors of tuberculosis in Bali province: an ecological study. JBE. 2020;8(1):26–34.
22. Ribeiro FKC, Pan W, Bertolde A, Vinhas SA, Peres RL, Riley L, et al. Genotypic and spatial analysis of *Mycobacterium tuberculosis* transmission in a high-incidence urban setting. Clin Infect Dis. 2015;61(5):758–66.
23. Inggarputri YR, Trihandini I, Novitasari PD, Makful MR. Spatial analysis of tuberculosis cases diffusion based on population density in Bekasi regency in 2017–2021. BKM. 2023;39(1):e6462.
24. Fatikha AN, Martini M, Hestiningsih R, Kusariana N. Spatial analysis of a tuberculosis incidence in Magelang city in 2021. DPPHJ. 2022;16(1):37–46.
25. Rao M, Johnson A. Impact of population density and elevation on tuberculosis spread and transmission in Maharashtra, India. J Emerg Invest. 2021;4:1–5.
26. Ardiyanti M, Sulistyawati S, Puratmaja Y. Spatial analysis of tuberculosis, population and housing density in Yogyakarta. ESHR. 2021;3(1):28–35.
27. de Abreu E Silva M, Di Lorenzo Oliveira C, Teixeira Neto RG, Camargos PA. Spatial distribution of tuberculosis from 2002 to 2012 in a midsize city in Brazil. BMC Public Health. 2016;16(1):912.
28. Wang X, Yin S, Li Y, Wang W, Du M, Guo W, et al. Spatiotemporal epidemiology of, and factors associated with, the tuberculosis prevalence in northern China, 2010–2014. BMC Infect Dis. 2019;19(1):365.
29. Suryani FT, Ibad M. Analisis faktor kepadatan penduduk, cakupan rumah sehat dan sanitasi rumah tangga terhadap kejadian tuberkulosis tahun 2018. Sosains. 2022;2(10):1086–95.

Global Medical and Health Communication

Online submission: https://ejournal.unisba.ac.id/index.php/gmhc
DOI: https://doi.org/10.29313/gmhc.v12i1.12495

GMHC. 2024;12(1):37–45
pISSN 2301-9123 | eISSN 2460-5441

RESEARCH ARTICLE

Ethnomedicinal Plants Used for Treatment of Infectious Diseases by Dayak Ethnic in Borneo, Indonesia

Nawan Nawan,[1] Septi Handayani,[2] Agnes Immanuela Toemon[3]

[1]Department of Microbiology, Faculty of Medicine, University of Palangka Raya, Palangka Raya, Indonesia,
[2]Department of Biochemistry Faculty of Medicine, University of Palangka Raya, Palangka Raya, Indonesia,
[3]Department of Parasitology Faculty of Medicine, University of Palangka Raya, Palangka Raya, Indonesia

Abstract

The Dayak tribe, residing on the island of Borneo in Indonesia, continues to uphold their ancestral cultural customs involving using medicinal plants for disease treatment. To assess the efficacy of chosen Dayak traditional medicinal plants, commonly utilized for treating diverse infectious ailments, against bacteria responsible for infections. Samples of medicinal plants (*Garptophyllum pictum*, *Eleutherine bulbosa*, *Oscimum sanctum*, *Cassia alata*, *Callicarpa longifolia* Lam., *Hibiscus rosa-sinensis*, *Dracaena cantleyi*, *Uncaria gambir* Roxb., *Rhodomyrtus tomentosa*, *Gomphrena globose*) were extracted using absolute methanol and water and tested for their antimicrobial activities against stock isolates and standard strains of *Staphylococcus aureus*, *Streptococcus pyogenes*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Enterobacter aerogenes* using agar well diffusion and micro-titer plate methods. Crude extracts of *Eleutherine bulbosa*, *Dracaena cantleyi*, *Oscimum sanctum*, and *Uncaria gambir* Roxb. inhibited bacterial growth by 100%, 100%, 40%, and 25% against the test organisms, respectively. These plants inhibited the growth of bacteria from 7 mm to 16 mm in diameter. Most of the plant extracts had antibacterial activities, among which *Eleutherine bulbosa* and *Dracaena cantleyi* inhibited the growth of 100% of the test organisms, respectively. The activities of methanolic extracts were greater than those of their corresponding water extracts. *Streptococcus pyogens* was the organism most susceptible to the extract, while *Enterobacter aerogenes* demonstrated the highest resistance.

Keywords: Bacteria, Dayak tribe, infections, traditional medicinal plants

Introduction

Bacterial infections are diseases that can affect various body parts, such as the skin, lungs, brain, and blood, resulting from single-celled organisms multiplying or releasing toxins in the body. Diseases caused by bacterial infections continue to be a significant concern, particularly in poor and developing countries, due to the growing issue of antibiotic resistance.[1] The uncovering of antibiotics represents a remarkable triumph in human history; however, the growing issue of antibiotic resistance casts a shadow over this achievement.[2] To address the issue of antibiotic resistance in the management of infectious diseases, it is crucial to persistently investigate natural substances as potential sources for novel antibacterial agents.[3–5]

There is a growing curiosity in uncovering the mysteries of traditional herbal treatments, drawing upon insights gathered from local inhabitants and customary practitioners across various regions worldwide.[6,7] Medicinal plants are plants that can be used to treat a disease. Since ancient times, medicinal plants have been used by rural communities.[8–10] Traditional medicine for diseases using concoctions with essential ingredients from plants and everything that exists in nature is still in great demand by the public because usually the ingredients can be found easily in the environment.[11–13] Plants have long been used as a source of medicine for the treatment of various diseases. Around 35,000–70,000 plant species have been screened for their medicinal use.[14] More than 4,000 phytochemicals have been cataloged and classified by protective function and physical and chemical characteristics, of which 150 phytochemicals have been studied in detail.[15] Plants synthesize hundreds of chemical compounds for various functions, including

Received: 28 August 2023; Revised: 23 March 2024; Accepted: 30 April 2024; Published: 30 April 2024

Correspondence: Dr. dr. Nawan, M.Ked.Trop. Department of Microbiology, Faculty of Medicine, University of Palangka Raya. Jln. Yos Sudarso, Palangka Raya 73111, Central Kalimantan, Indonesia. E-mail: nawan@med.upr.ac.id

defense and protection against insects, fungi, diseases, and herbivorous mammals. However, it is essential to note that the number of compounds derived from plants for traditional medicine may vary as research and discoveries continue.

Indonesia is the fourth most populous country, with more than 300 distinct ethnic and linguistic groups. One of the ethnic groups in Indonesia inhabiting the island of Kalimantan is the Dayak tribe. The renowned Dayak ethnic community in Kalimantan is known for its expertise in using plants for traditional medicinal practices, which are transmitted orally through successive generations.[16] The utilization of medicinal plants is distinctive and differs across specific regions, encompassing the creation and application of potions and occasionally being associated with legends.

The accumulated biological richness in diverse ecosystems has played a significant role in fulfilling the daily necessities of native populations, such as food, attire, housing, medical care, and spiritual well-being. One example includes various tribes or indigenous groups residing in remote areas using plants for medicinal purposes. The traditions and understanding of rural communities regarding medicinal plant usage are inextricably linked to the long-standing local culture. Research in ethnobotany has shown that a wider variety of Dayak plants are employed to treat infectious and other illnesses within the traditional healthcare practices of the community. Examination of Dayak plant extracts in different locations demonstrated potent antibacterial properties, suggesting that these plants may be a valuable source of efficient medications to combat bacteria-causing infections. Consequently, this study aimed to assess the efficacy of specific Dayak medicinal plants traditionally utilized in treating infectious diseases.

Methods

The research adhered to regional protocols and regulations. Local governing bodies and individual owners of the medicinal plants at each location approved plant collection. Plant data is collected through direct observation activities at several related agencies and literature studies such as research results, survey reports, books, journals, and other sources. The medicinal plants were collected from East, Central, North, West and South Kalimantan. Surveys were conducted periodically in the isolated regions of Kalimantan. Data about the medicinal applications of various plants was gathered via discussions with residents and traditional healers. Each conversation employed a semi-structured questionnaire to acquire details such as local terminology, plant components used, and their therapeutic purposes. Samples from every plant were compressed, desiccated, and arranged on herbarium sheets for identification.

The test bacteria were *Staphylococcus aureus* (*S. aureus*), *Streptococcus pyogenes* (*S. pyogens*), *Escherichia coli* (*E. coli*), *Pseudomonas aeruginosa* (*P. aeruginosa*), *Enterobacter aerogenes* (*E. aerogenes*), from stockical specimens stock of Department of Microbiology Faculty of Medicine of Universitas Palangka Raya, and standard strains [(American Type Culture Collection (ATCC)], *S. aureus* (ATCC 25923), *S. pyogens* (ATCC 19615), *E. coli* (ATCC 25922), *P. aeruginosa* (9027) and *E. aerogenes* (ATCC 13048).

The examined microorganisms were cultivated in 5 ml of brain heart infusion broth at 37°C and then confirmed and preserved in Mueller-Hinton agar medium.[18] Pure bacterial cultures that were 24 hours old were employed to create a concentration of 108 cells per ml^{-1}, adhering to the 0.5 McFarland standards for each assessment.[19] The Mueller-Hinton agar was prepared per the manufacturer's guidelines, sterilized using an autoclave, and then distributed onto a sterile plate.

The bacterial broth culture was created with 108 cells per ml^{-1} density, conforming to the 0.5 McFarland standard. A sterile cotton swab was used to distribute the sample uniformly onto Mueller-Hinton agar. Subsequently, the prepared medium was left to dry at ambient temperature for 30 minutes.[20] On every plate, uniformly spaced wells were created using a sterilized, 6 mm diameter cork borer situated 2 mm from the plate's edge. Each agar well received 50 microliters of plant extract (500 mg/ml) in a sterile manner. Ciprofloxacin (5 µg/ml) and amoxicillin (4 µg/ml) served as positive controls, while methanol and distilled water functioned as negative controls. The agar plate was then allowed to rest on the bench for 40 minutes for pre-diffusion before being incubated at 37°C for 24–48 hours. A clear inhibition zone with a diameter of ≥7 mm around the wells indicated significant susceptibility of the organisms to the extract. The test was conducted

twice, and if conflicting results emerged, a third trial was performed to facilitate a straightforward decision.[21]

The minimum inhibitory concentration (MIC) was established for extracts displaying a growth inhibition zone of at least 7 mm diameter. Both agar well diffusion and microtiter plate (microtube dilution) methods were used for the test. In the agar well diffusion method, the extract solution (500 mg/ml) was progressively diluted in a series of ratios: 1:2, 1:4, 1:8, 1:16, 1:32, 1:64, 1:128, and 1:256, resulting in concentrations of 250 mg/ml, 125 mg/ml, 62.5 mg/ml, 31.25 mg/ml, 15.63 mg/ml, 7.81 mg/ml, 3.91 mg/ml, and 1.95 mg/ml, respectively. The extract was then aseptically applied as outlined in Table 3. After incubating for 24 hours at 37°C, the inhibition zone was measured, and the lowest concentration that inhibited growth was deemed the MIC value for the extract.[20]

In the microtiter plate (microtube dilution) method, a 500 mg/ml extract underwent serial dilution in nutrient broth, as outlined earlier. Then, 20 µl of a standardized test organism suspension was incorporated into each extract concentration. The microtiter plates were incubated for 24 hours at 37°C, and bacterial growth was assessed by comparing the optical density (OD) of each well pre and post-incubation. The OD for the microtube dilution approach was measured using a Thermo Scientific™ Multiskan™ FC microplate spectrophotometer at 405 nm. If the OD difference (post-incubation–pre-incubation) for the test sample (broth, extract, and organism) exceeded that of the control (broth and extract) at any given concentration, it indicated the presence of bacterial growth or turbidity. The minimum extract concentration that showed no turbidity was considered the MIC value for the extract.

The minimum bactericidal concentration (MBC) was established by subculturing samples with a value less than or equal to the MIC value. The most significant dilution with no bacterial colonies present (lower concentration) was considered the MBC.

Results

The medicinal plants were collected from East, Central, North, West and South Kalimantan. Surveys were conducted periodically in the isolated regions of Kalimantan. Data about the medicinal applications of various plants was gathered via discussions with residents and traditional healers. Each conversation employed a semi-structured questionnaire to acquire details such as local terminology, plant components used, and their therapeutic purposes. Samples from every plant were compressed, desiccated, and arranged on herbarium sheets for identification. Ten plant samples were used in this study and came from locations all over the island of Kalimantan (Table 1).

Crude extracts of *Eleutherine bulbosa*, *Dracaena cantleyi*, *Oscimum sanctum*, and *Uncaria gambir* Roxb. showed bacterial growth inhibition of 100%, 100%, 40%, and 25% against the test organisms, respectively. These plants inhibited the growth of bacteria from 7 mm to 16 mm in diameter (Table 2). Both water and methanol extracts from *Eleutherine bulbosa* bulbs and *Dracaena cantleyi* leaves produced zones of inhibition with variations between 7 mm and 16 mm. *Eleutherine bulbosa* bulb extracts

Table 1 Plant Samples Used in This Study

No.	Plant Species Name	Local Name	Collected Part	Origin of Area	Province
1	*Garptophyllum pictum*	*Berakak bediang*	Leaf	Ketapang	West Kalimantan
2	*Eleutherine bulbosa*	*Bawang dayak*	Bulbs	Paku	Central Kalimantan
3	*Ocimum sanctum*	*Bawing*	Leaf	Malinau	North Kalimantan
4	*Cassia alata*	*Serugan*	Leaf	Sanggau	West Kalimantan
5	*Callicarpa longifolia* Lam.	*Sangkareho*	Leaf	Berau	East Kalimantan
6	*Hibiscus rosa-sinensis*	*Kambang bahandang*	Leaf	Pulang Pisau	Central Kalimantan
7	*Dracaena cantleyi*	*Tewukak*	Leaf	Palangkaraya	Central Kalimantan
8	*Uncaria gambir* Roxb.	*Bajakah kalalawit*	Root	Katingan	Central Kalimantan
9	*Rhodomyrtus tomentosa*	*Karamunting*	Leaf	Tapin	South Kalimantan
10	*Gomphrena globose*	*Bunga kancing*	Root	Ketapang	West Kalimantan

Table 2 The Average Inhibition Zones for Bacterial Growth Used the Agar Well Diffusion Method When Treated with 500 mg/ml of Plant Extracts

Plant Species		Bacteria									
		S. aureus		*S. pyrogens*		*E. coli*		*P. aeruginosa*		*E. aerogenes*	
		Stk	Std	Stk	Std	Stk	Std	Stk	Std	Stk	Std
Garptophyllum pictum	W	-	-	-	-	-	-	-	-	-	-
	M	-	-	-	9	-	7	-	-	-	-
Eleutherine bulbosa	W	11	14	13	12	7	8	9	10	10	12
	M	10	14	10	14	7	9	11	12	8	13
Oscimum sanctum	W	-	-	-	12	-	-	7	-	-	-
	M	14	15	9	13	-		8	9	-	-
Cassia alata	W	-	-	-	-	-	-	-	-	-	-
	M	-	-	-	7	8	12	-	-	-	-
Callicarpa longifolia Lam.	W	-	-	-	-	-	8	-	-	-	-
	M	-	-	-	-	-	7	-	-	-	-
Hibiscus rosa-sinensis	W	-	-	-	8	-	-	-	-	-	-
	M	-	13	-	-	-	-	-	-	-	-
Dracaena cantleyi	W	10	11	10	14	8	9	8	14	11	15
	M	9	14	8	10	9	10	12	8	12	16
Uncaria gambir Roxb.	W	-	-	-	10	-	-	-	-	-	-
	M	8	-	-	9	-	-	7	9	-	-
Rhodomyrtus tomentosa	W	-	-	-	-	-	-	-	7	-	-
	M	-	8	-	-	-	-	-	8	-	-
Gomphrena globose	W	-	7	-	-	-	-	-	-	-	-
	M	-	9	-	-	-	-	-	-	-	-
Amoxicillin		12	15	21	28	23	25	15	-	19	22
Ciprofloxacin		15	20	20	28	33	30	25	28	33	31

Note: measured in millimeters, Stk: stock isolate, Std: standard (ATCC) strains, W: water extract, M: methanol extract

with the highest inhibition zone of 14% were on the test bacteria *S. aureus* (ATCC) (both water and methanol extracts) and *S. pyrogens* (ATCC) water extract. *Dracaena cantleyi* extracts with the highest inhibition zone of 16% were seen in *E. aerogenes* (ATCC) methanol extract. The water extract of *Eleutherine bullbosa* bulb with the higher inhibition zone compared with methanol extract against stock isolates are *S. aureus* (11 mm), *S. pyogens* (13 mm), and *E. aerogenes* (10 mm). Isolates with the lowest inhibition zone (7 mm) were seen in the test bacteria, e. coli, in both water and methanol extracts.

The water extract of *Eleutherine bulbosa* bulb with the higher inhibition zone compared with the methanol extract against stock and standard isolates are *S. aureus* stock isolate (10 mm), *S. pyrogens* stock, and ATCC isolate (10 mm, 12 mm), and *P. aeruginosa* ATCC isolates (14 mm).

Methanolic extract of *Ocimum sanctum* leaf was the second to inhibit the growth of 6 bacterial strains with inhibition zones ranging from 8 mm (against stock isolated *P. aeruginosa*) to 15 mm [against standard *S. aureus* (ATCC)]. Its water extract inhibited *S. pyogens* (ATCC) growth within 12 mm diameter and *P. aeruginosa* stock isolate (7 mm). *Uncaria gambir* Roxb. leaf extract was the third to inhibit the growth of 5 bacterial strains, with the highest inhibition zone at 10 mm on water extract (against standard ATCC-isolated *P. aeruginosa*).

S. pyogens (ATCC) was the most inhibited bacteria by most of the plant extracts. The water extract of *Eleutherine bulbosa* and methanolic extracts of *Dracaena cantleyi* highly inhibited it. The standard strains of *S. aureus* experienced the second-highest level of inhibition by most of the plant extracts. The methanol extract of *Oscimum sanctum* demonstrated comparable inhibition zones to amoxicillin, the positive control when tested against standard *S. aureus* isolates. *E. aerogenes* is the most resistant bacteria to plant extracts, with only *Eleutherine bulbosa* and *Dracaena cantleyi* extracts producing an

Table 3 MIC Values of Selected Plant Extracts Against the Tested Organisms Using Agar Well Diffusion and Microtitration Methods

Plant Species	Methods		Bacteria									
			S. aureus		*S. pyrogens*		*E. coli*		*P. aeruginosa*		*E. aerogenes*	
			Stk	Std	Stk	Std	Stk	Std	Stk	Std	Stk	Std
E. bulbosa	Agar well diffusion	W	250.00	125.00	250.00	125.00	62.50	250.00	250.00	250.00	125.00	250.00
		M	125.00	62.50	250.00	250.00	250.00	250.00	125.00	125.00	500.00	500.00
	Microtitration	W	31.25	125.00	62.50	125.00	62.50	62.50	15.63	15.63	31.25	7.81
		M	7.81	15.63	62.50	7.81	15.63	15.63	15.63	7.81	15.63	15.63
D. cantleyi	Agar well diffusion	W	125.00	62.50	250.00	62.50	250.00	250.00	250.00	125.00	250.00	62.50
		M	125.00	125.00	62.50	250.00	250.00	125.00	125.00	250.00	125.00	250.00
	Microtitration	W	62.50	62.50	31.25	125.00	62.50	62.50	15.63	62.50	31.25	15.63
		M	3.91	15.63	15.63	7.81	15.63	15.63	15.63	15.63	15.63	15.63
O. sanctum	Agar well diffusion	M	125.00	125.00	250.00	250.00	-	-	250.00	250.00	-	-
	Microtitration	M	7.81	15.63	62.50	1.95	-	-	15.63	15.63	-	-
U. gambir Roxb.	Agar well diffusion	M	125.00	-	-	250.00	-	-	125.00	250.00	-	-
	Microtitration	M	31.25	-	-	62.50	-	-	15.63	7.81	-	-

Note: measured in mg/ml, Stk: stock isolate, Std: standard (ATCC) strains, W: water extract, M: methanol extract

inhibition zone.

The MIC value of plant extracts against the tested bacteria ranged from 1.95 mg/ml (methanolic extract of *Oscimum sanctum* on standard isolate of *S. pyogens*) to 500.00 mg/ml (methanolic extract of *Eleutherine bulbosa* on stock and a standard isolate of *P. vulgaris*). The most frequent MIC value of the extracts was 250.00 mg/ml, followed by 15.63 mg/ml, 125.00 mg/ml, 62.50 mg/ml, 7.81 mg/ml, 31.25 mg/ml, 3.91 and 1.95 mg/ml (Table 3).

The MIC values of *Eleutherine bulbosa* on the microtitration method ranged from 7.81 mg/ml to 125.00 mg/ml. Its water extract had higher MIC values than its methanolic extracts except for stock isolated of *S. Pyogens*, *P. aeruginosa* (same value), and standard strains of *E. aerogenes* (smaller value). The MIC values of *Dracaena cantleyi* on the microtitration method ranged from 3.91 mg/ml to 125.00 mg/ml. Its water extract had higher MIC values than its methanolic extracts except for stock isolated of *P. aeruginosa* and standard strains of *E. aerogenes* (similar value). The MIC values of *Ocimum sanctum* (methanol extract) on the microtitration method ranged from 1.95 mg/ml to 62.50 mg/ml. The lowest MIC value was 1.95 in the ATCC S. pyogens standard isolate. There are three isolates with a similar MIC value of 15.63, on ATCC S. aureus standard isolates and both isolate stock and standard *P. aeruginosa*. The MIC values of *Uncaria gambir* Roxb. (methanol extract) on the microtitration method ranged from 7.81 mg/ml to 62.50 mg/ml. The lowest MIC value was 7.81 in ATCC *P. aeruginosa* standard isolates.

Discussion

Investigations in ethnobotany have proven valuable in discovering and advancing traditional medicinal plants for use in contemporary pharmaceuticals. The impact of this field is also evident in the present research. Methanolic and aqueous extracts of *Eleutherine bulbosa* bulbs and *Dracaena cantleyi* leaves showed potent antibacterial activity against ten bacterial strains.

Prior studies have indicated that initial phytochemical analysis of *Eleutherine bulbosa* (*bawang dayak*) ethanol extracts revealed the presence of metabolites such as flavonoids, saponins, alkaloids, and tannins.[22] Flavonoids demonstrate strong antibacterial properties against a range of bacteria. They exhibit antibacterial action through three primary processes: hindering energy metabolism, obstructing nucleic acid synthesis, and causing harm to the cytoplasmic membrane.[23,24] Additional antimicrobial properties of *bawang dayak* are under investigation, including eleutherol A, a flavonoid derived from *bawang dayak*, recognized for its ability to hinder bacterial cell wall formation.[25] Alkaloids typically exhibit antibacterial properties by inhibiting efflux pump activity. They are more commonly bactericidal rather than bacteriostatic.[26,27] One way saponins exhibit antibacterial properties is by reducing

the effectiveness of glucose usage in bacteria, which in turn influences their reproduction or expansion, ultimately leading to an antibacterial impact. Additionally, numerous research findings indicate that tannins possess antibacterial characteristics, affecting both Gram-negative and Gram-positive bacteria.[28]

Tewukak (*Dracaena cantleyi*) is one of the plants used by the Dayak tribe, the leaves are often used when the body feels sore or has muscle pain (cramps) by 'pulling it with water' and then sticking it where it hurts. *Tewukak* leaves have also been proven empirically to be used by orangutans (*Pongo pygmaeus*) by chewing them and then sticking them to the body/or parts of the body that are thought to be experiencing pain. The results of research on the *Dracaena cantleyi* plant used by orangutans showed an inhibitory effect of *tewukak* leaf extract on TNFα which induces inflammatory cytokines (E-selectin, ICAM1, VCAM-1, and IL-6) resulting in decreased expression of E-selectin, ICAM1, VCAM-1, and IL-6. *Tewukak* leaf extract is proven to contain saponins E-selectin, ICAM1, VCAM-1, and IL-6. *Tewukak* leaf extract is proven to contain saponins.[29] Saponins are compounds that have been studied to have antibacterial activity against *E. coli*,[30] and methicillin-resistant *Staphylococcus aureus* (MRSA).[31]

Most of the MBC and MIC values for all plant extracts were nearly identical, or the MBC was one dilution factor lower than the MIC value of the extract. This resemblance or proximity of the MBC and MIC values in plant extracts might result from the microtitration method's sensitivity in identifying the minimal turbidity level, which served as a growth indicator for the test organisms instead of a visual examination.

Methanolic plant extracts exhibit more potent antibacterial activity than water extracts, suggesting that the compounds responsible for inhibiting bacterial growth may dissolve more effectively in methanol than in water.[32]

Methanolic extract of *Oscimum sanctum* on a microtitration method showed antibacterial activity at the lowest concentration compared to all other plant extracts. The lowest MIC value was 1.95 in the ATCC *S. pyogens* standard isolate. Tulsi, an aromatic shrub belonging to the Lamiaceae family and the Ocimeae tribe, is a well-known plant in the basil family. In Ayurveda, it is referred to as "the Incomparable One," "Mother Medicine of Nature," and "the Queen of Herbs." It is highly regarded as a unique "elixir of life" for its unparalleled medicinal and spiritual attributes.[33] Numerous scientific studies, encompassing in vitro, animal, and human experiments, have investigated the medicinal properties of *Oscimum sanctum*. Research has revealed that this plant possesses a distinct array of therapeutic actions, including antimicrobial (antibacterial, antiviral, antifungal, antiprotozoal, antimalarial, and anthelmintic). *Oscimum sanctum* chemical makeup is highly intricate, consisting of numerous nutrients and other biologically active substances, with the ratios varying significantly among strains and even among plants within the same field. Additionally, the amounts of several constituents are influenced by diverse growing, harvesting, processing, and storage conditions, still being studied. Eugenol (l-hydroxy-2-methoxy-4-allylbenzene), a key component found in *Oscimum sanctum*, is likely the main contributor to plants therapeutic properties. Other significant constituents are ursolic acid and carvacrol, which are responsible for the antimicrobial effects of *Oscimum sanctum*.[34]

The methanol extract of *Uncaria gambir* Roxb. showed antibacterial activity against stock and standard *P. aeruginosa* isolates, *S. pyogens* standard isolates, and *S. aureus* stock isolates. Research states that *Uncaria gambir* can fight infections caused by *S. aureus* and *P. aeruginosa*.[35] With the increasing medicinal applications of Uncaria species, numerous investigations have been conducted on the phytochemistry and pharmacology of *Uncaria*. Over 200 chemical components, such as indole alkaloids, triterpenes, flavonoids, and phenylpropanoids, have been extracted from the *Uncaria* genus.[36] *Uncaria* is commonly used in traditional medicine to treat wounds and ulcers, alleviate fevers and headaches, treat gastrointestinal issues, and combat bacterial and fungal infections. Over the last ten years, researchers have studied the metabolites of bioactive indole alkaloids found in *Uncaria* species. It is believed that these alkaloids can be metabolized into their 10- and 11- 11-hydroxyl derivatives, including compounds like rhynchophylline, isorhynchophylline, corynoxeine, and isocorynoxeine.[37]

Most plant extracts demonstrated the most significant inhibitory effect on the Gram-positive *S. pyogens*. At the same time, Gram-negative *E. aerogenes* strains showed the most resistance, only inhibited by the water-based and

methanolic extracts of *Eleutherine bulbous* bulb and *Dracaena cantleyi* leaf. *E. aerogenes*, which is called *Klebsiella aerogenes*, is a rod-shaped bacterium that is Gram-negative, oxidase-negative, catalase-positive, citrate-positive, and indole-negative. This nosocomial and pathogenic bacterium leads to various opportunistic infections. While many strains of this bacteria are initially sensitive to most antibiotics in its class, they can develop resistance quickly due to inducible resistance mechanisms, such as lactamase production. It necessitates a change in antibiotic treatment to prevent the exacerbation of sepsis.[38]

Conclusions

Most plant extracts demonstrated the most significant inhibitory effect on the Gram-positive *S. pyogens*. At the same time, Gram-negative *E. aerogenes* strains showed the most resistance, only inhibited by the water-based and methanolic extracts of *Eleutherine bulbosa* bulb and *Dracaena cantleyi* leaf. Overall, most methanolic extracts and a portion of aqueous extracts from plants exhibited antibacterial properties, suggesting their potential as antibacterial agents against pathogenic infections. To effectively utilize these plants for drug development against diseases and other harmful bacteria, additional research should be conducted using various extraction solvents, toxicity, and phytochemical evaluations.

Conflict of Interest

The authors state that there is no conflict of interest in this article.

Acknowledgment

Completing this research was only possible with the participation and assistance of many people. All kinds of contributions are sincerely appreciated and acknowledged. The authors would like to express their deep appreciation to Universitas Palangka Raya for its technical support in realizing this research.

References

1. Antimicrobial Resistance Collaborators. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. Lancet. 2022;399(10325):629–55.
2. Nawan, Handayani S. Molecular identification of *Streptomyces* sp. isolated from peat land of Palangka Raya, Kalimantan Tengah using 16S rRNA gene sequences analysis. Res J Pharm Technol. 2021;14(12):6639–44.
3. Frieri M, Kumar K, Boutin A. Antibiotic resistance. J Infect Public Health. 2017;10(4):369–78.
4. Nawan, Isnaeni, Wasito EB. Antimicrobial activity of *Streptomyces* sp. isolated from acidic peatlands against extended spectrum beta lactamase (ESBL) producing *Escherichia coli*. Res J Pharm Technol. 2020;13(3):1121–6.
5. Pariente N; PLOS Biology Staff Editors. The antimicrobial resistance crisis needs action now. PLoS Biol. 2022;20(11):e3001918.
6. Li FS, Weng JK. Demystifying traditional herbal medicine with a modern approach. Nat Plants. 2017;3:17109.
7. Wang Y, Chen S, Du K, Liang C, Wang S, Owusu Boadi E, et al. Traditional herbal medicine: therapeutic potential in rheumatoid arthritis. J Ethnopharmacol. 2021;279:114368.
8. AbouZid SF, Mohamed AA. Survey on medicinal plants and spices used in Beni-Sueif, Upper Egypt. J Ethnobiol Ethnomed. 2011;7:18.
9. Albuquerque UP, Ramos MA, de Lucena RFP, Alencar NL. Methods and techniques used to collect ethnobiological data. In: Albuquerque UP, Cruz da Cunha LVF, de Lucena RFP, Alves RNN, editors. Methods and techniques in ethnobiology and ethnoecology. New York: Humana Press, 2014 [cited 2023 Apr 27]. p. 15–37.
10. Vuddanda PR, Singh S, Velaga S. Boswellic acid – medicinal use of an ancient herbal remedy. J Herb Med. 2016;6(4):163–70.
11. Karunamoorthi K, Jegajeevanram K, Vijayalakshmi J, Mengistie E. Traditional medicinal plants: a source of phytotherapeutic modality in resource-constrained health care settings. J Evid Based Complementary Altern Med. 2012;18(1):67–74.
12. Jamshidi-Kia F, Lorigooini Z, Amini-Khoei H. Medicinal plants: past history and future perspective. J Herbmed Pharmacol. 2018;7(1):1–7.
13. Garcia S. Pandemics and traditional plant-based remedies. A historical-botanical review

in the era of COVID-19. Front Plant Sci. 2020;11:571042.
14. Veeresham C. Natural products derived from plants as a source of drugs. J Adv Pharm Technol Res. 2012;3(4):200–1.
15. Bhat SG. Medicinal plants and its pharmacological values. In: El-Shemy HA, editor. Natural medicinal plants [e-book]. London (UK): IntechOpen; 2021 [cited 2023 Apr 27]; Available from: https://www.intechopen.com/chapters/79065.
16. Az-Zahra FR, Sari NLW, Saputry R, Nugroho GD, Sunarto, Pribadi T, et al. Review: traditional knowledge of the Dayak tribe (Borneo) in the use of medicinal plants. Biodiversitas. 2021;22(10):4633–47.
17. Koohsari H, Ghaemi EA, Sadegh Sheshpoli M, Jahedi M, Zahiri M. The investigation of antibacterial activity of selected native plants from North of Iran. J Med Life. 2015;8(Spec Iss 2):38–42.
18. Jafari S, Mobasher MA, Najafipour S, Ghasemi Y, Mohkam M, Ebrahimi MA, et al. Antibacterial potential of *Chlorella vulgaris* and *Dunaliella salina* extracts against *Streptococcus mutans*. Jundishapur J Nat Pharm Prod. 2018;13(2):e13226.
19. Sieberi BM, Omwenga GI, Wambua RK, Samoei JC, Ngugi MP. Screening of the dichloromethane: methanolic extract of *Centella asiatica* for antibacterial activities against *Salmonella typhi*, *Escherichia coli*, *Shigella sonnei*, *Bacillus subtilis*, and *Staphylococcus aureus*. ScientificWorldJournal. 2020; 2020:6378712.
20. Delelegn A, Sahile S, Husen A. Water purification and antibacterial efficacy of *Moringa oleifera* Lam. Agric Food Secur. 2018;7:25.
21. Bizualem E, Yohannes T, Gebrehiwot S. Antimicrobial effects of *Rumex nepalensis* and *Echinop sphaerocephalus* crude extracts on selected pathogenic bacteria. J Microbiol Antimicrob. 2023;15(1):1–11.
22. Novaryatiin S, Ardhany SD. The antibacterial activity of bawang dayak (*Eleutherine bulbosa* (Mill.) urb.) from Central Kalimantan against acne-causing bacteria. Int J Appl Pharm. 2019;11(Spec Iss 5):22–5.
23. Górniak I, Bartoszewski R, Króliczewski J. Comprehensive review of antimicrobial activities of plant flavonoids. Phytochem Rev. 2019;18:241–72.
24. Babii C, Mihalache G, Bahrin LG, Neagu AN, Gostin I, Mihai CT, et al. A novel synthetic flavonoid with potent antibacterial properties: in vitro activity and proposed mode of action. PLoS One. 2018;13(4):e0194898.
25. Pratama MRF, Aziz IR. Molecular docking of bawang dayak (*Eleutherine bulbosa*) secondary metabolites as bacterial cell wall synthesis inhibitor. In: Harini S, Hafsan H, Sahara S, Aziz IR, Rahim R, editors. Proceeding of 1st International Conference on Science and Technology (ICOST); 2019 May 2–3; Makassar, Indonesia. Bratislava, Slovakia: European Alliance for Innovation; 2019. p. 2284686. Available from: https://eudl.eu/doi/10.4108/eai.2-5-2019.2284686.
26. Thawabteh A, Juma S, Bader M, Karaman D, Scrano L, Bufo SA, et al. The biological activity of natural alkaloids against herbivores, cancerous cells and pathogens. Toxins (Basel). 2019;11(11):656.
27. Khameneh B, Iranshahy M, Soheili V, Fazly Bazzaz BS. Review on plant antimicrobials: a mechanistic viewpoint. Antimicrob Resist Infect Control. 2019;8:118.
28. Villanueva X, Zhen L, Ares JN, Vackier T, Lange H, Crestini C, et al. Effect of chemical modifications of tannins on their antimicrobial and antibiofilm effect against Gram-negative and Gram-positive bacteria. Front Microbiol. 2023;13:987164.
29. Morrogh-Bernard HC, Foitová I, Yeen Z, Wilkin P, De Martin R, Rárová L, et al. Self-medication by orangutans (*Pongo pygmaeus*) using bioactive properties of *Dracaena cantleyi*. Sci Rep. 2017;7(1):16653.
30. Tagousop CN, Tamokou JDD, Ekom SE, Ngnokam D, Voutquenne-Nazabadioko L. Antimicrobial activities of flavonoid glycosides from *Graptophyllum grandulosum* and their mechanism of antibacterial action. BMC Complement Altern Med. 2018;18(1):252.
31. Ajibade VA, Oluwasusi VO, Ibiyemi MF, Ajenifuja OA, Famurewa O. Antibacterial activity of saponin extracted from *Phyllanthus* niruri on methicillin-resistant *Staphylococcus aureus* (MRSA). J Complement Altern Med Res. 2019;7(1):1–9.
32. Nigussie D, Davey G, Legesse BA, Fekadu A, Makonnen E. Antibacterial activity of methanol extracts of the leaves of three medicinal plants against selected bacteria

isolated from wounds of lymphoedema patients. BMC Complement Med Ther. 2021;21(1):2.
33. Cohen MM. Tulsi - *Ocimum sanctum*: a herb for all reasons. J Ayurveda Integr Med. 2014;5(4):251–9.
34. Pattanayak P, Behera P, Das D, Panda S. *Ocimum sanctum* Linn. A reservoir plant for therapeutic applications: an overview. Pharmacogn Rev. 2010;4(7):95–105.
35. Ifora I, Bellatasie R, Efelzita D. Antibacterial activity of purified gambier (*Uncaria gambir* Roxb.). Int J Res Publ Rev. 2022;3(12):1638–41.
36. Wei S, Luo Z, Cui S, Qiao J, Zhang Z, Zhang L, et al. Molecular identification and targeted quantitative analysis of medicinal materials from *Uncaria* species by DNA barcoding and LC-MS/MS. Molecules. 2019; 24(1):175.
37. Zhang Q, Zhao JJ, Xu J, Feng F, Qu W. Medicinal uses phytochemistry and pharmacology of the genus *Uncaria*. J Ethnopharmacol. 2015;173:48–80.
38. Davin-Regli A, Pagès JM. *Enterobacter aerogenes* and *Enterobacter cloacae*; versatile bacterial pathogens confronting antibiotic treatment. Front Microbiol. 2015;6:392.

Global Medical and Health Communication

Online submission: https://ejournal.unisba.ac.id/index.php/gmhc
DOI: https://doi.org/10.29313/gmhc.v12i1.12363

GMHC. 2024;12(1):46–53
pISSN 2301-9123 | eISSN 2460-5441

RESEARCH ARTICLE

Blood Pressure, Total Cholesterol, and Triglycerides Associated with Cardiovascular Risk Score in Low 25-Hydroxy Vitamin D Level among Online Motorcycle Drivers, Jakarta, Indonesia

Joice Viladelvia Kalumpiu, Elly Herwana, Yenny Yenny, Kurniasari Kurniasari
Department of Pharmacology, Faculty of Medicine, Universitas Trisakti, West Jakarta, Indonesia

Abstract

Low 25-hydroxy vitamin D is associated with many chronic diseases, such as coronary heart disease. Online motorcycle drivers spend prolonged hours on the road and may face many stressors and occupational hazards that can create the development of cardiovascular disease. This study aims to determine factors contributing to cardiovascular risk among online motorcycle drivers. This study was an observational analytic with a cross-sectional design. Data were collected in September 2022 with consecutive random sampling methods for 114 subjects at Universitas Trisakti Jakarta. The ages of the subjects ranged from 25 to 62 years. Cardiovascular risk was assessed based on the Jakarta Cardiovascular Risk Score (JAKVAS). The data collection included physical examination and blood biochemistry (lipid profile, fasting blood glucose, and 25(OH)D). The data were analyzed using a chi-square test with $p<0.05$. The majority of subjects were male 83 (72.8%). On blood pressure examination, mean systolic blood pressure was 128.9±16.7 mmHg, and diastolic blood pressure was 86.7±11.9 mmHg. The mean cardiovascular risk was 4.4±2.8, and 52.6% had a high-risk score. All subjects had low 25(OH)D serum levels, with mean 25(OH)D serum levels of 18±5.7 ranging between 6.9 and 29.8. Among online motorcycle drivers, there was a significant association between blood pressure, total cholesterol, and triglyceride with cardiovascular risk scores in low 25-hydroxy vitamin D levels. Blood pressure, total cholesterol, and triglyceride could affect cardiovascular health in low 25-hydroxy vitamin D levels among online motorcycle drivers.

Keywords: 25-hydroxy vitamin D, blood pressure, Jakarta Cardiovascular Risk Score, lipid profile, online motorcycle drivers

Introduction

Vitamin D plays a significant role in supporting overall health. Vitamin D deficiency is a widespread health issue that affects the world. The global prevalence of deficiency serum 25(OH)D was 15.7% between 2000 and 2022.[1] Unexpectedly, Indonesia, as a tropical country, has a high prevalence of vitamin D deficiency. Pulungan et al.[2] and Poh et al.,[3] showed that vitamin D deficiency in Indonesia was 44.6% and 94.4%, respectively. Insufficient exposure to sunlight and low intake of vitamin D are two leading causes of vitamin D deficiency, and it can contribute to an increased risk of chronic disease, such as cardiovascular disease, cancer, diabetes mellitus, etc.[4]

Coronary heart disease (CHD) or coronary artery disease (CAD) is the most common cardiovascular dysfunction disease, and its prevalence is approximately 5–8% worldwide.[5] In Indonesia, the Basic Health Research data 2018 showed that 1.5% of Indonesians suffered from CHD, with death reaching 12.9%.[6] Siadat et al.[7] showed an association of 25(OH)D serum deficiency and coronary artery disease with cardiovascular risk factors. Its risk rises to 5.8 times (1.77–18.94) higher than in people with an average 25(OH)D serum level. Measurement of serum 25(OH)D levels has not been widely carried out in Indonesia, especially for online motorcycle drivers (*ojek* online) who are exposed to sunlight every day. Online motorcycle driving is a job that is now in great demand by the people of Indonesia, and there are still not many published studies on this job. Drivers spend prolonged hours on the road and may face many stressors and occupational hazards that can develop cardiovascular risk factors.[8] Drivers with high-risk cardiovascular disease had a higher

Received: 24 July 2023; Revised: 30 April 2024; Accepted: 30 April 2024; Published: 30 April 2024

Correspondence: Joice Viladelvia Kalumpiu, MD, Sp.F.K. Department of Pharmacology, Faculty of Medicine, Universitas Trisakti. Jln. Kyai Tapa No. 260, West Jakarta 11440, Special Capital Region of Jakarta, Indonesia. E-mail: joice.vk@trisakti.ac.id

likelihood of crash and death.[9,10]

Preventing CHD through early detection of risk factors and efforts to control them are very important. Risk factors for CHD include modified and non-modified risk factors. Previous studies have documented that age, gender, hypertension, diabetes, hyperlipidemia, alcohol intake, low physical activity, and long duration of work were cardiovascular risks for drivers. Blood pressure and biochemical parameters are essential in determining a person's cardiovascular risk. Studies showed that biochemical parameters such as blood sugar, lipid profile, and even 25(OH)D status were often used to analyze cardiovascular risk.[8,11]

This article aims to determine the relationship factors contributing to cardiovascular risk in online motorcycle drivers with low 25(OH)D levels.

Methods

It is an analytic observational study with a cross-sectional design conducted in September 2022. The selection of research subjects used consecutive non-random sampling techniques. The study inclusion criteria were male and female online motorcycle drivers aged 25–64 years, willing to participate, and signed informed consent. Exclusion criteria were having a cognitive impairment, a history of cardiovascular disease, not fully completing the questionnaire, having normal to high serum 25(OH)D level (≥30 ng/ml), and having a high a high low-density lipoprotein cholesterol (LDL-C) ≥300 mg/dl. The study subjects who met the inclusion and exclusion criteria were asked to come to the study location after an overnight fast of 12 hours before blood collection for laboratory examination. Data were collected by interview using a demographic characteristics questionnaire and Jakarta's Cardiovascular Risk Score (JAKVAS) instrument adapted from the Framingham risk score. Jakarta's Cardiovascular Risk Score is based on the Indonesian population and is used for cardiovascular risk stratification in developing countries. It has been shown to have a sensitivity of 77.9%, a specificity of 90%, a positive predictive value of 92.2%, and a negative predictive value of 72.8%.12 It consists of 7 items (gender, age, blood pressure, body mass index, smoking behavior, diabetes, and physical activity), and the level of risks was divided into three categories: low risk if the score was (–)7–1, moderate risk if the score was 2–4, and high risk if the score was ≥5. Two previously trained nurses performed physical examinations of height, weight, waist circumference, blood pressure (with a mercury sphygmomanometer), and blood sample collection.

Laboratory examinations were performed using blood samples of 10 ml each to determine fasting glucose, lipid profile, and 25(OH)D. The 25(OH)D level was determined by indirect competitive chemiluminescence immunoassay (CLIA).[13] Vitamin D deficiency was defined as a serum 25(OH)D level below 20 ng/ml or 50 nmol/l. A 25(OH)D level in the range of 21–29 ng/ml (52–72 nmol/l) was designated vitamin D insufficiency, while a level of ≥30 ng/ml was deemed sufficient.[14] The laboratory examinations were performed at Prodia Laboratories, Jakarta. The Friedewald equation determines LDL-C. The equation subtracts high-density lipoprotein cholesterol (HDL-C) and a fixed ratio of triglycerides/5.

The sample size was determined using the infinite-finite population formula with a 95% significance level of 1.96. The prevalence for counting samples was 1.5%, with a measurement accuracy of 0.05%. The minimal sample size was 109, rounded upwards to 114. The data processing used SPSS for Windows version 29.0. Descriptive statistical analysis (frequency, percentage, mean, standard deviation, minimal, and maximal) was used to display subjects' characteristics and biochemical parameters. The bivariate data analysis used a chi-square test with a significance level of <0.05.

This research protocol has passed a research ethics review from the Research Ethics Committee of the Faculty of Medicine, Universitas Trisakti number 163/KER/FK/VIII/2022.

Results

One hundred twenty-four (124) online motorcycle drivers aged 25–64 agreed to participate in this study, with 10 subjects who did not meet the inclusion criteria excluded. The univariate analysis was used to determine the subjects' characteristics and biochemical parameter distribution.

Table 1 shows the data characteristics of 114 study subjects. The mean subjects were aged 38±7.8 years, with a waist circumference of 89±13

Table 1 Distribution of Features and Characteristics of the Subjects

Characteristics	n=114	%	Mean (SD)	Min–Max
Age (years)			38 (7.8)	25–62
Gender				
Male	83	72.8		
Female	31	27.2		
Waist circumference (cm)			89 (13.0)	60–128
Duration of being an online motorcycle driver (years)				
<5	51	44.7		
5–10	60	52.6		
>10	3	2.6		
Smoking				
Never	26	22.8		
Ex-smoker	9	69.3		
Smoker	79	7.9		
Physical activity				
Never	36	31.6		
Low	59	51.8		
Medium	19	16.7		
High	0	0		
Blood pressure status				
Systolic (mmHg)			128.9 (16.7)	87–174
<140	91	79.8		
≥140	23	20.2		
Diastolic (mmHg)			86.7 (11.9)	60–127
<90	66	57.9		
≥90	48	42.1		
Jakarta Cardiovascular Risk Score			4.4 (2.8)	(–4)–14
Low risk	16	14.0		
Moderate risk	38	33.3		
High risk	60	52.6		

cm. The majority of them were male; 83 (72.8%) and 60 (52.6%) subjects had been working as online motorcycle drivers for 5–10 years. On blood pressure examination, mean systolic blood pressure (SBP) was 128.9±16.7 mmHg, and diastolic blood pressure (DBP) was 86.7±11.9 mmHg. Based on Jakarta's Cardiovascular Risk Score, the online motorcycle drivers participating in this study had a mean cardiovascular risk of 4.4±2.8, and 60 (52.6%) had high-risk scores.

Table 2 shows biochemical parameters from 114 online motorcycle drivers. Lipid profile, i.e., the level of total cholesterol, high-density lipoprotein (HDL) cholesterol, and triglyceride, were standard in most subjects (except LDL-C). Mean total cholesterols were 184.6±30.1, HDL 45±9.9, LDL 109.6±26.3, and triglyceride 151.5±94.2. The mean fasting glucose was 82.5±31.7, and 103 (90.4%) subjects had average fasting glucose. All subjects had low 25(OH)D serum levels, with mean 25(OH)D serum levels of 18±5.7 ranging between 6.9 and 29.8.

Table 3 shows a significant association between blood pressure, triglycerides, total cholesterol, and Jakarta Cardiovascular Risk Score with p-value <0.005. Meanwhile, the relationship between HDL, LDL, and fasting glucose with Jakarta Cardiovascular Risk Score was found to have no significant association.

Discussion

Jakarta's Cardiovascular Risk Score (JAKVAS) is an instrument that predicts the risk of cardiovascular events in the next ten years. Our study showed that % prevalence in the high-

Table 2 Biochemical Parameters

Characteristics	n=114	%	Mean (SD)	Min–Max
Total cholesterol (mg/dl)			184.6 (30.1)	130–296
<200	82	71.9		
≥200	32	28.1		
HDL cholesterol (mg/dl)			45 (9.9)	22–68
<40	41	36.0		
≥40	73	64.0		
LDL cholesterol (mg/dl)			109.6 (26.3)	44.4–184.4
<100	44	36.1		
≥100	78	63.9		
Triglycerides (mg/dl)			151.5 (94.2)	44–581
<150	71	62.3		
≥150	43	37.7		
Fasting glucose (mg/dl)			82.5 (31.7)	57–290
<100	103	90.4		
≥100	11	9.6		
25(OH)D status			18 (5.7)	6.9–29.8

risk category based on JAKVAS was 52.6%. This prevalence is different from a study conducted on athletes, which only shows a prevalence of 3.85% in the high-risk category,[15] and on health cadres, who also have a high-risk outcome category of only 11.7%.[16] Work-related cardiovascular risk factors can significantly impact an individual's health. Our research was conducted on online

Table 3 Blood Pressure, Biochemical Parameters, and Cardiovascular Risk Profile

Variables	Jakarta Cardiovascular Risk Score			p
	Low n (%)	Moderate n (%)	High n (%)	
Blood pressure (mmHg)				
Systolic				
<140	14 (15.4)	36 (39.6)	41 (45.1)	0.005*
≥140	2 (8.7)	2 (8.7)	19 (82.6)	
Diastolic				
<90	11 (16.7)	29 (43.9)	26 (39.4)	0.004*
≥90	5 (10.4)	9 (18.8)	34 (70.8)	
Total cholesterol (mg/dl)				
<200	16 (19.5)	27 (32.9)	39 (47.6)	0.021*
≥200	0 (0)	11 (34.4)	21 (65.6)	
HDL cholesterol (mg/dl)				
<40	3 (7.3)	16 (39.0)	22 (53.7)	0.260*
≥40	13 (17.8)	22 (30.1)	38 (52.1)	
LDL cholesterol (mg/dl)				
<100	8 (18.6)	12 (27.9)	23 (53.5)	0.439*
≥100	8 (11.3)	26 (36.6)	37 (52.1)	
Triglycerides (mg/dl)				
<150	14 (20.0)	28 (40.0)	28 (40.0)	0.002*
≥150	2 (4.5)	10 (22.7)	32 (72.7)	
Fasting glucose (mg/dl)				
<100	15 (14.6)	34 (33.0)	54 (52.4)	1.000#
≥100	1 (9.1)	4 (36.4)	6 (54.5)	

Note: *chi-square test, #Fisher test, significant p<0.05

motorcycle drivers who had a sizable percentage of smoking at 69.3% and low physical activity (never-low category) at 83.4%. At the same time, studies on athletes found that physical activity was quite high (optimum-excessive category), reaching>95%, and smokers only 35.9%. A survey of health cadres also showed that smokers comprise only 2.3% of the population, and moderate physical activity is 90.9%.

A meta-analysis study in 2017, conducted by Hackshaw et al.[17] on 141 cohort studies, showed men and women who smoked about one cigarette per day had a 48% and 57% higher risk of heart disease than non-smokers, respectively. Cigarettes have adrenergic effects, which result in an increased heart rate, inotropic status, coronary microvascular resistance, and reduced insulin sensitivity. It affects blood pressure, heart rate, and lipid profile and results in the development of atherosclerotic changes, narrowing of the vascular lumen, endothelial dysfunction, and impaired response of coronary blood flow.[18] A systematic review in 2022 by Gonzalez-Jaramillo et al.[19] with 33,576 patients from nine prospective cohort studies showed that higher levels of physical activity were associated with a lower mortality risk and cardiovascular risk. Regular physical activity can help strengthen the heart muscle, improve blood flow, and enhance the heart's ability to use oxygen.[20]

This study found a significant relationship between systolic and diastolic blood pressure with cardiovascular risk. A recent cohort study by Whelthon et al.,[21] which included 1,457 subjects, found that for every 10 mmHg increase in systolic blood pressure, there was a 53% higher risk for atherosclerotic cardiovascular disease. High systolic blood pressure alters the dynamics of normal blood flow and encourages plaque formation. Its increased shear stress in arteries disrupts endothelial function, which can cause reduced production of nitric oxide and trigger inflammatory responses, leading to the formation of atherosclerosis.[22] Although both systolic and diastolic blood pressure have been reported to be associated with future cardiovascular risk, the association of DBP with cardiovascular risk diminishes with age as vascular compliance is attenuated. High diastolic blood pressure leads to increased arterial resistance, compromising the delivery of oxygen and nutrients to the heart muscle and can lead to endothelial dysfunction.[23] A systematic review and meta-analysis by Okamoto et al.[24] suggest that reducing DBP to 80 mmHg or less would significantly reduce coronary revascularization and heart failure but potentially cause hypotension in CHD patients.

This study had a significant association between total cholesterol and cardiovascular risk (p=0.021). This study was in line with Peters et al.,[25] and Jeong et al.,[26] which showed that raised total cholesterol is a strong risk factor for CHD. The fundamental process that causes CHD is atherosclerosis. It occurs when cholesterol and other substances accumulate within the walls of arteries, forming plaques. Total cholesterol is transported in blood as low-density lipoprotein or LDL-C (about 70%) and high-density lipoprotein or HDL-C (about 30%). Increased levels of total cholesterol, especially LDL-C, might increase the development of atherosclerosis by increasing the amount of cholesterol deposited in the artery walls. High LDL-C particles penetrate the arterial walls, attracting immune cells and inflammation. This process causes fatty plaques to develop over time, which narrows the arteries and reduces blood flow to the heart.[27]

Many studies stated that there was a relationship between cholesterol levels and cardiovascular risk.[28] But in this study we found no significant association between LDL or HDL-C with cardiovascular risk (p=0.439 and p=0.260, respectively). A current literature study also found that low-density lipoprotein cholesterol (LDL-C) does not cause cardiovascular disease. It said that people with low cholesterol levels became just as atherosclerotic as people with high levels, and their risk of suffering from cardiovascular disease (CVD) is the same or higher.[29] It is important to note that the relationship between LDL-C and cardiovascular risk is complex and influenced by other factors such as inflammation, genetics, and individual patient characteristics. In this study, LDL-C levels were not obtained from blood tests but were determined using the Friedewald formula. The Friedewald equation is commonly used to estimate LDL-C levels. However, it has some limitations and weaknesses that can affect its accuracy, particularly at high triglyceride and/or low LDL-C values where inaccuracy in VLDL-C estimation using a "one size fits all approach" constitutes a more significant proportion of estimated LDL-C.[30]

Low levels of HDL-C predict increased cardiovascular risk because HDL-C has a protective role in heart and blood vessel health.

The positive effect of HDL is due to its role in reverse cholesterol transport and removing excess cholesterol from the body.[31] However, data from several cohorts have revealed a plateau in the inverse association above certain HDL-C levels, and there is even a suggestion of increased cardiovascular outcomes in those with high HDLs-C.[32,33]

This study found a significant association between triglycerides and cardiovascular risk (p=0.002). High triglyceride levels are often associated with other lipid abnormalities, such as low levels of high-density lipoprotein (HDL) cholesterol and small, dense, low-density lipoprotein (LDL) particles. These lipid abnormalities contribute to the development of atherosclerosis, the underlying process of CHD. High triglyceride levels can also trigger inflammation and oxidative stress within the blood vessels. It can contribute to the damage of the endothelial lining, which lines the blood vessel walls, making them more susceptible to plaque formation. Elevated triglyceride levels are often associated with reduced clearance of triglyceride-rich lipoproteins from the bloodstream. It can result from various factors, including impaired lipoprotein lipase activity, an enzyme that breaks down triglycerides. Reduced clearance leads to the accumulation of these lipoproteins and their remnants, contributing to the development of atherosclerosis.[34,35]

This study was conducted in a population with low levels of 25(OH)D. Vitamin D is involved in regulating the synthesis of cholesterol in the body. Studies have shown that vitamin D deficiency may be associated with dyslipidemia (total cholesterol, HDL-C, LDL-C, and triglycerides).[36,37] It has been proposed that vitamin D may reduce the production of LDL-C in the liver and increase the expression of LDL receptors, which helps remove LDL-C from the bloodstream. Vitamin D plays a role in regulating lipid metabolism, including the synthesis and breakdown of cholesterol. Both vitamin D deficiency and dyslipidemia (abnormal lipid levels) are associated with increased inflammation and oxidative stress. Vitamin D deficiency may contribute to systemic inflammation, impacting lipid metabolism and altering cholesterol levels.[38]

This study found no association between fasting glucose level and cardiovascular risk (p=1.000). It might be due to differences in the study's cutoff point for fasting blood sugar. Research conducted by Park et al.[39] showed the relationships between fasting glucose levels and CVD risks generally followed J-shape curves, with the lowest risk in the glucose range of 85–99 mg/dl. As fasting glucose levels increased to ≥110 mg/dl, risks for atherosclerotic cardiovascular disease increased.[39] High fasting glucose levels can contribute to endothelial dysfunction, a condition in which the inner lining of blood vessels becomes impaired. Endothelial dysfunction is a critical early step in the development of atherosclerosis and promotes inflammation within blood vessels, contributing to the progression of CVD.[40] High fasting glucose levels also can lead to increased production of reactive oxygen species, causing oxidative stress. Oxidative stress damages blood vessels, promotes inflammation, and accelerates the development of atherosclerosis, thus increasing cardiovascular risk.[41] Both high fasting glucose levels and vitamin D deficiency have been associated with increased inflammation and oxidative stress. Chronic inflammation and oxidative stress can contribute to insulin resistance and impaired glucose metabolism.[42]

Conclusions

There was a significant relationship between blood pressure, total cholesterol, and triglycerides and the Jakarta Cardiovascular Risk Score in low 25-hydroxy vitamin D levels among online motorcycle drivers in Jakarta. Early detection of blood pressure, total cholesterol, and triglycerides can prevent the increasing risk of cardiovascular disease.

Conflict of Interest

All authors have disclosed any actual or potential competing interests regarding the submitted article and the nature of those interests.

Acknowledgment

The researchers would like to thank all online motorcycle drivers who were willing to participate in this study. The study was supported by the Faculty of Medicine, Universitas Trisakti, Jakarta, Indonesia.

References

1. Cui A, Zhang T, Xiao P, Wang H, Zhuang Y.

Global and regional prevalence of vitamin D deficiency in population-based studies from 2000 to 2022: a pooled analysis of 7.9 million participants. Front Nutr. 2023;10:1070808.
2. Pulungan A, Soesanti F, Tridjaja B, Batubara J. Vitamin D insufficiency and its contributing factors in primary school-aged children in Indonesia, a sun-rich country. Ann Pediatr Endocrinol Metab. 2021;26(2):92–8.
3. Poh BK, Rojroongwasinkul N, Nguyen BK, Sandjaja, Ruzita AT, Yamborisut U, et al. 25-hydroxy-vitamin D demography and the risk of vitamin D insufficiency in the South East Asian Nutrition Surveys (SEANUTS). Asia Pac J Clin Nutr. 2016;25(3):538–48.
4. Muscogiuri G, Altieri B, Annweiler C, Balenciaga G, Pal HB, Bouncer BJ, et al. Vitamin D and chronic diseases: the current state of the art. Arch Toxicol. 2017;91(1):97–107.
5. Bauersachs R, Zeymer U, Brière JB, Marre C, Bowrin K, Huelsenbeck M. Burden of coronary artery disease and peripheral artery disease: a literature review. Cardiovasc Ther. 2019;2019:8295054.
6. Badan Penelitian dan Pengembangan Kesehatan, Kementerian Kesehatan Republik Indonesia. Laporan nasional Riskesdas 2018. Jakarta: Lembaga Penerbit Badan Penelitian dan Pengembangan Kesehatan; 2019.
7. Siadat ZD, Kiani K, Sadeghi M, Shariat AS, Farajzadegan Z, Kheirmand M. Association of vitamin D deficiency and coronary artery disease with cardiovascular risk factors. J Res Med Sci. 2012;17(11):1052–5.
8. Elshatarat RA, Burgel BJ. Cardiovascular risk factors of taxi drivers. J Urban Health. 2016;93(3):589–606.
9. Ronna BB, Thiese MS, Ott U, Effiong A, Murtaugh M, Kapellusch J, et al. The association between cardiovascular disease risk factors and motor vehicle crashes among professional truck drivers. J Occup Environ Med. 2016;58(8):828–32.
10. Chen GX, Amandus HE, Wu N. Occupational fatalities among driver/sales workers and truck drivers in the United States, 2003–2008. Am J Ind Med. 2014;57(7):800–9.
11. Shin SY, Lee CG, Song HS, Kim SH, Lee HS, Jung MS, et al. Cardiovascular disease risk of bus drivers in a city of Korea. Ann Occup Environ Med. 2013;25(1):34.
12. Putri FU, Dalimunthe NN, Ginting AR, Fujiati II. Cardiovascular risk assessment in type 2 diabetic patients at Universitas Sumatera Utara Hospital. JETROMI. 2023;5(2):96–102.
13. Enko D, Kriegshäuser G, Stolba R, Worf E, Halwachs-Baumann G. Method evaluation study of a new generation of vitamin D assays. Biochem Med (Zagreb). 2015;25(2):203–12.
14. Holick MF. The vitamin D deficiency pandemic: approaches for diagnosis, treatment and prevention. Rev Endocr Metab Disord. 2017;18(2):153–65.
15. Achmad BF, Alim S, Kusumawati HI, Fitriawan AS, Kurniawan D, Kafil RF. Cardiovascular disease risk profiles in Indonesian athletes. OAMJMS. 2022;10(A):924–9.
16. Tiksnadi BB, Afrianti R, Sofiatin Y, Rhida A, Fihaya FY, Roesly RMA, et al. Gambaran profil risiko kardiovaskular berdasarkan Skor Kardiovaskular Jakarta pada kader kesehatan di Desa Cilayung Kecamatan Jatinangor. J Pengabdi Kpd Masy. 2018;2(11):926–9.
17. Hackshaw A, Morris JK, Boniface S, Tang JL, Milenković D. Low cigarette consumption and risk of coronary heart disease and stroke: meta-analysis of 141 cohort studies in 55 study reports. BMJ. 2018;360:j5855.
18. Gallucci G, Tartarone A, Lerose R, Lalinga AV, Capobianco AM. Cardiovascular risk of smoking and benefits of smoking cessation. J Thorac Dis. 2020;12(7):3866–76.
19. Gonzalez-Jaramillo N, Wilhelm M, Arango-Rivas AM, Gonzalez-Jaramillo V, Mesa-Vieira C, Minder B, et al. Systematic review of physical activity trajectories and mortality in patients with coronary artery disease. J Am Coll Cardiol. 2022;79(17):1690–700.
20. Varghese T, Schultz WM, McCue AA, Lambert CT, Sandesara PB, Eapen DJ, et al. Physical activity in preventing coronary heart disease: implications for the clinician. Heart. 2016;102(12):904–9.
21. Whelton SP, McEvoy JW, Shaw L, Psaty BM, Lima JAC, et al. Association of normal systolic blood pressure level with cardiovascular disease in the absence of risk factors. JAMA Cardiol. 2020;5(9):1011–8.
22. Gallo G, Volpe M, Savoia C. Endothelial dysfunction in hypertension: current concepts and clinical implications. Front Med (Lausanne). 2022;8:798958.
23. Matsuzawa Y. Is diastolic blood pressure key to detecting risk and preventing heart failure

with preserved ejection fraction? Hypertens Res. 2023;46(2):534–6.
24. Okamoto R, Kumagai E, Kai H, Shibata R, Ohtsubo T, Kawano H, et al. Effects of lowering diastolic blood pressure to <80 mmHg on cardiovascular mortality and events in patients with coronary artery disease: a systematic review and meta-analysis. Hypertens Res. 2019;42(5):650–59.
25. Peters SAE, Singhateh Y, Mackay D, Huxley RR, Woodward M. Total cholesterol as a risk factor for coronary heart disease and stroke in women compared with men: a systematic review and meta-analysis. Atherosclerosis. 2016;248:123–31.
26. Jeong SM, Choi S, Kim K, Kim SM, Lee G, Park SY, et al. Effect of change in total cholesterol levels on cardiovascular disease among young adults. J Am Heart Assoc. 2018;7(12):e008819.
27. Brown RA, Shantsila E, Varma C, Lip GY. Current understanding of atherogenesis. Am J Med. 2017;130(3):268–82.
28. Jung E, Kong SY, Ro YS, Ryu HH, Shin SD. Serum cholesterol levels and risk of cardiovascular death: a systematic review and a dose-response meta-analysis of prospective cohort studies. Int J Environ Res Public Health. 2022;19(14):8272.
29. Ravnskov U, de Lorgeril M, Diamond DM, Hama R, Hamazaki T, Hammarskjöld B, et al. LDL-C does not cause cardiovascular disease: a comprehensive review of the current literature. Expert Rev Clin Pharmacol. 2018;11(10):959–70.
30. Martin SS, Blaha MJ, Elshazly MB, Brinton EA, Toth PP, McEvoy JW, et al. Friedewald-estimated versus directly measured low-density lipoprotein cholesterol and treatment implications. J Am Coll Cardiol. 2013;62(8):732–9.
31. Ouimet M, Barrett TJ, Fisher EA. HDL and reverse cholesterol transport. Circ Res. 2019;124(10):1505–18.
32. Liu C, Dhindsa D, Almuwaqqat Z, Ko YA, Mehta A, Alkhoder AA, et al. Association between high-density lipoprotein cholesterol levels and adverse cardiovascular outcomes in high-risk populations. JAMA Cardiol. 2022;7(7):672–80.
33. Kim HJ, Jeong S, Oh YH, Park SJ, Cho Y, Park SM. Changes in high-density lipoprotein cholesterol with risk of cardiovascular disease among initially high-density lipoprotein-high participants. Cardiovasc Diabetol. 2023;22(1):71.
34. Peng J, Luo F, Ruan G, Peng R, Li X. Hypertriglyceridemia and atherosclerosis. Lipids Health Dis. 2017;16(1):233.
35. Nordestgaard BG. Triglyceride-rich lipoproteins and atherosclerotic cardiovascular disease: new insights from epidemiology, genetics, and biology. Circ Res. 2016;118(4):547–63.
36. Jiang X, Peng M, Chen S, Wu S, Zhang W. Vitamin D deficiency is associated with dyslipidemia: a cross-sectional study in 3788 subjects. Curr Med Res Opin. 2019;35(6):1059–63.
37. Dibaba DT. The effect of vitamin D supplementation on serum lipid profiles: a systematic review and meta-analysis. Nutr Rev. 2019;77(12):890–902.
38. Surdu AM, Pînzariu O, Ciobanu DM, Negru AG, Căinap SS, Lazea C, et al. Vitamin D and its role in the lipid metabolism and the development of atherosclerosis. Biomedicines. 2021;9(2):172.
39. Park C, Guallar E, Linton JA, Lee DC, Jang Y, Son DK, et al. Fasting glucose level and the risk of incident atherosclerotic cardiovascular diseases. Diabetes Care. 2013;36(7):1988–93.
40. Zuo Y, Han X, Tian X, Chen S, Wu S, Wang A. Association of impaired fasting glucose with cardiovascular disease in the absence of risk factor. J Clin Endocrinol Metab. 2022;107(4):e1710–8.
41. Higashi Y. Roles of oxidative stress and inflammation in vascular endothelial dysfunction-related disease. Antioxidants (Basel). 2022;11(10):1958.
42. Gu JC, Wu YG, Huang WG, Fan XJ, Chen XH, Zhou B, et al. Effect of vitamin D on oxidative stress and serum inflammatory factors in the patients with type 2 diabetes. J Clin Lab Anal. 2022;36(5):e24430.

Global Medical and Health Communication

Online submission: https://ejournal.unisba.ac.id/index.php/gmhc
DOI: https://doi.org/10.29313/gmhc.v12i1.12279

GMHC. 2024;12(1):54–62
pISSN 2301-9123 | eISSN 2460-5441

RESEARCH ARTICLE

Correlation of NLR and D-dimer Levels with Clinical Severity of COVID-19 and Determination of Cut-off Values at a Hospital in Cirebon

Fitria Ratna Sari,[1] Rika Nilapsari[1,2]

[1]Clinical Pathology Laboratory, Permata Cirebon Hospital, Cirebon, Indonesia,
[2]Department of Clinical Pathology, Faculty of Medicine, Universitas Islam Bandung, Bandung, Indonesia

Abstract

Inflammation and coagulation markers play a crucial role in assessing the systemic involvement of COVID-19. Early identification of disease severity through neutrophil-lymphocyte ratio (NLR) and D-dimer levels can aid physicians in promptly identifying potentially severe cases and determining appropriate treatment strategies. This study explored the relationship between NLR, D-dimer levels, and clinical severity in COVID-19 patients. This retrospective cross-sectional study reviewed 237 medical records of adult COVID-19 patients treated at Permata Cirebon Hospital from July to October 2021. The seriousness of COVID-19 served as the outcome variable, while NLR and D-dimer values were considered independent variables. Correlation analysis examined the relationship between NLR, D-dimer, and COVID-19 severity. Receiver operating characteristic (ROC) curve analysis was employed to establish the cut-off values. The majority of COVID-19 patients exhibited moderate disease severity. Male gender, advanced age, and comorbidities such as diabetes, hypertension, CVD, and stroke were associated with a higher likelihood of severe disease. A significant positive correlation was found between NLR and disease severity, as well as between D-dimer and disease severity. Notably, the correlation between D-dimer and disease severity was more substantial than that of NLR. Furthermore, the cut-off values obtained from the ROC analysis were 3.79 for NLR (sensitivity=68.8%, specificity=68.1%) and 1,110 for D-dimer (sensitivity=79.2%, specificity=87.5%). The study revealed a significant positive correlation between the severity of NLR, D-dimer levels, and COVID-19. Therefore, NLR and D-dimer can serve as prognostic markers for COVID-19 patients.

Keywords: COVID-19, cut-off, D-dimer, NLR, severity

Introduction

Clinical symptoms of COVID-19 are categorized as asymptomatic, mild, moderate, severe, and critical.[1] Patients of advanced age (>65 years), smokers, patients with hypertension, diabetes, cardiovascular disease, chronic obstructive pulmonary disease, and malignancies are at higher risk for more severe disease progression and mortality when infected with COVID-19.[2] COVID-19 may also cause complications in the hematologic and neurologic systems.[3,4] Changes in the hematologic system include lymphopenia, elevated inflammatory markers, and hypercoagulopathy.[3–5]

COVID-19 spreads rapidly and has a relatively high mortality rate. Therefore, one of the keys to reducing the mortality rate of COVID-19 is early detection of COVID-19 severity. Several previous studies have found that several inflammatory and coagulation parameters, including neutrophil-lymphocyte ratio,[4,6] C-reactive protein, lactate dehydrogenase,[7] D-dimer,[8] and ferritin, have predictive value and are associated with COVID-19 severity, increased risk of intensive care unit (ICU) admission, and mortality.[3,5,7,8]

The neutrophil-lymphocyte ratio (NLR) indicates impaired cell-mediated immunity associated with systemic inflammation.[9] NLR is essential in determining the inflammatory status in COVID-19 patients and is more sensitive than neutrophils or lymphocytes alone. NLR values are markedly increased in COVID-19 patients with severe symptoms. This increase is due to dysregulated expression of inflammatory cytokines.[6,9,10] An exaggerated inflammatory response is characterized by a cytokine storm that can lead to systemic inflammatory syndrome. Inflammation-triggered viruses increase NLR, which then triggers the progression of

Received: 10 July 2023; Revised: 22 January 2024; Accepted: 25 April 2024; Published: 30 April 2024

Correspondence: Fitria Ratna Sari. Clinical Pathology Laboratory, Permata Cirebon Hospital. Jln. Tuparev No. 117, Cirebon 45153, West Java, Indonesia. E-mail: dr.fitriars@gmail.com

COVID-19.[10] The NLR value is calculated by dividing the absolute number of neutrophils by the absolute number of lymphocytes. In the healthy adult population, NLR values have been reported to range from 0.78 to 3.53, with a cut-off value of 3.13. COVID-19 patients with an NLR value <3.13 are considered to have a good prognosis.[9,10]

In COVID-19 patients, hematologic abnormalities in hypercoagulopathy are frequently found in addition to lymphopenia, placing COVID-19 patients at high risk for venous thromboembolism. Coagulopathic disorders are common in COVID-19 patients.[3] Coagulopathic disorders may be characterized by elevated D-dimer. D-dimer is a fibrin degradation product or small protein fragment in the peripheral circulation after plasminogen activators have degraded fibrin. Elevated circulating D-dimers indicate activation of the coagulation system and ongoing fibrinolysis, support the presence of thrombus, and correlate directly with the amount of fibrin undergoing lysis but do not directly indicate the location of the thrombus. Fibrin degradation products, including D-dimer, cause platelet activation.[11,12] The normal value of D-dimer is <0.5 μg/ml. An increase in plasma D-dimer indicates an increase in hemostatic and thrombolytic activity. Elevated D-dimer levels are also associated with increased in-hospital mortality.[13,14] The incidence of thrombotic complications in COVID-19 patients is approximately 16–69%. High D-dimer levels are expected to predict the severity of COVID-19, pulmonary complications, and thromboembolic events. D-dimer levels can be used to evaluate coagulation and fibrinolytic activity in the body for early diagnosis and therapy to reduce morbidity and mortality.[14]

Based on the above description, inflammation, and coagulation are essential indicators that can be used to assess the systemic involvement of COVID-19. Early detection of disease severity with NLR and D-dimer can help physicians identify potentially severe cases early, determine appropriate treatment steps, and initiate effective therapy promptly, which can ultimately prevent the development of COVID-19, save medical resources, and reduce mortality and morbidity. This study investigated the relationship between NLR and D-dimer levels with clinical severity in COVID-19 patients.

Methods

A cross-sectional study was conducted retrospectively, reviewing the medical records of patients diagnosed with COVID-19 on the first day of admission in the Emergency Room in Permata Cirebon Hospital between July 2021 and October 2021. The inclusion criteria for the study were patients who had COVID-19 confirmed by RT-PCR and were ≥18 years of age. Patients with a comorbid history of coagulopathy and leukocyte disorders were excluded from this study. The Health Research Ethics Committee approved all research procedures, Universitas Islam Bandung (189/KEPK-Unisba/VI/2023).

The primary outcome of this study is the severity of COVID-19 patients. The seriousness of COVID-19 is classified as moderate and severe according to the criteria of the Indonesian COVID-19 guideline. Data on the severity of COVID-19 that were obtained were divided into moderate and severe degrees, regarded with mild degrees that had no recommendation for admission; therefore, D-dimer and NLR values were not obtained. Moderate-degree criteria in this study reported clinical symptoms of pneumonia (fever, cough, tightness, rapid breathing) but no signs of severe pneumonia, including SpO_2≥93% with room air. The severe-degree criteria are reported with moderate degrees plus one of the signs and symptoms: breathing frequency >30 ×/minute, severe respiratory distress, or SpO_2<93% in room air.[2,5] The independent variables in this study were NLR and D-dimer levels. The NLR value compares the number of neutrophils with the number of lymphocytes obtained from medical records. NLR values are categorized into average (<3.13) and abnormal values (≥3.13). D-dimer levels were obtained from medical records and reported as usual (<500 mg/ml) and abnormal (≥500 mg/ml). Data on patient characteristics such as age, sex, concomitant diseases such as diabetes, hypertension, renal diseases, cardiovascular diseases, lung disease, malignancies, and stroke, which is known as medical history, vital signs such as systolic blood pressure, respiratory rate, body temperature, and oxygen saturation, laboratory examination such as hemoglobin which divided into normal if hemoglobin count >13 g/dl for males, and >12 g/dl for females based on WHO criteria, thrombocyte count, leucocyte count, and random blood glucose which divided into normal

if glucose <200 mg/dl, and not normal if glucose >200 mg/dl. Data on patient characteristics were also collected on the first day of admission in the emergency room to describe patients according to clinical severity.

After collecting the data, we conducted double data entry using Microsoft Excel. Data analysis was performed using SPSS ver. 26 (IBM, SPSS, New York). The descriptive data for categorical variables were presented as relative proportions. In contrast, numerical variables were summarized using mean measures, including the minimum and maximum range of values and standard deviation. To examine the relationship between the severity of COVID-19 and NLR and D-dimer values, a bivariate analysis was conducted using the Spearman correlation test. The significance level set for this study was 0.05. Additionally, we employed the receiver operating characteristic (ROC) curve to determine the cut-off values for the NLR and D-dimer variables in predicting severe cases of COVID-19.

Results

Participants in this study were obtained from medical record data from July 2021 to October 2021—237 confirmed patients with COVID-19 were included. Based on clinical severity, 160 cases were classified as moderate (67.5%), and 77 others were classified as severe (32.5%). More than half of the patients were men (51.1%); the dominant age group was 18-60 (74.3%).

In addition, patient characteristics were

Table 1 COVID-19 Patient Characteristics

Characteristics	COVID-19 Severity Level			
	Moderate		Severe	
	n=160	%	n=77	%
Gender				
Male	75	31.6	46	19.4
Female	85	35.9	31	13.1
Age (years)				
18–60	121	51.1	55	23.2
>60	39	16.5	22	9.3
Diabetes				
Yes	33	13.9	23	9.7
No	127	53.6	54	22.8
Hypertension				
Yes	15	6.3	13	5.5
No	145	61.2	64	27
Renal disease				
Yes	5	2.1	1	0.4
No	155	65.4	76	32.1
Cardiovascular diseases				
Yes	11	4.6	12	5.1
No	149	62.9	65	27.4
Lung disease				
Yes	1	0.4	0	0.0
No	159	67.1	77	32.5
Malignancy				
Yes	0	0.0	4	1.7
No	160	67.5	73	30.8
Stroke				
Yes	0	0.0	1	0.4
No	160	67.5	76	32.1
Outcome				
Survivor	160	67.5	75	31.6
Non-survivor	0	0.0	2	0.8

Table 2 Vital Signs and Laboratory Characteristics by Severity Level

Characteristics	COVID-19 Severity Level			
	Moderate		Severe	
	n=160	%	n=77	%
Systolic blood pressure (mmHg)				
<140 (normal)	132	70.2	56	29.8
>140 (high)	28	57.1	21	42.9
Respiratory rate (×/minute)				
<30	158	69.9	68	30.1
≥30	2	18.2	9	81.8
Body temperature (°C)				
≤37.3	22	59.5	15	40.5
>37.3	138	69.0	62	31.0
SpO_2 (%)				
>93	107	99.1	1	0.9
≤93	53	41.1	76	58.9
Haemoglobin (g/dl)				
Normal	154	69.1	69	30.9
Not normal	6	42.9	8	57.1
Thrombocyte count (×109 /L)				
≥150	140	68.3	65	31.7
<150	20	62.5	12	37.5
Leucocyte count (×109 /L)				
4–10	148	75.9	47	24.1
>10	12	28.6	30	71.4
Random blood clucose (mg/dl)				
<200 (normal)	119	72.6	45	27.4
>200 (not normal)	41	56.2	32	43.8

subdivided according to disease severity (Table 1). Severe disease was relatively more common in men than in women (38% vs 26.8%) and in patients older than 60 years (36.1% vs 31.3%). The proportion of severe disease was also higher in patients with diabetes mellitus (41.1%), hypertension (46.4%), cardiovascular disease (52.2%), malignant disease (100%), and stroke (100%). Two of the 77 patients with severe disease died (2.6%).

Table 2 shows the characteristics of vital signs and laboratory values for COVID-19 patients based on the disease severity. High systolic blood pressure (>140 mmHg) is more common in patients with severe disease than in patients with moderate disease. Similarly, respiratory rate ≥30 ×/minute and SpO_2≥93 are more likely to be found in patients with severe than moderate disease. Among laboratory indicators, patients with severe disease are likelier to have abnormal Hb levels, higher leukocyte counts, and abnormal random blood glucose levels than patients with moderate disease.

Table 3 shows that the mean value of NLR and D-dimer is relatively higher in patients with severe disease than those with moderate disease.

Table 3 Correlation of NLR and D-dimer with COVID-19 Severity Level

Variables	COVID-19 Severity Level						r	p
	Moderate			Severe				
	Mean	Min–Max	±SD	Mean	Min–Max	±SD		
NLR	3.43	0.15–24.30	±2.93	7.79	1.00–47.47	±7.23	0.460	<0.001*
D-dimer	598.69	52.00–4,290.00	±660.81	4,545.27	200.00–14,430.00	±4,327.71	0.613	<0.001*

Note: r: correlation coefficient, *significant p<0.05

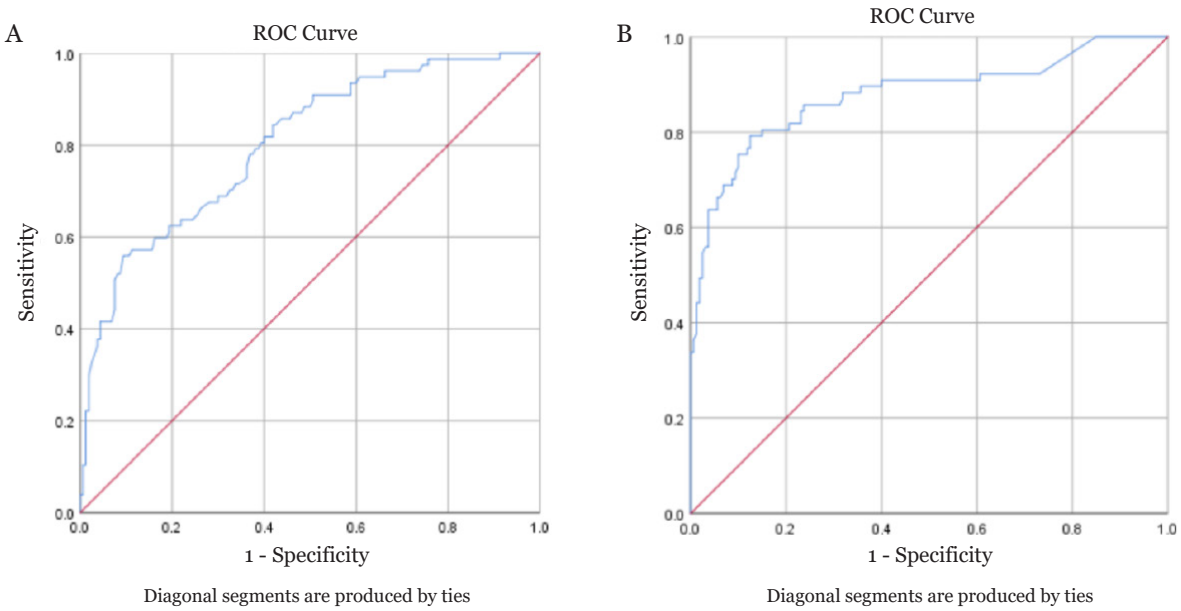

Figure (A) ROC Analysis for NLR and (B) ROC Analysis for D-dimer

In addition, the results of Spearman correlation analysis between NLR and COVID-19 severity showed a significant correlation (p<0.001) with moderate strength of positive direction (r=0.460). These results suggest that an increase in NLR value positively correlates with an increase in disease severity. A similar picture was found for the D-dimer value with a stronger correlation (r=0.613). These results suggest that an increase in D-dimer level has a strong positive correlation with an increase in the severity of COVID-19.

We further analyzed the ROC curve to determine the cut-off values for the NLR and D-dimer variables in predicting severe cases of COVID-19. The ROC analysis for NLR yielded an area under the curve (AUC) value of approximately 80.2%, with a 95% CI ranging from 74.3% to 86.1% and a p-value of 0.000. This analysis found that the optimal cut-off value for the negative likelihood ratio accurately predicted severe COVID-19 in 80 out of 100 individuals. Therefore, the NLR demonstrated an excellent ability to predict the severity of COVID-19. Similarly, the ROC analysis for D-dimer resulted in an AUC value of approximately 87.8%, with a 95% confidence interval ranging from 82.5% to 93.1% and a p-value of 0.000. The optimal cut-off value for D-dimer accurately predicted severe COVID-19 in 87 out of 100 individuals. Hence, D-dimer exhibited a good predictive ability for severe COVID-19 (Figure).

The determination of cut-off values from the graph resulted in an NLR value of 3.79, with a sensitivity of 68.8% and a specificity of 68.1%. Meanwhile, the cut-off value for D-dimer was 1,110, with a sensitivity of 79.2% and a specificity of 87.5% (Table 4).

Discussion

The results showed that more than half of the confirmed COVID-19 patients were male and in the age range of 18–60 years. Similarly, in most studies of COVID-19 patients, male patients were found to be more dominant than females and had a more severe disease course.[15,16] Males have

Table 4 Cut off Value of NLR and D-dimer for Severe COVID-19

Variables	AUC	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
NLR ≥3.79	0.802	68.8	68.1	53	87
D-dimer ≥1,110.0	0.878	79.2	87.5	75	89

been reported to have a higher risk of disease progression than females. COVID-19 elevated levels of proinflammatory cytokines such as IL-8 were higher in men than women, whereas women were more likely to have a strong T-cell response.[15–17] In addition, men are also associated with a higher prevalence of smoking and tobacco use, but this needs further investigation.[16] The 18-to-60-year-old age group is the dominant age group affected by COVID-19 due to high mobility and activity outside the home.[18] However, older individuals (>60 years) are at higher risk of developing more severe diseases because overexpression of ACE2 is a sign of decreased immunity, decreased organ function, and concomitant diseases.[17]

The results showed a tendency toward severe disease in patients with diabetes, hypertension, heart disease, malignant disease, and stroke. Diabetes mellitus is an essential complication in COVID-19 patients. A systematic review by Singh et al.[19] found an increase in the frequency and severity of COVID-19 in patients with diabetes mellitus. Diabetes mellitus and its complications may increase the risk of morbidity and death during acute infection due to suppression of innate and humoral immune function. Several predisposing factors are thought to be the cause of the severity of COVID-19 in patients with diabetes mellitus, including increased expression of ACE2; increased furin, a membrane-bound protease that facilitates internalization of the virus; and impaired T-cell function leading to lymphopenia and increased IL -6, which is also known to increase in diabetes mellitus and plays an essential role in organ failure during COVID-19 infections.[19,20] Lippi et al.[20] reported that hypertension and cardiovascular disease are associated with a 2.5-fold increase in COVID-19 progression and death, particularly in patients >60 years of age. The involvement of hypertension and cardiovascular disease in the pathogenesis of COVID-19 through a direct role as a causative factor in ARDS and multiorgan failure. This condition may be due to an increase in converting enzyme inhibitors (ACEi) in hypertensive patients, which increases their susceptibility to COVID-19 and increases the risk of death.[21]

This study's characteristics of SpO_2 in COVID-19 patients were mostly ≤93%, regardless of disease severity. To date, there have not been many studies of differences in peripheral oxygen saturation based on the severity of COVID-19, and therefore, only brief generalizations can be made; according to referrals, patients with severe symptoms usually show an oxygen saturation <93%, resulting in a worse prognosis.[20] A study in Jakarta also showed that more patients with moderate to severe symptoms required hospitalization than patients with mild or no symptoms.[22]

In this study, NLR values were higher in patients with severe disease than those with moderate. In addition, a significant relationship was found between NLR and the severity of COVID-19 disease, with a moderate correlation strength. This is consistent with several previous studies that found the NLR higher on average in patients with severe COVID-19 than in patients with milder disease.[23] A high NLR in COVID-19 patients on admission may be an early sign of the patient's prognosis. In addition, a higher NLR is usually found in patients with more severe symptoms, such as fever, cough, respiratory tract infection, pneumonia, and a drop in oxygen saturation below 93%. Initial treatment is generally given immediately in the respiratory ICU for these various clinical signs.[6,22] Increased neutrophil counts are caused by an inflammatory response and lymphocytopenia due to the expression of ACE2 receptors, which make them one of the targets of infection, and by increased inflammatory cytokines, which can trigger a reduction in lymphocytes.[24] Lymphocytopenia in COVID-19 patients can trigger lymphocyte apoptosis and pyroptosis, bone marrow suppression due to the release of proinflammatory cytokines, thymic suppression, activation-induced lymphocyte cell death, lymphocyte tissue redistribution, and several other pathways.[24,25]

This study found that the average D-dimer level was higher in patients with severe disease than in moderate. A significant relationship was also found between D-dimers and the severity of COVID-19 disease, with a strong positive correlation. Luo et al.'s[25] study in Wuhan obtained similar results, according to which there was a significant correlation between D-dimer and mortality and severity of COVID-19 patients ($p<0.05$). Yao et al.'s[26] study in China found that elevated D-dimers were likelier in patients with severe grades (Kendall's tau-b=0.374, p=0.000). A meta-analysis study also showed that mortality and disease severity increased with elevated D-dimers. In addition, the study showed that the

risk of mortality was four times higher in patients with positive D-dimers than in negative ones, so D-dimer can be considered as a biomarker for testing the severity and mortality of COVID-19.[27]

D-dimer is a fibrin degradation product; its presence in the circulation indicates the degradation of fibrin polymer by plasmin so that it can be used as a parameter of coagulopathy. D-dimers >1,000 ng/ml indicate a 20-fold higher risk of death than patients with lower D-dimers.[27,28] The pathogenesis of coagulopathy in COVID-19 is not significantly different from disseminated induced coagulopathy (DIC), in which there is an excess of proinflammatory cytokines, increased damage-associated molecular activity, stimulation of cell death mechanisms, and damage to the vascular endothelium.[11,14] In coagulopathy due to COVID-19, there is widespread inflammation and dysfunction of endothelial cells, abnormal blood flow dynamics, and activation of platelets, cell-free DNA, histones, and viral RNA that cumulatively activates factor XI and the formation of thrombin and fibrin. Coagulopathy manifests as thrombosis and hemorrhage.[12–14] Vascular thrombosis contributes to tissue ischemia and organ dysfunction. In addition, the thrombus formed may break loose and travel through the blood vessels, resulting in embolism.[11] In a study, the incidence of venous thromboembolism associated with COVID-19 was 14.7%, involving pulmonary embolism and deep vein thrombosis, whereas the incidence of arterial thromboembolism in this study was 3.9%.[29] These thromboembolic events play an essential role in the severity and mortality of COVID-19 patients.

Based on the data analysis and ROC curve, the NLR was found to have an AUC of 0.802 (95% CI=0.743–0.861, p<0.000). The optimal cut-off value for NLR, ≥3.79, was determined as the minimum threshold for predicting the severity of COVID-19 upon admission to the hospital. This cut-off value demonstrated a sensitivity of 68.8% and a specificity of 68.1%. The positive predictive value (PPV) was 53%, while the negative predictive value (NPV) was 87%. These results indicate that NLR can serve as a reliable predictor for the severity of COVID-19. A study by Fei et al.[28] in China, which examined 72 COVID-19 patients on the second day of treatment, also supported the findings of this study. Fei et al.[28] obtained an AUC NLR value of 0.888, demonstrating the ability of NLR to differentiate between different degrees of severity. Based on the data, no other study observed the correlation and cut-off between NLR and the seriousness of COVID-19, especially in Indonesia when the analyses were performed.

Similarly, the analysis of the D-dimer values using the ROC curve revealed an AUC of 0.878 (95% CI=0.825–0.931, p<0.000). The cut-off value for D-dimer, ≥1,110.0, was identified as the minimum threshold for predicting the severity of COVID-19 upon admission to the hospital. This cut-off value showed a sensitivity of 79.2% and a specificity of 87.5%. The PPV was 75%, and the NPV was 89%. Therefore, D-dimer can be considered a valuable predictor of the severity of COVID-19. This study identified D-dimer levels higher than 1,500 ng/ml as a predictor of mortality in severe COVID-19 cases.[30] Additionally, Zhang et al.'s[30] study aligned with these findings, showing that a D-dimer level >2.0 ng/ml predicted mortality in patients with severe COVID-19 compared to non-severe degrees. Therefore, patients with elevated D-dimer levels should be closely monitored following the guidelines for managing coagulopathy in COVID-19.

The result of this study should be considered in the context of several potential limitations. First, these studies retrieved data from the first day the patient was admitted to the ER; therefore, developed results of NLR and D-Dimer when the patient was still inpatient were not being observed. Second, as the studies were only performed in the regent of Cirebon of Permata Hospital, the size of the samples in this study needed to provide more power for the responder analyses. Last, the inclusion and exclusion criteria may be limited in generalizability.

Conclusions

The study revealed a significant correlation between NLR and D-dimer levels and the severity of COVID-19. Notably, the correlation between D-dimer and disease severity was stronger. Therefore, NLR and D-dimer can be valuable prognostic markers for COVID-19 patients.

Conflict of Interest

The authors declare no conflict of interest.

Acknowledgment

Thanks are due to all the healthcare professionals

who continue the daily struggle against this pandemic.

References

1. Kementerian Kesehatan Republik Indonesia. Pedoman pencegahan dan pengendalian coronavirus disease (COVID-19). Jakarta: Kementerian Kesehatan Republik Indonesia; 2020.
2. Zheng Z, Peng F, Xu B, Zhao J, Liu H, Peng J, et al. Risk factors of critical and mortal COVID-19 cases: a systematic literature review and meta-analysis. J Infect. 2020;81(2):e16–25.
3. Terpos E, Ntanasis-Stathopoulos I, Elalamy I, Kastritis E, Sergentanis TN, Politou M, et al. Hematological findings and complications of COVID-19. Am J Hematol. 2020;95(7):834–47.
4. Yang AP, Liu JP, Tao WQ, Li HM. The diagnostic and predictive role of NLR, d-NLR and PLR in COVID-19 patients. Int Immunopharmacol. 2020;84:106504.
5. Aly MM, Meshref TS, Abdelhameid MA, Ahmed SA, Shaltout AS, Abdel-Moniem AE, et al. Can hematological ratios predict outcome of COVID-19 patients? A multicentric study. J Blood Med. 2021;505–15.
6. Regolo M, Vaccaro M, Sorce A, Stancanelli B, Colaci M, Natoli G, et al. Neutrophil-to-lymphocyte ratio (NLR) is a promising predictor of mortality and admission to intensive care unit of COVID-19 patients. J Clin Med. 2022;11(8):2235.
7. Kermali M, Khalsa RK, Pillai K, Ismail Z, Harky A. The role of biomarkers in diagnosis of COVID-19 – A systematic review. Life Sci. 2020;254:117788.
8. Keddie S, Ziff O, Chou MKL, Taylor RL, Heslegrave A, Garr E, et al. Laboratory biomarkers associated with COVID-19 severity and management. Clin Immunol. 2020;221:108614.
9. Faria SS, Fernandes PC Jr, Silva MJ, Lima VC, Fontes W, Freitas-Junior R, et al. The neutrophil-to-lymphocyte ratio: a narrative review. Ecancermedicalscience. 2016;10:702.
10. Li X, Liu C, Mao Z, Xiao M, Wang L, Qi S, et al. Predictive values of neutrophil-to-lymphocyte ratio on disease severity and mortality in COVID-19 patients: a systematic review and meta-analysis. Crit Care. 2020;24(1):647.
11. Iba T, Levy JH, Levi M, Thachil J. Coagulopathy in COVID-19. J Thromb Haemost. 2020;18(9):2103–9.
12. McGonagle D, O'Donnell JS, Sharif K, Emery P, Bridgewood C. Immune mechanisms of pulmonary intravascular coagulopathy in COVID-19 pneumonia. Lancet Rheumatol. 2020;2(7):e437–45.
13. Gómez-Mesa JE, Galindo-Coral S, Montes MC, Muñoz Martin AJ. Thrombosis and coagulopathy in COVID-19. Curr Probl Cardiol. 2021;46(3):100742.
14. Asakura H, Ogawa H. COVID-19-associated coagulopathy and disseminated intravascular coagulation. Int J Hematol. 2021;113(1):45–57.
15. Takahashi T, Ellingson MK, Wong P, Israelow B, Lucas C, Klein J, et al. Sex differences in immune responses that underlie COVID-19 disease outcomes. Nature. 2020;588(7837):315–20
16. Galbadage T, Peterson BM, Awada J, Buck AS, Ramirez DA, Wilson J, et al. Systematic review and meta-analysis of sex-specific COVID-19 clinical outcomes. Front Med (Lausanne). 2020;7:348.
17. Putri NA, Putra AE, Mariko R. Hubungan usia, jenis kelamin dan gejala dengan kejadian COVID-19 di Sumatera Barat. Maj Kedokt Andalas. 2021;41(2):104–11.
18. Elviani R, Anwar C, Sitorus RJ. Gambaran usia pada kejadian COVID-19. JMJ. 2021;9(2):204–9.
19. Singh AK, Gupta R, Ghosh A, Misra A. Diabetes in COVID-19: prevalence, pathophysiology, prognosis and practical considerations. Diabetes Metab Syndr. 2020;14(4):303–10.
20. Lippi G, Wong J, Henry BM. Hypertension and its severity or mortality in coronavirus disease 2019 (COVID-19): a pooled analysis. Pol Arch Intern Med. 2020;130(4):304–9.
21. Rahayu LAD, Admiyanti JC, Khalda YI, Ahda FR, Agistany NFF, Setiawati S, et al. Hipertensi, diabetes mellitus, dan obesitas sebagai faktor komorbiditas utama terhadap mortalitas pasien COVID-19: sebuah studi literatur. JIMKI. 2021;9(1):90–7.
22. Ibrahim F, Natasha A, Saharman YR, Sudarmono P. Preliminary report of COVID-19 testing: experience of the clinical microbiology laboratory Universitas Indonesia, Jakarta, Indonesia. New Microbes

New Infect. 2020;37:100733.
23. Yang AP, Liu JP, Tao WQ, Li HM. The diagnostic and predictive role of NLR, d-NLR and PLR in COVID-19 patients. Int Immunopharmacol. 2020;84:106504.
24. Rotty L, Kurube J, Harijanto PN, Wantania F, Haroen H, Hendratta C, et al. The correlation between neutrophil-to-lymphocyte ratio with C-reactive protein and D-dimer level among Indonesian COVID-19 cases. Open Access Maced J Med Sci. 2022;10(B):335–8.
25. Luo X, Xia H, Yang W, Wang B, Guo T, Xiong J, et al. Characteristics of patients with COVID-19 during epidemic ongoing outbreak in Wuhan, China. MedRxiv [preprint]. 2020 medRxiv 20033175 [posted 2020 Mar 23; cited 2023 Jun 10]: [17 p.]. Available from: https://www.medrxiv.org/content/10.1101/2020.03.19.20033175v1.
26. Yao Y, Cao J, Wang Q, Shi Q, Liu K, Luo Z, et al. D-dimer as a biomarker for disease severity and mortality in COVID-19 patients: a case-control study. J Intensive Care. 2020;8:49.
27. Shah S, Shah K, Patel SB, Patel FS, Osman M, Velagapudi P, et al. Elevated D-dimer levels are associated with increased risk of mortality in coronavirus disease 2019: a systematic review and meta-analysis. Cardiol Rev. 2020;28(6):295–302.
28. Fei M, Tong F, Tao X, Wang J. Value of neutrophil-to-lymphocyte ratio in the classification diagnosis of coronavirus disease 2019. Zhonghua Wei Zhong Bing Ji Jiu Yi Xue. 2020;32(5):554–8.
29. Suastika NKW, Suega K. The optimal cut-off value of d-dimer levels to predict in hospital mortality in severe cases of coronavirus disease 2019. Open Access Maced J Med Sci. 2021;9(B):1561–4.
30. Zhang L, Yan X, Fan Q, Liu H, Liu X, Liu Z, et al. D-dimer levels on admission to predict in-hospital mortality in patients with COVID-19. J Thromb Haemost. 2020;18(6):1324–9.

Global Medical and Health Communication

Online submission: https://ejournal.unisba.ac.id/index.php/gmhc
DOI: https://doi.org/10.29313/gmhc.v12i1.12311

GMHC. 2024;12(1):63–68
pISSN 2301-9123 | eISSN 2460-5441

RESEARCH ARTICLE

Bacteriological and Antibiotic Susceptibility Profile of Urinary Tract Infection among Online Motorcycle Drivers in Jakarta, Indonesia

Ida Effendi, Thomas Robertus, Jihan Samira, Arleen Devita, Widyasari Kumala, Isa Bella

Department of Microbiology, Faculty of Medicine, Universitas Trisakti, West Jakarta, Indonesia

Abstract

Urinary tract infection (UTI) is a bacterial infection that contributes significantly to morbidity rates. UTI is a health concern due to multidrug-resistant (MDR) organisms. Therefore, the profile of bacteria and antibiotic susceptibility patterns are very important to know in order to make the best treatment choice. Working as an online motorcycle (*ojol* driver) carries a risk of urinary tract infections. Online drivers are assumed to often hold their urination for short or long periods. The descriptive study with a cross-sectional design was conducted to obtain the prevalence of urinary tract infections, bacteria profile, and antibiotic susceptibility in urine specimens collected from Jakarta *ojol* drivers in September 2022–March 2023. Of 98 midstream urine specimens, 17 samples are considered to have UTI (17.34%). The identification of the 17 isolates shows that the microorganisms' distribution was more likely to be caused by Gram-positive than Gram-negative bacteria (70.59%). The causative bacteria were coagulase-negative *Staphylococcus* (17.65%), *Escherichia coli* (11.76%), and *Enterococcus faecalis* (11.76%). Our results showed that the prevalence of urinary tract infections in *ojol* drivers is high with the distribution of the causative organisms by coagulase-negative *Staphylococcus*, *Escherichia coli*, and *Enterococcus faecalis* and still showed good susceptibility to narrow-spectrum antibiotics such as cotrimoxazole.

Keywords: Antibiotic susceptibility, bacteria, *ojol* drivers, urinary tract infection prevalence

Introduction

It has been estimated that about 150 million people worldwide develop urinary tract infections each year, with high social costs in terms of hospitalizations and medical expenses.[1] Urinary tract infections (UTI) are a significant cause of morbidity in infant boys, older men, and females of all ages.[2] Urinary tract infection is an infection that is often found in women aged 16–35 years; 10% of these women suffer from UTI annually, and more than 40–60% suffer from UTI at least once during their life. Recurrent infections are common; almost half will get a second infection within one year. Urinary tract infections occur at least four times more often in women than men. In men, UTI generally occurs at the age of over 50 years; infection under 50 years occurs with a lower prevalence.[3]

A definite diagnosis of urinary tract infection can be established if significant bacteriuria is found. Bacteriuria is a general term indicating the presence of bacteria in the urine on laboratory findings.[4] Based on the findings of the number of bacteria in the urine, it was significant bacteriuria if the urine culture showed the growth of pure microorganisms more than ≥105 colony forming units/ml (CFU/ml) in two consecutive sampling.[5–7] Bacteriuria with a bacterial count of 1,000–100,000 CFU/ml accompanied by a clinical presentation can be managed according to urinary tract infections. Asymptomatic bacteriuria occurs when bacteria are found in urine culture with a count of >105 CFU/ml and do not cause clinical symptoms of UTI.[5,7] Asymptomatic bacteriuria is not defined as a urinary tract infection.[8] Gram-negative, Gram-positive, and fungi can be found in bacteriuria. A single bacterial species causes most cases of UTI. Symptomatic bacteriuria (UTI) is generally caused by uropathogenic colonization of the urinary tract.[9] Uropathogenic *Escherichia coli* (UPEC) is the dominant infectious agent in UTI. Meanwhile, infection by the Gram-positive bacteria *Staphylococcus saprophyticus* is less common. The use of antibiotics in cases of

Received: 14 July 2023; Revised: 30 April 2024; Accepted: 30 April 2024; Published: 30 April 2024

Correspondence: dr. Ida Effendi, Sp.M.K. Department of Microbiology, Faculty of Medicine, Universitas Trisakti. Jln. Kyai Tapa No. 260, West Jakarta 11440, Special Capital Region of Jakarta, Indonesia. E-mail: idaeffendi@trisakti.ac.id

infection (UTI) is very recommended, but incorrect use and overuse create new health problems. The relative frequency of uropathogens varies depending on age, sex, catheterization, hospitalization, and previous antimicrobial exposure.[9] Some bacteria can develop resistance to certain antimicrobials. It is essential to update the sensitivity patterns of antimicrobials periodically because they vary and change in place and at different times.[10] UTI is a health concern due to multidrug-resistant (MDR) organisms.[11]

In recent years, the profession of an online motorcycle driver (online driver/*ojol*) has been popular due to public demand, and it can provide a good income. The non-governmental organization Prakarsa surveyed 213 online drivers and obtained results showing that 30% of online drivers tended to work beyond working hours (>8 hours/day).[12] The profession as an online driver has a risk of urinary tract infections caused by lack of hydration and the behavior of frequently holding urine for short or long periods.[7,13] In most cases, holding your urine briefly is not dangerous. However, urine retained in the bladder decreases bacterial eradication and increases bacterial growth, associated with an increased risk of infection in the urinary tract. [14]

This study aimed to provide information regarding the bacteria and its susceptibility profile as the frequent infectious agent found in *ojol* drivers' community urinary tract infections.

Methods

A descriptive study with a cross-sectional approach was conducted at the Faculty of Medicine Universitas Trisakti, West Jakarta city, Indonesia between September 2022–March 2023. The inclusion criteria were ojol drivers of all genders aged 17–60 years old. Consumption of any antibiotics in the last week was excluded. The information about gender, age, and length of work was collected by filling out the form. Data about the clinical manifestation of urinary tract infection was collected from the questionnaire. Collection of midstream urine is required to perform bacteria culture. We used a 0.01 µl sterile loop to streak the specimen to media cultivation and incubate it at 2–8°C for 18–24 hours before we did a colony count to obtain the number of colonies in CFU/ml. Species identification and antibiotic testing are performed from isolates with colony number 100,000 CFU/ml or 1,000–10,000 CFU/ml with UTI symptoms data. Data analysis was performed descriptively using tables and narrative statements, which include the distribution of respondents' characteristics (age, sex, length of work, clinical manifestations, UTI status, bacterial profile, and antibiotic susceptibility pattern. All data were shown as numbers and percentages. Ethics Committee approval was given for this research (ethical clearance number: 167/KER/FK/VIII/2022).

Results

This study obtained 98 urine specimens from 98 respondents (Table 1). The respondents were men-dominant (78.94%). The age group is between 17 and 40 years (67.35%). The average respondent has worked for 1–5 years as an online driver (72.63%). After the urine culture was performed, there were three samples with a colony count of >105 CFU/ml (significant bacteriuria) on agar culture and 14 samples with a colony count of 1,000–100,000 with clinical symptoms of a urinary tract infection. Of the total respondents who filled out the questionnaire, 25 respondents stated that they had at least one of the symptoms of cloudy colored urine, urinating more than one time during sleep at night, urinating in small quantities and frequently, voiding feeling incomplete, pain or burning feeling while urinating.

In this study, culture identification and

Table 1 Distribution of Respondents

Respondents Characteristics	n=98 (%)
Gender	
Male	77 (78.57)
Female	21 (21.43)
Age (years)	
17–40	66 (67.35)
41–60	32 (32.65)
Length of work (year)	
<1	2 (2.04)
1–5	69 (70.41)
>5	27 (27.55)
UTI manifestation	
Yes	25 (25.51)
No	73 (74.49)
Confirmed UTI	
Confirmed	17 (17.34)
Not confirmed	81 (82.65)

Table 2 Distribution of Bacteria Causing Urinary Tract Infections

Microorganisms	n=98 (%)
Gram-negative	5 (29.41)
Eschericia coli	2 (11.76)
Enterobacter cloacae complex	1 (5.88)
Pantoea sp.	1 (5.88)
Sphingomonas paucimobilis	1 (5.88)
Gram-positive	
Enterococcus faecalis	2 (11.76)
Staphyococcus aureus	1 (5.88)
Coagulase-negative *Staphylococcus*	3 (17.65)
Streptococcus agalactiae	1 (5.88)
Kochuria rosea	1 (5.88)
Corynebacterium minutissimum	2 (11.76)
Corynebacterium amycolatum	1 (5.88)
Corynebacterium sp.	1 (5.88)

antibiotic sensitivity were carried out in specimens with bacteriuria ≥100,000 CFU/ml or 1,000-100,000 CFU/ml with clinical manifestation of UTI. Seventeen isolates from 17 samples were identified. Data were obtained from the identification of bacteria (Table 2).

From Table 2, the infectious agents of urinary tract infections in *ojol* drivers in this study were more commonly caused by Gram-positive bacteria than Gram-negative bacteria. In the Gram-negative group, *Escherichia coli* is the most common species found in UTIs. In the Gram-positive group, coagulase-negative *Staphylococcus* is the most common species, followed by *Enterococcus faecalis*.

The antibiotic sensitivity test was carried out with the identification test to obtain the sensitivity pattern of the tested bacteria. Tables 3 and Table 4 show the description and pattern of sensitivity of Gram-negative and Gram-positive bacteria, respectively.

We use 9–17 antibiotic disks in the Gram-negative bacteria sensitivity test. All *Escherichia coli* bacteria are sensitive (100%) to the antibiotics amikacin, aztreonam, cefazolin, cefepime, ceftazidime, ceftriaxone, ertapenem, fosfomycyn, meropenem, nitrofurantoin, piperacillin-tazobactam, tigecycline, trimethoprim-sulfamethoxazole. The *Escherichia coli* bacteria obtained were excluded from the extended-spectrum beta-lactamase (ESBL) group.

In Gram-positive bacteria, 6–18 antibiotic discs are used for sensitivity testing. Cefoxitin test was only carried out on *Staphylococcus* sp. bacteria (*Staphylococcus aureus*, *Staphylococcus shiurim*, *Staphylococcus xylosus*, and *Staphylococcus haemolyticus*) with negative results. All *Enterococcus faecalis* bacteria show sensitivity (100%) to the antibiotics ampicillin, benzylpenicillin, ciprofloxacin, gentamycin, levofloxacine, linezolid, nitrofurantoin, streptomycin, tigecycline, and vancomycin.

Discussion

Urinary tract infections (UTIs) are among the most common and severe infections in community and hospital environments. They are an important health concern because the number of multiresistant bacteria that cause them is increasing.

The prevalence of UTI in this study was 17.34%. This figure is higher than the prevalence of UTI stated by Mayangsari et al.[15] and Rosana et al.[16] This study showed that the incidence of UTI was more common in women (52.90%). Urinary tract infections occur at least four times more often in women than men in a previous study by Bono et al.[3] Syaikacitta et al.[17] also found in their

Table 3 Bacterial Profile and Antibiotic Susceptibility Pattern of Gram-negative Bacteria

No	Microorganisms Gram-negative	No of Isolate	Antibiotics																				
			AK	AMP	AMS	ATM	CZO	FEP	CAZ	CRO	CXM	CIP	DOR	ETP	FOS	GEN	IPM	LVX	MEM	NIT	TZP	TGC	SXT	ESBL
1	*Eschericia coli*	2	100	0	0	100	100	100	100	100	–	50	–	100	100	50	–	–	100	100	100	100	100	Neg
2	*Enterobacter cloacae* complex	1	100	0	0	100	0	100	100	100	–	0	–	100	100	100	–	–	100	100	100	100	100	–
3	*Pantoea* sp.	1	100	–	100	–	–	100	–	–	100	–	100	–	100	–	–	100	0	–	–	–	0	–
4	*Sphingomonas paucimobilis*	1	100	–	100	–	–	100	–	–	0	100	–	–	0	–	0	0	0	–	–	–	–	–

Note: n=5, –: not tested, AK: amikacin, AMP: ampicillin, AMS: ampicillin-sulbactam, ATM: aztreonam, CZO: cefazoline (urine), FEP: cefepime, CAZ: ceftazidime, CRO: ceftriaxone, CXM: cefuroxime, CIP: ciprofloxacin, DOR: doripenem, ETP: ertapenem, fosfomycyn: FOS, gentamycin: GEN, imipenem: IPM, levofloxacin: LVX, meropenem: MEM, nitrofurantoin: NIT, TZP: , TGC: piperacillin-tazobactam tigecycline, SXT: trimethoprim-sulfamethoxazole, ESBL: extended-spectrum beta-lactamase

Table 4 Bacterial Profile and Antibiotic Susceptibility Pattern of Gram-positive Bacteria

No	Microorganisms Gram-negative	No of Isolate	Antibiotics																			
			AMP	P	FEP	C	CIP	DA	GEN	LVX	LZD	MFX	NIT	OXA	QD	RIF	STR	TE	TGC	SXT	VAN	CS	ICR
1	*Enterococcus faecalis*	2	100	100	–	–	100	–	100	100	100	–	100	–	0	–	100	50	100	–	100	–	–
2	*Staphyococcus aureus*	1	–	0	–	–	100	100	100	100	100	100	100	100	100	100	–	100	100	100	100	Neg	Neg
3	*Coagulase-negative Staphylococcus*	3	–	33.3	–	–	100	100	100	100	100	100	100	100	100	100	–	66.7	100	100	100	Neg	Neg
4	*Streptococcus agalactiae*	1	100	100	–	–	–	100	–	100	100	100	100	–	100	–	–	0	100	–	100	–	–
5	Kochuria rosea	1	–	–	100	100	–	–	–	–	100	–	–	–	–	–	–	0	–	100	–	–	–
6	*Corynebacterium minutissimum*	2	–	–	0	100	–	–	–	–	100	–	–	–	–	–	–	100	–	0	–	–	–
7	*Corynebacterium amycolatum*	1	–	–	0	0	–	–	–	–	100	–	–	–	–	–	–	100	–	0	–	–	–
8	*Corynebacterium* sp.	1	–	–	0	100	–	–	–	–	100	–	–	–	–	–	–	100	–	0	–	–	–

Note: n=12, –: not tested, AMP: ampicillin, P: benzylpenicillin, FEP: cefepime, C: chloramphenicol, CIP: ciprofloxacin, DA: clindamycin, E: erythromycin, GEN: gentamycin, LVX: levofloxacine, LZD: linezolid, MFX: moxifloxacin, NIT: nitrofurantoin, OXA: oxacillin, QD: quinupristin-dalfopristin, RIF: rifampicin, STR: streptomycin, TE: tetracycline, TGC: tigecycline, SXT: trimethoprim-sulfamethoxazole, VAN: vancomycin, CS: cefoxitin screen, ICR: inducible clindamycin resistance

research that the highest incidence of UTI was in females (57.58%) compared to males (12.12%). Anatomically, women have shorter urethra and the proximity of the external urethral meatus to the anus compared to men, and these are risk factors that increase urinary tract infections through the ascending route.[6]

Bacteria found were more Gram-positive (70.59%) than Gram-negative (29.41%). *Escherichia coli* is the most Gram-negative bacteria (40%). At the same time, the most Gram-positive is coagulase-negative *Staphylococcus* (25%), followed by *Enterococcus faecalis* (16.67%). The results of this study showed a different variety of etiological agents from previous research. Previous retrospective research showed the most common bacteria found were Gram-negative, namely *Escherichia coli* and *Klebsiella pneumonia*.[10] Similar studies in Pawe General Hospital in Northwest Ethiopia showed that the most predominant bacterium isolated from urine is *Escherichia coli*, which belongs to Gram-negative.[18] Study results in 2019–2020 from patients with UTI at Islamic Hospital Surabaya, Indonesia, showed the proportion Gram-negative and Gram-positive was 52.0% and 48% with dominantly *Escherichia coli* and *Enterococcus* sp.[17]

Most of the Gram-positive bacteria found are sensitive to all antibiotics. Coagulase-negative *Staphylococcus* is 100% sensitive to the antibiotics ciprofloxacin, levofloxacin, moxifloxacin, vancomycin, linezolid, tigecycline, and cotrimoxazole. *Staphylococcus* sp. bacteria were found to be 100% sensitive to cefoxitin and not included in the methycillin-resistant *Staphylococcus* group, so they can still be killed with beta-lactam antibiotics, for example, cephalosporins 1st and 2nd generation. Other narrow-spectrum antibiotics, such as cotrimoxazole, have susceptibility test results that are still very good (100%). *Enterococcus faecalis* bacteria were found 100% sensitive to the antibiotics penicillin, ampicillin, ciprofloxacin, levofloxacin, vancomycin, linezolid, and tigecycline, while other studies showed many *Enterococcus* spp. were resistant to vancomycin (vancomycin-resistant enterococci, VRE) and beta-lactams vary in each region due to intrinsic and acquired antibiotic resistance genes.[19,20]

Meanwhile, the most common Gram-negative bacteria isolate, *Escherichia coli*, is not an ESBL-producing strain. This bacterium is still sensitive to most beta-lactam antibiotics and cotrimoxazole. Other studies showed vast differences in bacteria and their susceptibility patterns. According to the sensitivity profiles, Zúniga-Moya et al.[21] found the most effective antibiotics were fosfomycin (68.9%), amikacin (68.4%), nitrofurantoin (62.5%), gentamicin (60.5%), and ceftriaxone (50.1%).

Antibiotic cotrimoxazole (trimethoprim-sulfamethoxazole) has been a first-line drug in urinary tract infections since 1960. It shows good effectiveness against most *Enterobacteriaceae* and *Staphylococcus* sp. in UTI.[22] Our study demonstrated that narrow-spectrum antibiotics such as cotrimoxazole can still be used as a choice for uncomplicated UTI therapy since it has 100% sensitivity. This result is in concordance with a study conducted by Rosana et al.[16] that revealed the effectiveness of cotrimoxazole for uncomplicated UTI in outpatients in Indonesia.

Decreased susceptibility was found

in quinolones antibiotics. The activity of ciprofloxacin against *Escherichia coli* and *Enterobacter cloacae* in this study was 50% and 0%. Quinolones were found to have a high percentage of resistance in a study conducted by Zuniga-Moya et al.[21] The study result showed that quinolones have resistance to Gram-negative and Gram-positive bacteria tested.

The limitation of this study was the number of isolates tested. In this study, 17 isolates were tested for identification and antibiotic sensitivity. Further studies with larger sample sizes are needed to make an antibiotic recommendation for UTI.

Conclusion

The prevalence of UTI in the *ojol* driver community was found to be high, and the causative bacteria were coagulase-negative *Staphylococcus*, *Escherichia coli*, and *Enterococcus faecalis*, which is highly sensitive to narrow-spectrum antibiotics such as cotrimoxazole.

Conflict of Interest

The authors affirm no conflict of interest in this study.

Acknowledgment

The author would like to thank Facuty of Medicine Universitas Trisakti and all the respondents who have participated in this study.

References

1. Terlizzi ME, Gribaudo G, Maffei ME. UroPathogenic *Escherichia coli* (UPEC) infections: virulence factors, bladder responses, antibiotic, and non-antibiotic antimicrobial strategies. Front Microbiol. 2017;8:1566.
2. Flores-Mireles AL, Walker JN, Caparon M, Hultgren SJ. Urinary tract infections: Epidemiology, mechanisms of infection and treatment options. Nat Rev Microbiol. 2015;13(5):269–84.
3. Bono MJ, Leslie SW, Reygaert WC, Doerr C. Uncomplicated urinary tract infection (nursing). In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021 [cited 2023 April 20]. Available from: https://europepmc.org/article/NBK/nbk568701.
4. Ipe DS, Horton E, Ulett GC. The basics of bacteriuria: strategies of microbes for persistence in urine. Front Cell Infect Microbiol. 2016;6:14.
5. Cai T, Bartoletti R. Asymptomatic bacteriuria in recurrent UTI - to treat not to treat. GMS Infect Dis. 2017;5:Doc09.
6. Hernández-Hernández D, Padilla-Fernández B, Ortega-González MY, Castro-Díaz DM. Recurrent urinary tract infections and asymptomatic bacteriuria in adults. Curr Bladder Dysfunct Rep. 2022;17(1):1–12.
7. Nicolle LE, Bradley S, Colgan R, Rice JC, Schaeffer A, Hooton TM; Infectious Diseases Society of America; American Society of Nephrology; American Geriatric Society. Infectious Diseases Society of America guidelines for diagnosing and treating asymptomatic bacteriuria in adults. Clin Infect Dis. 2005;40(5):643–54.
8. Crader MF, Kharsa A, Leslie SW. Bacteriuria. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 [cited 2023 May 10]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK482276.
9. Khan MI, Xu S, Ali MM, Ali R, Kazmi A, Akhtar N, et al. Assessment of multidrug resistance in bacterial isolates from urinary tract-infected patients. J Radiat Res Appl Sci. 2020;13(1):267–75.
10. Samirah S, Darwati D, Windarwati W, Hardjoeno H. Pola dan sensitivitas kuman di penderita infeksi saluran kemih. IJCPML. 2006;12(3):110–3.
11. Bhargava K, Nath G, Bhargava A, Kumari R, Aseri GK, Jain N. Bacterial profile and antibiotic susceptibility pattern of uropathogens causing urinary tract infection in the eastern part of Northern India. Front Microbiol. 2022;13:965053.
12. Maftuchan A, Djamhari EA, Thaariq RM. Policy Brief 08 - Pengemudi ojek daring dan kerja layak [Internet]. Jakarta Selatan: Prakarsa; 2018 [cited 2023 May 15]. Available from: https://repository.theprakarsa.org/media/publications/293911-policy-brief-08-pengemudi-ojek-daring-da-377022e1.pdf.
13. Lean K, Nawaz RF, Jawad S, Vincent C. Reducing urinary tract infections in care homes by improving hydration. BMJ Open Qual. 2019;8(3):e000563.
14. Beetz R. Mild dehydration: a risk factor of

urinary tract infection? Eur J Clin Nutr. 2003;57(Suppl 2):S52–8.
15. Mayangsari S, Sjakoer NAA, Lisminingsih RD. Prevalensi infeksi saluran kemih (ISK) pada pasien di Rumah Sakit Islam (RSI) Unisma Malang tahun 2018. E-JBST. 2021;6(2):34–9.
16. Rosana Y, Ocviyanti D, Akbar W. Bacterial susceptibility patterns to cotrimoxazole in urinary tract infections of outpatients and inpatients in Jakarta, Indonesia. Med J Indones. 2020;29(3):316–21.
17. Syaikacitta A, Diyantoro, Sundari AS, Indriati DW. The bacterial profile and antibiotic resistance among patients with urinary tract infection in Surabaya, Indonesia. Mal J Med Health Sci. 2020;16(Suppl 16):14–8.
18. Girma A, Aemiro A. The bacterial profile and antimicrobial susceptibility patterns of urinary tract infection patients at Pawe General Hospital, Northwest Ethiopia. Scientifica (Cairo). 2022;2022:3085950.
19. Pfaller MA, Cormican M, Flamm RK, Mendes RE, Jones RN. Temporal and geographic variation in antimicrobial susceptibility and resistance patterns of enterococci: results from the SENTRY Antimicrobial Surveillance Program, 1997–2016. Open Forum Infect Dis. 2019;6(Suppl 1):S54–62.
20. Miller WR, Munita JM, Arias CA. Mechanisms of antibiotic resistance in enterococci. Expert Rev Anti Infect Ther. 2014;12(10):1221–36.
21. Zúniga-Moya JC, Bejarano-Cáceres S, Valenzuela-Cervantes H, Gough-Coto S, Castro-Mejía A, Chinchilla-López C, et al. Antibiotic sensitivity profile of bacteria in urinary tract infections. Acta Méd Costarric. 2016;58(4):146–53.
22. Beauduy CE, Winston LG. Sulfonamides, trimethoprim, and quinolones. In: Katzung BG, Trevor AJ, editors. Basic and clinical pharmacology. 14th edition. New York: McGraw-Hill Company, Inc.; 2018. p. 868–9.

Global Medical and Health Communication

Online submission: https://ejournal.unisba.ac.id/index.php/gmhc
DOI: https://doi.org/10.29313/gmhc.v12i1.12691

GMHC. 2024;12(1):69–75
pISSN 2301-9123 | eISSN 2460-5441

RESEARCH ARTICLE

Ruang Sehati: Innovating Portable Lactation Pods for Wellness Tourism Using Design Thinking Method in Yogyakarta

Giyawati Yulilania Okinarum,[1] Venny Vidayanti,[2,3] Sri Hasta Mulyani[4]

[1]Midwifery Profession Study Program, Faculty of Midwifery, Universitas Respati Yogyakarta, Sleman, Indonesia,
[2]Nursing Study Program, Faculty of Midwifery, Universitas Respati Yogyakarta, Sleman, Indonesia,
[3]Department of Midwifery and Social Science, University of Manchester, Manchester, United Kingdom,
[4]Informatic Engineering Program, Faculty of Science and Technology, Universitas Respati Yogyakarta, Sleman, Indonesia

Abstract

Yogyakarta, a renowned tourist city in Indonesia, currently needs more lactation rooms and public facilities within tourist areas. To address this, inventors propose a portable lactation pod. This study utilized the design thinking method, emphasizing user needs. Interviews were conducted with thirty breastfeeding mothers on Malioboro Street in Yogyakarta to assess the necessity of lactation rooms in this popular tourist spot. From February to June 2022, the stages of "empathize," "define," "ideate," "prototype," and "test" were completed. The findings indicate that the "SEHATI" portable lactation room innovation meets user requirements, with feature satisfaction scores ranging from 4.2 to 4.9 out of 5.0. However, improvements are needed in the ventilation, exhaust fan, and fan sections, which received lower satisfaction scores during the "testing" stage. This innovation could serve as a pilot project, showcasing wellness tourism in Yogyakarta nationally.

Keywords: Design thinking method, portable lactation pod, wellness tourism

Introduction

Breastfeeding is a child's human right that must be fulfilled and protected by law, as stated in articles 128, 129, and 200 of Health Law No. 36 of 2009. Despite intensive breastfeeding campaigns around the world, the scope of exclusive breastfeeding still needs to be expanded, particularly in developing countries.[1] Based on data from the Central Statistics Agency, exclusive breastfeeding for infants under six months in Yogyakarta is 77.16% in 2022. Despite being above 50%, it is still less than the national target of 80%.[2]

Cultural norms in Indonesia show that breastfeeding in public is currently an issue of privacy. Other countries also declare that there is low awareness of breastfeeding in public places due to stigmatization, discomfort, and feelings of shame. Therefore, providing a lactation room that fulfills the requirements of breastfeeding mothers is essential to maintain their privacy.[3–5]

However, access to lactation rooms currently needs to be improved. For example, one tourist building on Jalan Malioboro has only benches in a 1.5×2.5-meter room. Other lactation rooms need more proper facilities and comfort, as researchers observed during initial observations in Yogyakarta City's tourist area. Some have even been converted to warehouses or storage areas. Regulations such as the Minister of Health of the Republic of Indonesia Number 15 of 2013 and Yogyakarta City Regional Regulation No. 1 of 2014 set standards for lactation rooms, but these often must be met.

Yogyakarta is an attractive destination with various popular sites that expand annually. This is evidenced by the many visitors contributing IDR 177 billion in local revenue. The tourism sector remains a vital component of Yogyakarta's economy, contributing approximately 17.46% to the city's GDP in 2019, compared to the national tourism sector's contribution of about 4.8%.[6] Given the importance of the tourism sector and the significant role of breastfeeding in infant health and regional welfare, the concept of

Received: 19 September 2023; Revised: 30 April 2024; Accepted: 30 April 2024; Published: 30 April 2024

Correspondence: Giyawati Yulilania Okinarum, S.S.T., M.Keb. Midwifery Profession Study Program, Faculty of Health Sciences, Universitas Respati Yogyakarta. Jln. Raya Tajem km 1.5, Sleman 55282, Special Region of Yogyakarta, Indonesia. E-mail: gitaokinarum@respati.ac.id

wellness tourism should be further explored in Yogyakarta. The *Ruang Sehati* portable lactation pod innovation could support this concept. This aligns with the city of Yogyakarta, which provides particular benefits to its people and tourists who are breastfeeding mothers.

This study employs the design thinking method, particularly suited for addressing complex, user-centered problems. Design thinking is an approach to generating human-centered innovation using a toolkit commonly used by designers that integrates three things, including user needs, the possibility of using technology, and the need to produce benefits so that the resulting innovation is valuable. The design thinking process involves five stages: empathize, define, ideate, prototype, and test.[7,8] This method is used to profoundly understand breastfeeding mothers' needs and develop practical and innovative solutions. By interviewing thirty breastfeeding mothers on Malioboro street, the study aimed to gather insights and design a portable lactation pod that meets their needs, ensuring privacy and comfort. This user-centered approach is critical for creating compelling and acceptable solutions for public lactation rooms, ultimately contributing to the wellness of both mothers and babies.

Methods

This study employed the design thinking method in developing the *Ruang Sehati* portable lactation pod. Thirty breastfeeding mothers traveling on Jalan Malioboro in Yogyakarta city were recruited as participants, and the research period lasted from February to June 2022. The aim was to meet user demands by prioritizing user-centered design, ensuring the innovations developed were beneficial. The design thinking stages were empathized, defined, ideated, prototyped, and tested.

Participants were recruited through convenience sampling. Breastfeeding mothers visiting Malioboro street were approached and invited to participate. Inclusion criteria included being a breastfeeding mother and willing to share their experiences and needs regarding lactation rooms. Participants were recruited on various days and times to ensure a diverse sample.

Researchers conducted in-depth interviews with 30 breastfeeding mother tourist participants during the empathize stage, each lasting 60 minutes. An interview guide was used to ensure consistency across interviews, focusing on the needs and challenges faced by breastfeeding mothers in tourist areas. The interview guide included questions about the frequency of visits to tourist areas, experiences with existing lactation facilities, specific needs for a lactation room, and any discomfort or challenges faced while breastfeeding in public. While throughout the testing phase, data was collected by applying a validated lactation room facility questionnaire.[9]

During the empathize stage, the interviews explored variables such as privacy needs, comfort, accessibility, safety, and additional features that mothers would find helpful in a lactation room. Researchers framed themselves as breastfeeding mothers to understand better and validate the target users' needs.

Data from the empathize stage were analyzed in the define stage to identify common themes and specific user needs. This information was then used to create a use-case diagram illustrating the users of portable lactation rooms and their

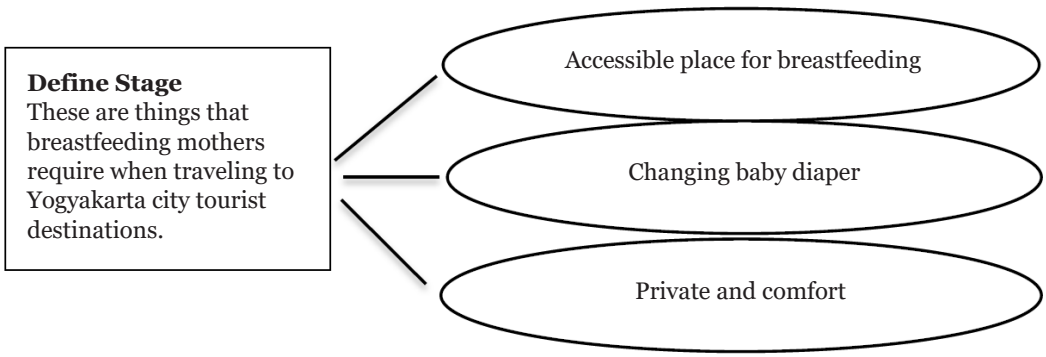

Figure 1 Use a Case Diagram of *Ruang Sehati* Portable Lactation Pod based on the Defined Stage

potential interactions with the pod (see Figure 1). The ideate stage involved brainstorming and sketching mock-ups of the lactation pod. Visual media or flat design concepts were created to provide a tangible preview of the proposed solution. In the prototype stage, the researchers and development team constructed the *Ruang Sehati* portable lactation pod based on the ideas and sketches from the previous stages. Finally, the testing stage involved field testing the prototype with the participants to gather feedback and identify areas for improvement. This iterative process helped refine the prototype, ensuring it effectively met users' needs.

This study used univariate analysis to describe the frequency distribution of participant characteristics and user satisfaction with the *Ruang Sehati* lactation pod. The study was approved in 2022 by the Health Research Ethics Committee, Faculty of Health Sciences, Universitas Respati Yogyakarta, Indonesia.

Figure 1 presents a use case diagram for the *Ruang Sehati* portable lactation pod, developed during the define stage of the design thinking process. This diagram visually represents the lactation pod's key functionalities and user requirements.

Accessible place for breastfeeding: the pod needs to be located in easily accessible areas within tourist sites, ensuring that breastfeeding mothers can find and reach the pod without difficulty. It includes clear signage, proximity to other amenities, and barrier-free access for mothers with strollers or other needs.

Changing baby diaper: the pod has facilities for changing diapers, providing a clean and hygienic space for mothers to attend to their babies' needs. It includes a changing table, diaper disposal units, and easy access to sanitizing materials.

Private and comfort: privacy and comfort are paramount for breastfeeding mothers. The pod is designed to offer a private space where mothers can breastfeed without feeling exposed or uncomfortable. It includes comfortable seating, proper ventilation, adequate lighting, and soundproofing to ensure a quiet and peaceful environment. The pod should also maintain a pleasant temperature and have features like fans or air conditioning.

Results

This study involved thirty breastfeeding mothers traveling on Malioboro street in Yogyakarta city. On average, breastfeeding mothers are 26 years old, have a six-month-old baby, have a monthly income of IDR 3.5 million, are working mothers, have a bachelor's degree, and have their first child (see Table).

Based on the ideate stage, we designed the exterior appearance of the *Ruang Sehati* portable lactation pod inspired by the symbol of the Yogyakarta City Government, specifically *Segoro Amarto* (*Semangat Gotong Royong Agawe Majune Ngayogyakarta*), which in Indonesian means the acronym for the spirit of collaborative effort towards the advancement of Yogyakarta. *Ruang Sehati* portable lactation pod is a representation of a *Gunungan* (a symbol of wayang or puppet in Indonesia), and it contains five colors, including white, green, yellow, red, and orange (see Figure 2).

In this study, researchers and the development team focused on one of Yogyakarta's most popular tourist destinations, which does not have a long-term room, specifically Teras Malioboro 2. Therefore, there is an urgent demand for a lactation room that is designed to be portable and can be placed outdoors but with solid and comfortable materials for breastfeeding mothers. The components and specifications for the portable lactation room that have been developed are listed as follows: (1) composite

Table Characteristic of Participants

Characteristics	n=30
Mothers' age (years)	
Mean±SD	25.7±4.8
Min–max	19–36
Babys' age (months)	
Mean±SD	5.6±1.9
Min–max	3–12
Household income (IDR)	
Mean±SD	3,553,333±1,793,135
Min–max	1,500,000–8,000,000
Occupation	
Housewife	14
Working mom	16
Education	
Junior high school	1
Senior high school	14
College	15
Number of children	
1	18
>1	12

Figure 2 Mock-up Design of *Ruang Sehati* Portable Lactation Pod

aluminum body cover; (2) frame hollo galvanized 40×40 thickness 1.6; (3) laminated aluminum composite flooring; (4) sink sets; (5) a table for changing baby diapers along with a baby bath; (6) chairs for lactation mothers; (7) fan; (8) ventilation exhaust fans; (9) pipe from the water source to the sink reservoir; (10) water sewer pipe from the sink to the sewer; (11) trash can; (12) branding/educational posters; (13) outdoor branding sticker on the front; (14) mirror; (15) tissue holder; (16) light and electrical mechanics; and (17) live plants (see Figure 3).

The researcher used a checklist for the quality of the lactation room adapted from Dutch research and modified for Indonesian conditions[9] to determine the average satisfaction of respondents with the *Ruang Sehati* portable lactation pod facility, the results of which are shown in Figure 4.

A majority of the participants stated that they were satisfied using the *Ruang Sehati* portable lactation pod facilities, based on the range of average scores between 4.20 and 4.90 for the following elements: conveniently located lactation pod, educational poster, tissues, air freshener, lamps, table, rubbish bin, mirror, living plant, sink, baby diaper changer, mother's stool, door with lock, lactation room sign, and wall color/room design.

Participants were highly dissatisfied with the ventilation component (2.73), which was thought to cause discomfort due to a lack of ventilation, causing it to feel heated up, mainly when used during the entire day in hot temperatures. Participants were also dissatisfied with the exhaust fan (3.47) and fan component (3.8), claiming that it has minimal impact on air circulation in the room when used throughout the day.

Discussion

Participants in this study were, on average, 26 years old, with an age range of 19–36. Several similar studies have found that breastfeeding mothers over 25 and under 35 are more likely

Figure 3 *Ruang Sehati* Portable Lactation Pod (Preview)

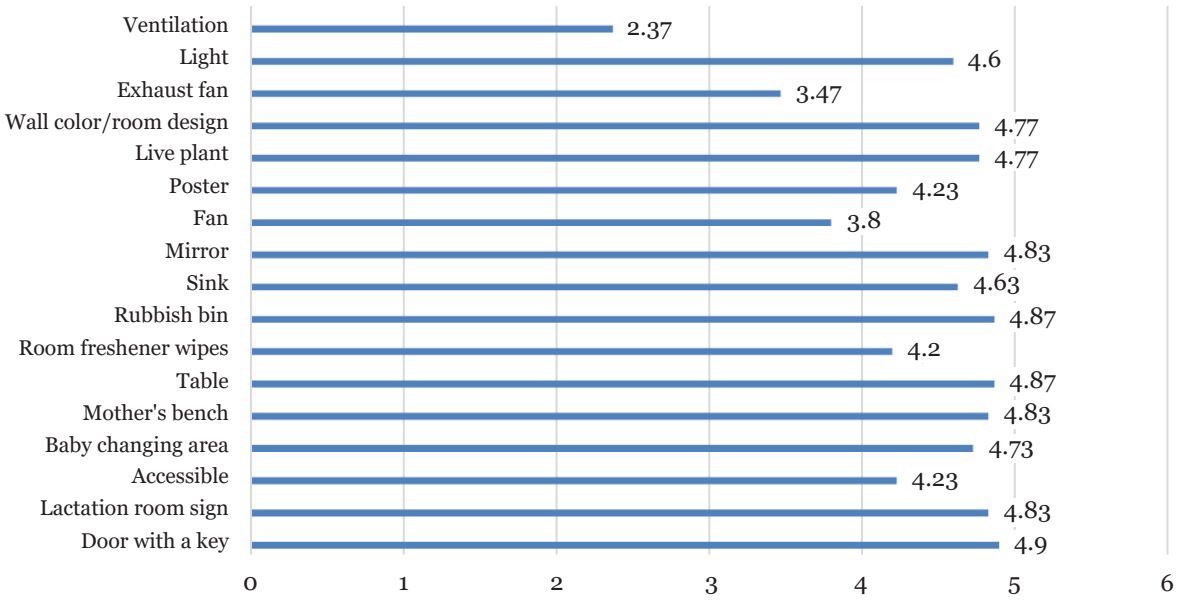

Figure 4 Graphic of Testing Stage: User Satisfaction of *Ruang Sehati* Portable Lactation Pod

to successfully provide exclusive breastfeeding to their babies because their psychological state is already secure in breastfeeding their baby.[10,11] In response to the findings of this study, breastfeeding mothers under the age of 25 continue to provide exclusive breastfeeding and even breastfeed until their child is 12 months old.

Other findings in this study reveal that mothers who provide exclusive breastfeeding generally have more significant financial resources, have a minimum college degree, and are working mothers. This baby is not their first child. This is consistent with several previous studies. Breastfeeding mothers with higher education understand the benefits of exclusive breastfeeding better, particularly since they have higher salaries. In this study, people who are breastfeeding mothers with high incomes prefer to buy the most nutritious vitamins and nutritional intake for themselves and their babies. Previous studies have reported that employing mothers with a working system that supports breastfeeding for infants might raise the awareness of working mothers to continue breastfeeding their babies.[11–15]

At the "define stage" in this research study, 30 participants require a lactation room in the popular tourist destination of Yogyakarta city, which is conveniently located, has a place to change baby diapers, and maintains an atmosphere of comfort and privacy. Responding to these user requirements, researchers and the development team generated an innovative *Ruang Sehati* portable lactation pod, which was evaluated at the testing stage. This portable lactation room is equipped with other features, including a fan, conveniently located lactation pod, educational poster, tissues, air freshener, lamps, table, rubbish bin, mirror, living plant, sink, baby diaper changer, mother's stool, door with lock, lactation room sign, and wall color/ room design.

The elements that the researchers and the development team have invented refer to regulations in Indonesia stated in the Regulation of the Minister of Health of the Republic of Indonesia Number 15 of 2013 concerning procedures for providing special facilities for breastfeeding and expressing breast milk.[16] Based on the materials and specifications used in the *Ruang Sehati* portable lactation room, the components provided by this room are adjusted, ensuring that several facilities are unavailable, including equipment for storing expressed breast milk and breastfeeding counseling kits. Furthermore, the researchers adjusted the checklist for the quality of lactation rooms in the Netherlands, which they modified to accommodate the requirements of portable lactation rooms in Indonesia.[9]

In this study, participants expressed

satisfaction with implementing the *Ruang Sehati* portable lactation pod suitable for their needs, particularly those active in popular tourist destinations. However, development still needs to be accomplished because users experience that the portable lactation room is uncomfortable since the building is not wide enough. The lack of ventilation makes it stuffy and steaming during daylight hours (see graphic in Figure 4). Therefore, a review based on existing government regulations is required.[16]

This innovation might solve the issue surrounding the need for lactation rooms in public facilities, particularly those in non-permanent tourist destinations. On the other hand, comfort in traveling is an essential point in the growth of wellness tourism that encourages positive psychology for mothers and children. Nowadays, the phenomenon suggests that more individuals travel to achieve better wellness in their daily lives. They want to maintain a healthy way of life, reduce stress, prevent disease, and improve their overall mental and physical well-being.[17]

Conclusions

This innovation might serve as a pilot to be shown nationally to present a portrait of wellness tourism in Jogja. The *Ruang Sehati* portable lactation pod innovation gained public acceptance based on user needs evaluated through the "testing stage." The "define stage" states the four needs of lactation room users in popular tourist destinations, including an easy-to-reach location, changing baby's diapers, privacy, and comfort. However, two aspects must be enhanced for further development: the convenience of breastfeeding mothers and their babies in this lactation room. It can be determined by the average satisfaction score in the ventilation, exhaust fan, and fan components at the "testing stage" which were considered unsatisfactory by the user. This portable lactation pod innovation was modified in 2023 based on the findings of the design thinking technique in this pilot project study.

Conflict of Interest

The authors declare no conflict of interest.

Acknowledgment

The Yogyakarta City Government funded this research. We would like to express our gratitude to Universitas Respati Yogyakarta for supporting this project.

References

1. Jama A, Gebreyesus H, Wubayehu T, Gebregyorgis T, Teweldemedhin M, Berhe T, et al. Exclusive breastfeeding for the first six months of life and its associated factors among children aged 6–24 months in Burao district, Somaliland. Int Breastfeed J. 2020;15(1):5.
2. Badan Pusat Statistik. Persentase bayi usia kurang dari 6 bulan yang mendapatkan ASI eksklusif menurut provinsi (persen), 2021–2023 [Internet]. Jakarta: Biro Pusat Statistik; 2023 [cited 2023 Sep 13]. Available from: https://www.bps.go.id/id/statistics-table/2/MTM0MCMy/persentase-bayi-usia-kurang-dari-6-bulan-yang-mendapatkan-asi-eksklusif-menurut-provinsi--persen-.html.
3. Grant A, Pell B, Copeland L, Brown A, Ellis R, Morris D, et al. Views and experience of breastfeeding in public: a qualitative systematic review. Matern Child Nutr. 2022;18(4):e13407.
4. Coomson JB, Aryeetey R. Perception and practice of breastfeeding in public in an urban community in Accra, Ghana. Int Breastfeed J. 2018;13:18.
5. Lee JS, Ganzert A, Jackson C. The traveling mother: navigating, visualizing, and utilizing lactation spaces in U.S. airports. Build Environ. 2019;164:106323.
6. Wicaksono A. New normal pariwisata Yogyakarta. Kepariwisataan. 2020;14(3): 139–50.
7. Mueller-Roterberg C. Handbook of design thinking: tips & tools for design thinking. Seattle: Kindle Direct Publishing; 2018.
8. Shanks M. An introduction to design thinking process guide [Internet]. Stanford, CA: Institute of Design at Stanford; 2020 [cited 2023 Oct 10]. Available from: https://web.stanford.edu/~mshanks/MichaelShanks/files/509554.pdf.

9. Dellen SA van, Wisse B, Mobach MP, Albers CJ, Dijkstra A. A cross-sectional study of lactation room quality and Dutch working mothers' satisfaction, perceived ease of, and perceived support for breast milk expression at work. Int Breastfeed J. 2020;16(1):67).
10. Abekah-Nkrumah G, Antwi MY, Nkrumah J, Gbagbo FY. Examining working mothers' experience of exclusive breastfeeding in Ghana. Int Breastfeed J. 2020;15(1):56.
11. Hunegnaw MTLDG, Teferra AS. Exclusive breastfeeding and associated factors among mothers in Gozamin district, northwest Ethiopia: a community-based cross-sectional study. Int Breastfeed J. 2017;12:30.
12. Hendaus MA, Alhammadi AH, Khan S, Osman S, Hamad A. Breastfeeding rates and barriers: a report from the state of Qatar. Int J Womens Health. 201810:467–75.
13. Maonga AR, Mahande MJ, Damian DJ, Msuya SE. Factors affecting exclusive breastfeeding among women in Muheza district Tanga Northeastern Tanzania: a mixed method community-based study. Matern Child Health J. 2016;20(1):77–87.
14. Hadi SPI, Pramana C, Supinganto A, Ernawati K, Sirait LI, Staryo NA, et al. Prevention of transmission of SARS-COV-2 infection: a review. Ann Rom Soc Cell Biol. 2021;25(1):5302–15.
15. Putri AT, Ivone J, Hasianna ST. Working mothers and successful exclusive breast milk provision; an observational study in Hermina Bogor Public Hospital. J Med Health. 2020;2(6):166–76.
16. Peraturan Menteri Kesehatan Republik Indonesia Nomor 15 tahun 2013 tentang Tata Cara Penyediaan Fasilitas Khusus Menyusui dan/atau Memerah Air Susu Ibu.
17. Wayne S, Russell E. Analysis of the global and Asian wellness tourism sector [Internet]. Mandaluyong City, Philippines:Asian Development Bank; 2020 [cited 2023 Oct 15]. Available from: https://www.adb.org/sites/default/files/institutional-document/633886/adou2020bp-global-asian-wellness-tourism.pdf.

Global Medical and Health Communication

Online submission: https://ejournal.unisba.ac.id/index.php/gmhc
DOI: https://doi.org/10.29313/gmhc.v12i1.13462

GMHC. 2024;12(1):76–81
pISSN 2301-9123 | eISSN 2460-5441

RESEARCH ARTICLE

Clinicopathological Characteristics of Breast Cancer at Cibabat Regional General Hospital in 2022–2023

Meike Rachmawati,[1] Nuzirwan Acang,[2,3] Wida Purbaningsih,[4] Rian Robian,[5] Adhi Nugraha,[5] Rina Melati,[6] Aryanti Aryanti,[6] Aninditya Putri Anugrah,[7] Nazmy Noor Laila[8]

[1]Departement of Anatomy Pathology, Faculty of Medicine, Universitas Islam Bandung, Bandung, Indonesia, [2]Department of Internal Medicine, Faculty of Medicine, Universitas Islam Bandung, Bandung, Indonesia, [3]Internal Medicine Installation, Cibabat Regional General Hospital, Cimahi, Indonesia, [4]Department of Histology, Faculty of Medicine, Universitas Islam Bandung, Bandung, Indonesia, [5]Surgical Oncology Installation, Cibabat Regional General Hospital, Cimahi, Indonesia, [6]Laboratory of Anatomy Pathology, Al Islam Hospital, Bandung, Indonesia, [7]Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran, Sumedang, Indonesia, [8]Biopath Laboratory, Bandung, Indonesia

Abstract

Breast cancer is the most common malignancy found in women throughout the world and is the fifth leading cause of cancer death in the world. Cibabat Regional General Hospital is one of the places for breast cancer examination and treatment in West Java. This study aims to determine the clinical and histopathological features at Cibabat Regional General Hospital. The method used in this research is descriptive-analytic with a total sampling technique using secondary data obtained from the medical records of Cibabat Regional General Hospital patients from 2022 to June 2023. The results show that most cases of breast cancer at Cibabat Regional General Hospital occur in those aged 45–54 (32.3%), left breast (52.1%), grade 3 (44.8%), histopathological type invasive carcinoma of no special type (75%), lymph node status unknown (88.5%), negative lymphovascular invasion (43.7%), and fat invasion status unknown (68.7%). The conclusion is that breast cancer cases at Cibabat Regional General Hospital mainly occur in patients of productive age with a high grade and predominantly in the left breast, with the most common type being invasive carcinoma of no particular type.

Keywords: Breast cancer, clinicopathology

Introduction

Breast cancer is the most common malignancy found in women throughout the world (154 out of 185 countries) and is the fifth leading cause of cancer death in the world.[1,2] The number of new cases of breast cancer in the world in 2020 reached 2,261,419 cases, with a death rate of 6.9% or the equivalent of 684,996 deaths. The number of new cases and deaths has increased over the last few decades, including in Asian countries. There have been 158,939 new cases of breast cancer in Southeast Asia, with 58,670 deaths from the disease.[3]

Breast cancer ranks first in terms of the highest number of cancer cases. It is the first contributor to cancer deaths in Indonesia, which is the country with the largest population in Southeast Asia. The number of new cases of breast cancer in Indonesia in 2020 reached 65,858 cases (16.6%), with 22,430 deaths (9.6%) spread across all provinces in Indonesia.[3] Western Java is one of the three provinces with the most significant number of cancer patients in 2013, with 45,473.[4]

Hospitals have an essential role in diagnosing and treating breast cancer cases. Breast cancer diagnosis is crucial because it plays a role in determining the prognosis of breast cancer. Prognostic factors for breast cancer consist of 1) clinical features including age and tumor size; 2) histopathological features including tumor type and histopathological grading, axillary lymph node status, fat invasion, and lymphovascular invasion; 3) the immunophenotype profile includes ER, PR, HER2, and KI67.[5] The prognosis of breast cancer is essential to know because it can provide information about the development of the disease in the future and can be used to

Received: 4 February 2024; Revised: 30 April 2024; Accepted: 30 April 2024; Published: 30 April 2024

Correspondence: Meike Rachmawati, dr., M.Kes., Sp.P.A. Department of Anatomy Pathology, Faculty of Medicine, Universitas Islam Bandung. Jln. Tamansari No. 22, Bandung 40116, West Java, Indonesia. E-mail: meikerachmawati@unisba.ac.id

find out the most appropriate type of treatment to treat breast cancer cases.[6]

Cibabat Regional General Hospital, located in Cimahi city, West Java, has an oncology sub-specialist, one of the places to examine and treat breast cancer in West Java. Several previous studies have discussed the clinical and pathological profiles of breast cancer patients in West Java, but there is no complete data regarding breast cancer cases at Cibabat Regional General Hospital. This study aims to determine the clinical and histopathological features at Cibabat Regional General Hospital.

Methods

The method used in this research is descriptive-analytic with a total sampling technique using secondary data obtained from patient's medical records at the Cibabat Regional General Hospital from 2022 to June 2023. In this study, data was collected from 96 female patients. The variables measured were age, laterality, histopathological type, histopathological grade, lymph node status, lymphovascular invasion, and fat invasion. The data and its distribution are then presented in a table. The study's use of subjects and patients' clinical data was approved by the Research Ethics Committee at Cibabat Regional General Hospital (No. 070/45/Ethical Clearance/RSUD Cibabat/VI/2023) in compliance with the provisions set out in the Declaration of Helsinki. Confidentiality of the patient's data was ensured by withholding the patient's data.

Results

The number of breast cancer cases at Cibabat Regional General Hospital from January 2022 to June 2023 was 96. In 2022, there were 56 cases (58%), and from January to June 2023, there were 40 (42%). The clinicopathological characteristics of the patients are presented in Table.

Breast cancer patients can be classified into five age groups: under 35, 35–44, 45–54, 55–64, and over 64. The majority of breast cancer cases at Cibabat Regional General Hospital occurred in those aged 45 to 54, with 31 cases (32%), followed by 35–44-year-olds with 24 cases (25%), 55–64-year-olds with 20 cases (21%), 15 cases over 64 years old (16%), 5 cases under 35 years old (5%), and 1 case (1%) unknown. Figure 1 shows that 2022 and 2023 have distinct peaks.

Table Clinicopathological Characteristics of Breast Cancer Patients at Cibabat Regional General Hospital in 2022–2023

Characteristics	n=96 (%)
Age (years)	
<35	5 (5)
35–44	24 (25)
45–54	31 (32)
55–64	20 (21)
>64	15 (16)
Laterality	
Sinistra	49 (52)
Dextra	38 (40)
Bilateral	4 (4)
Unknown	3 (3)
Histopathological type	
Invasive carcinoma of no special type	72 (75)
Invasive lobular carcinoma	4 (4)
Pleomorphic invasive lobular	1 (1)
Mucinous carcinoma	3 (3)
Papillary carcinoma	1 (1)
High ductal carcinoma in situ	1 (1)
Metastasis carcinoma	3 (3)
Metaplastic carcinoma	1 (1)
Micropapillary carcinoma	1 (1)
Medullary carcinoma	1 (1)
Unknown	8 (8)
Histopathological grade	
1	2 (2)
2	31 (32)
3	43 (45)
Unknown	20 (21)
Lymph node status	
+	4 (4)
–	7 (7)
Unknown	85 (88)
Lymphovascular invasion	
+	27 (28)
–	42 (44)
Unknown	27 (28)
Fat invasion	
+	26 (27)
–	4 (4)
Unknown	66 (69)

The peak in 2022 was 35–44 years, while the peak from January to June 2023 was 45–54 years.

Based on laterality, breast cancer cases at Cibabat Regional General Hospital mainly occurred in the left breast with 49 cases (52%), followed by cases in the right breast with 38 cases (40%), bilateral with 4 cases (4%), and unknown as many as 3 cases (3%). The most common

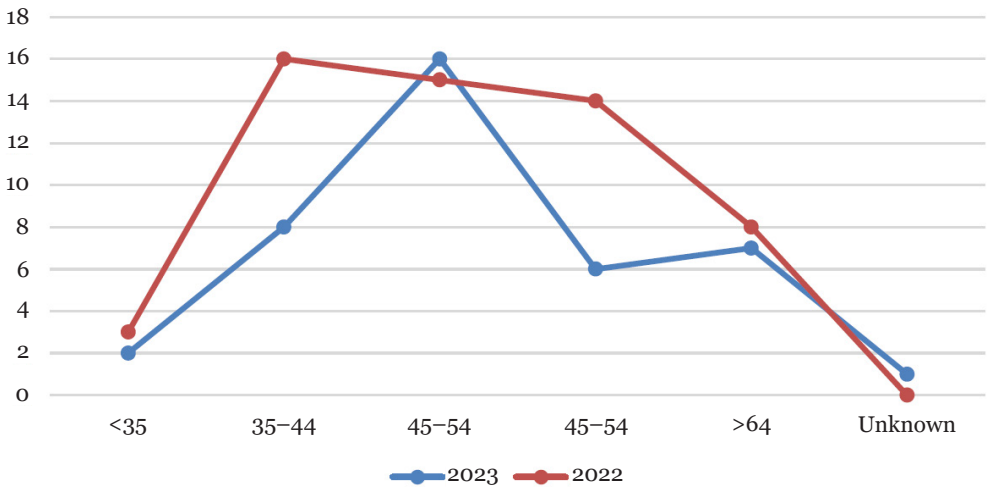

Figure 1 Age Distribution of Breast Cancer Patients at Cibabat Regional General Hospital in 2022–2023

histopathological type was invasive carcinoma of no particular kind, with 72 cases (75%). Other types can also be found, although the numbers are very few. There were 8 cases of breast cancer whose histopathological type was unknown (8%). The most common histopathological grade was Grade 3 with 43 cases (45%), followed by Grade 2 with 31 cases (32%), Grade 1 with 2 cases (2%), and 20 cases with an unknown grade (21%).

Lymph node metastases can be identified by positive or negative lymph node status. Most cases at Cibabat Regional General Hospital had unknown lymph node status, with 85 cases (88%). The number of cases with positive lymph node status was 4 (4%), while the number with negative status was 7 (7%). Lymphovascular invasion is known to be associated with the presence of lymph node metastases in the axilla. Negative lymphovascular invasion had the most significant number, with 42 cases (44%). Fat invasion is also a factor that can indicate a poor prognosis for breast cancer. In this study, most fat invasions were unknown, with 66 cases (69%).

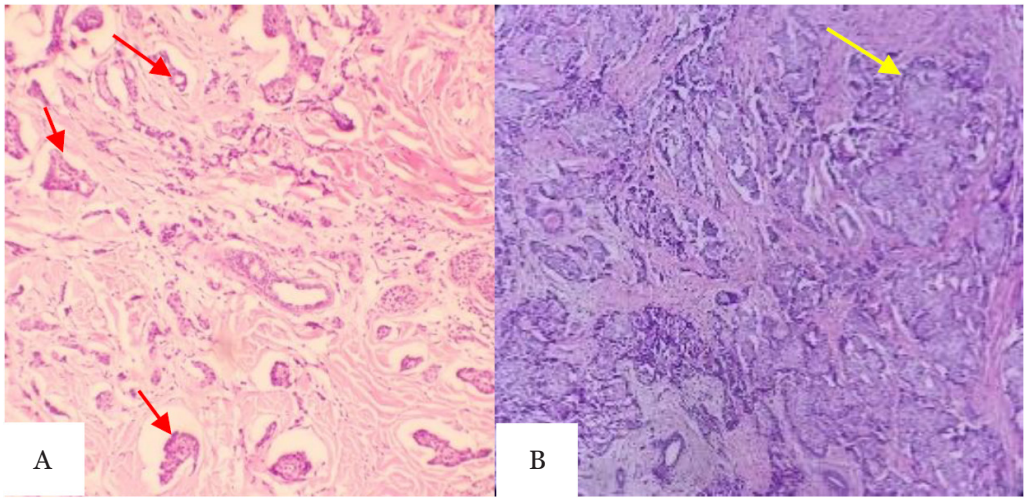

Figure 2 Histopathology of Breast Cancer with HE Stain and Magnification of 100×

Note: (A) grade 2 is indicated by 10–75% of gland appearance (red arrow), (B) grade 3 is indicated by the solid appearance (yellow arrow)

Discussion

Most cases of breast cancer at Cibabat Regional General Hospital occurred among those aged 45 to 54, with 31 cases (32%). These results are similar to research by Fajar et al.,[7] which states that breast cancer cases in Al Ihsan Hospital, West Java, most often occur in the 45–54 year age group (44.36%). Research by Ervina et al.[8] also stated that breast cancer cases at Dr. Saiful Anwar Hospital Malang most often occur in the 46–55-year age group (28%). This is supported by Shoemaker et al.,[9] that breast cancer cases in 2004–2013 among Asian and Pacific Islander ethnic groups experienced a significant increase in 45–49. Based on Figure 1, 2022 and 2023 have different peaks. It is thought to be due to differences in factors that cause breast cancer, such as lack of physical activity, high calorie and fat consumption, alcohol use, and use of hormone replacement therapy.[10]

Based on laterality, breast cancer cases at Cibabat Regional General Hospital mainly occurred in the left breast, with 49 cases (52%). This follows previous research, which states that the number of cases of left breast cancer is higher than right breast cancer, with a ratio ranging from 1.05 to 1.26.[11] Despite having the same genetic and environmental risk factors for cancer, the left and right breasts differ in tissue shape, artery and venous supply, and lymphatic drainage during embryonic development. This is what causes differences on the two sides and is a possible cause of laterality in breast cancer.[12] The left breast is known to have more tissue mass, which is thought to result in a mild tendency for breast cancer on the left side. However, subsequent research stated that the risk of cancer was not related to breast size. Laterality in breast cancer is hypothesized to be caused by cerebral hemisphere laterality as well as handedness. Most women are thought to be right-handed; therefore, a palpable bump on the left chest is more likely to be discovered. Breastfeeding patterns and lactation dysfunction in the left breast are also suspected causes. However, subsequent research has not confirmed these allegations or accepted uniformly.[13] Until now, the exact cause of the more significant number of cases found in the left breast is not known, but research by Abdou et al.[12] stated that left breast cancer has a more proliferative genomic profile, a lower response to neoadjuvant chemotherapy, and slightly worse long-term outcomes compared with right breast cancer.

The most common histopathological type was invasive carcinoma of no special type, with 72 cases (75%). These results are from previous research, which stated that invasive carcinoma of no special type or invasive ductal carcinoma is the most common histological type of invasive breast cancer, which is around 70–75% of all cases.[14] This is because invasive carcinoma of no special type originates from the epithelial lining of the breast ducts and does not exhibit sufficient characteristics to warrant classification as a particular type.[15]

The most common histopathological grading of breast cancer cases at Cibabat Regional General Hospital was grade 3, with 43 cases (45%). These results are similar to research by Fajar et al.[7] at Al Ihsan Hospital, West Java, with 136 cases (51.13%) and research by Ervina et al.[8] at Dr. Saiful Anwar Hospital Malang, with 240 cases (47%). Grade 3 indicates that the cancer has poor differentiation with rapid and uncontrolled cell growth and spread and also does not resemble the original cells, so there is a high possibility of breast cancer recurrence. Many grade 3 cases were discovered at Cibabat Regional General Hospital due to a lack of an effective screening procedure. In addition, lack of awareness about symptoms and delays in treatment are also thought to contribute to this occurrence.[16]

Cibabat Regional General Hospital reported that up to 88% of breast cancer cases had no known lymph node status. Lymph node status is an important prognostic factor and is closely related to breast cancer treatment, morbidity, and mortality. Histological evaluation of the axillary lymph nodes can help detect metastasis, which is a common complication of breast cancer.[17] Breast cancer cells that experience lymph node metastases initially pass through the sentinel lymph node and then move to the axillary lymph node. For breast cancer patients, the higher the degree of lymph node metastasis, the lower the cumulative survival rate.[18]

Lymphovascular invasion is also an essential prognostic factor in breast cancer that can indicate the level of tumor aggressiveness and be a predictor of worse survival outcomes in breast cancer. Lymphovascular invasion is defined as tumor cells in endothelial-lined spaces (lymphatics or blood vessels) in the breast that surround the invasive carcinoma. The presence of lymphovascular

invasion is associated with an increased risk of axillary lymph node metastasis.[19] In this study, the negative lymphovascular invasion had the highest number with 42 cases (44%), while the positive lymphovascular invasion was 27 cases (28%), and cases of unknown invasion were 27 cases (28%). Based on these results, there is a possibility of metastasis in positive cases, with 28%. This result is different from the research results of Fajar et al.,[7] which had a higher number of cases with positive lymphovascular invasion, 192 cases (72.18%). This difference is assumed to occur due to incomplete data.

In this research, most fat invasions were unknown, with 66 cases (69%). Fat invasion is essential to know because it is a biological indicator of tumor aggressiveness in early-stage breast cancer. The tumor microenvironment is a heterogeneous cell population consisting of tumor cells and endogenous stromal cells, such as vascular endothelial cells, pericytes, fibroblasts, bone marrow mesenchymal stromal cells, immune cells, and adipocytes. These stromal cells are recruited by cancer cells and promote cell migration, tumor angiogenesis, proliferation, invasion, metastasis, and drug resistance. Adipocytes are abundant stromal partners in breast tissue, and cancer cell invasion into local fat may increase metastatic potential in animal model studies.[20] Proper evaluation of fat invasion has proven helpful in formulating therapeutic strategies and predicting which breast cancer patients will have an excellent prognosis.

This research has limitations, including a lack of medical records, which prevent it from investigating various additional factors that can influence the prognosis of breast cancer.

Conclusion

Breast cancer cases at Cibabat Regional General Hospital mainly occur in patients of productive age with a high grade and dominantly in the left breast.

Conflict of Interest

None declared.

Acknowledgment

This study is supported by an internal grant from the Faculty of Medicine of Universitas Islam Bandung with a number record 044/PPM/SP-DS/IV/2023.

References

1. do Nascimento RG, Otoni KM. Histological and molecular classification of breast cancer: what do we know? Mastology. 2020;30:e20200024.
2. World Health Organization. Cancer [Internet]. Geneva: World Health Organization; 2022 Feb 3 [cited 2023 Aug 11]. Available from: https://www.who.int/news-room/fact-sheets/detail/cancer.
3. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global Cancer Statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2021;71(3):209–49.
4. Pusat Data dan Informasi Kementerian Kesehatan Republik Indonesia. Infodatin Kanker Payudara [Internet]. Jakarta: Kementerian Kesehatan Republik Indonesia; 2016 [cited 2023 Aug 11]. Available from: https://www.kemkes.go.id/article/view/17010500002/infodatin-kanker-payudara.html.
5. Shen SD, Zhong SZ, Wang CZ, Huang WH. Correlation of lymphovascular invasion with clinicopathological factors in invasive breast cancer: a meta-analysis. Int J Clin Exp Med. 2015; 8(10):17789–95.
6. Phung MT, Tin Tin S, Elwood JM. Prognostic models for breast cancer: a systematic review. BMC Cancer. 2019;19(1):230.
7. Fajar IM, Heriady Y, Aji HW. Karakteristik usia, gambaran klinis dan histopatologi pasien kanker payudara di RSUD Al-Ihsan Provinsi Jawa Barat periode Januari 2018–Oktober 2020. JRK. 2021;1(2):85–91.
8. Ervina R, Norahmawati E, Angelina A. Profil klinikopatologi karsinoma payudara di Instalasi Patologi Anatomi RSUD Dr. Saiful Anwar Malang. JK-RISK. 2021;1(1):12–21.
9. Shoemaker ML, White MC, Wu M, Weir HK, Romieu I. Differences in breast cancer incidence among young women aged 20–49 years by stage and tumor characteristics, age, race, and ethnicity, 2004–2013. Breast Cancer Res Treat. 2018;169(3):595–606.
10. Ellington TD, Miller JW, Henley SJ, Wilson RJ, Wu M, Richardson LC. Trends in breast

cancer incidence, by race, ethnicity, and age among women aged ≥20 years — United States, 1999–2018. MMWR Morb Mortal Wkly Rep. 2022;71(2):43–7.
11. Al Saad S, Al Shenawi H, Almarabheh A, Al Shenawi N, Mohamed AI, Yaghan R. Is laterality in breast cancer still worth studying? Local experience in Bahrain. BMC Cancer. 2022;22(1):968.
12. Abdou Y, Gupta M, Asaoka M, Attwood K, Mateusz O, Gandhi S, et al. Left sided breast cancer is associated with aggressive biology and worse outcomes than right sided breast cancer. Sci Rep. 2022;12(1):13377.
13. Cheng SA, Liang LZ, Liang QL, Huang ZY, Peng XX, Hong XC, et al. Cancer management and research dovepress breast cancer laterality and molecular subtype likely share a common risk factor. Cancer Manag Res. 2018;10:6549–54.
14. Surabhi DM, Wilson JC, Singh M, Green L. Recognizing invasive breast carcinoma of no special type with medullary pattern. Radiol Case Rep. 2023;18(5):1788–92.
15. Makki J. Diversity of breast carcinoma: histological subtypes and clinical relevance. Clin Med Insights Pathol. 2015;8:23–31.
16. Gogia A, Deo SV, Shukla NK, Mathur S, Sharma DN, Tiwari A. Clinicopathological profile of breast cancer: an institutional experience. Indian J Cancer. 2018;55(3):210–3.
17. Chakraborty A, Bose CK, Basak J, Sen AN, Mishra R, Mukhopadhyay A. Determinants of lymph node status in women with breast cancer: a hospital-based study from eastern India. Indian J Med Res. 2016;143(Suppl):S45–51.
18. Dong X, Chunrong Y, Hongjun H, Xuexi Z. Differentiating the lymph node metastasis of breast cancer through dynamic contrast-enhanced magnetic resonance imaging. BJR Open. 2019;1(1):20180023.
19. Ryu YJ, Kang SJ, Cho JS, Yoon JH, Park MH. Lymphovascular invasion can be better than pathologic complete response to predict prognosis in breast cancer treated with neoadjuvant chemotherapy. Medicine (Baltimore). 2018;97(30):e11647.
20. Yamaguchi J, Moriuchi H, Ueda T, Kawashita Y, Hazeyama T, Tateishi M, et al. Active behavior of triple-negative breast cancer with adipose tissue invasion: a single center and retrospective review. BMC Cancer. 2021;21(1):434.

Global Medical and Health Communication

Online submission: https://ejournal.unisba.ac.id/index.php/gmhc
DOI: https://doi.org/10.29313/gmhc.v12i1.11203

GMHC. 2024;12(1):82–88
pISSN 2301-9123 | eISSN 2460-5441

RESEARCH ARTICLE

Tuberculosis Treatment Using a Religious Approach

Olih Solihin,[1,2] Djuara P Lubis,[2] Pudji Hasta Muljono,[2] Siti Amanah[1,2]
[1]Department of Communication Science, Universitas Komputer Indonesia, Bandung, Indonesia,
[2]Development Communication Sciences Study Program, Faculty of Human Ecology,
IPB University, Bogor, Indonesia

Abstract

In 2020, Bandung city ranked second in West Java for tuberculosis (TB) cases. The city government and stakeholders have taken health education, early detection, free treatment, and surveillance measures to address TB. Yet, a comprehensive approach is still needed. Despite previous studies exploring TB management, the role of religious approaches still needs to be explored. Employing a qualitative approach through a case study method, this research involves data collection through observation, in-depth interviews, and literature reviews. Participants are TB healthcare workers and religious speakers in Universitas 'Aisyiyah Bandung city. In 2020, Bandung reported 8,504 TB cases with increased detection success. 'Aisyiyah TB Care uses a religious approach to offer emotional and spiritual support to patients facing physical challenges, emotional burdens, and stigma. Religious perspectives introduce spiritual support via Islamic teachings emphasizing hygiene and self-care. Interviews reveal changed patient perceptions due to the religious approach. 'Aisyiyah addresses TB complexity and stigma, conducting educational efforts to reshape perceptions. The religious approach assists TB sufferers, aiming for positive influence, improved relationships, and fostering hope, gratitude, and trust in God. Collaborative efforts among health, religious, and government organizations are essential for effective TB management. The research highlights the positive impact of 'Aisyiyah TB Care's religious approach on management, addressing stigma, and enhancing well-being. Improved information dissemination and support are vital, particularly in areas with high TB burdens.

Keywords: Religious approach, stigma, tuberculosis (TB)

Introduction

Tuberculosis (TB) is an infectious disease caused by *Mycobacterium tuberculosis* (MTB), primarily affecting the respiratory system.[1] In 2020, Bandung city was the region with the highest number of TB cases in West Java province, with 8,504 cases reported.[2] To address this high number of cases, the Bandung City Government and various institutions have implemented multiple approaches for TB management in the city.[3] These approaches include health education, early detection, free treatment, and establishing a surveillance network. However, more significant and integrated efforts from all parties are still required to reduce the TB case count in Bandung city and Indonesia.[4]

Previous research on the same topic has been conducted by earlier researchers, such as a study titled "Cultural and Religious Belief Approaches of a Tuberculosis Program for Hard-to-Reach Populations in Mentawai and Solok, West Sumatra, Indonesia." The research findings show that cultural and religious belief approaches play a significant role in the Tuberculosis Program for hard-to-reach populations.[5] Next is a study on "Infectious Diseases, Religion, and Spirituality," its research findings reveal the critical role of religion and belief in tackling infectious disease outbreaks.[6]

Although both of these studies discuss approaches in TB management, their research focuses are distinct from those of this current study. The first previous study focuses on the role of religion and culture in TB management. Meanwhile, the second study addresses the role of religion and belief in managing infectious diseases. In contrast, this study focuses on the Islamic religious approach.

Drawing from the background and previous research, the researcher will take a different approach from previous studies. This study

Received: 8 January 2023; Revised: 30 April 2024; Accepted: 30 April 2024; Published: 30 April 2024

Correspondence: Olih Solihin. Department of Communication Science, Universitas Komputer Indonesia. Jln. Dipatiukur No. 102–118, Bandung 40132, West Java, Indonesia. E-mail: olih.solihin@email.unikom.ac.id

analyzes how Islamic values are adopted in TB management as a health communication strategy. This research explores how 'Aisyiyah TB Care incorporates religious values as a strategy in TB management in Bandung city. This research employs a qualitative approach through a case study method. Data collection techniques involve observation, in-depth interviews, and literature reviews. Research informants include TB health workers serving as religious speakers within Universitas 'Aisyiyah Bandung city.

Methods

This research employs a qualitative approach with research subjects, including Aisiyah TB Care volunteers and several TB patients in Bandung. The research design used is a field study involving data collection techniques such as in-depth interviews, field observations, and literature reviews. The applied method of analysis is content analysis.

The research subjects consist of Aisiyah TB Care volunteers with direct experience addressing TB-related issues in Bandung. Additionally, several TB patients were interviewed to gain insights into their perspectives on TB treatment with a religious approach.

The research design involves conducting field observations in various locations relevant to TB activities and symptoms in Bandung. These observations were conducted to gain a deep understanding of the on-ground conditions.

Data collection includes in-depth interviews with three informants from Aisiyah TB Care volunteers and four TB patients undergoing treatment at the Tuberculosis Technical Implementation Units (UPT TB) Garuda and UPT TB Sukahaji, Bandung city. These interviews aim to obtain more detailed information about their experiences and views regarding TB treatment with a religious approach. In addition to interviews, a literature review was conducted to understand the theoretical framework and broader research context, helping to connect field findings with relevant theories.

The research was conducted from October to December 2022. The method of analysis applied is content analysis. Data collected from interviews, field observations, and literature reviews are extensively analyzed to identify patterns, themes, and relationships within the obtained information. This study investigates the religious approach to TB treatment using data obtained from diverse and relevant informants.

Results

The total number of tuberculosis cases in 2021 was 8,191, comprising 6,281 cases within Bandung city and 2,638 cases outside Bandung city. The total number of tuberculosis cases in 2021 increased compared to the previous year, which was 8,504, with 5,908 originating from Bandung city. With the total number of tuberculosis cases in 2021, a case notification rate (CNR) of 346 per 100,000 population was obtained.[7]

The CNR in 2021 was higher than the previous year's, 339 per 100,000 population. It implies that ongoing healthcare services can more effectively identify TB patients in the community. Table 1 compares CNR indicators in Bandung city from 2015 to 2021.

Based on the interview results with Aisyiyah TB Care volunteers, who are also *ustadzah* (Islamic scholars), it is evident that the Aisyiyah institution emphasizes the importance of a religious approach in tuberculosis (TB) treatment. This view aligns with several studies that state that religiosity must be applied in various aspects of life.[8–9] According to her perspective, TB patients not only face physical challenges due to the disease but also experience emotional burdens arising from the lengthy and exhausting treatment process, as well as the negative stigma surrounding TB. Ironically, this stigma doesn't only originate from external sources but can also emerge from the patients themselves.

Table 1 Tuberculosis Cases in Bandung City for the Years 2020 and 2021

Year	Total Cases	Within Bandung City	Outside Bandung City	CNR (per 100,000 Population)
2020	8,504	5,908	N/A	339
2021	8,191	6,281	2,638	346

Note: Source: Dinas Kesehatan Kota Bandung[7]

In this context, introducing a religious perspective is considered an effort to provide spiritual support to the patients. Explaining that their journey with TB is a test and lesson from God is expected to offer them tranquility and hope. This analysis illustrates that the spiritual dimension can play a role in helping TB patients confront the treatment journey with a more meaningful and optimistic outlook. "Patients should be reminded that in Islam, it is stated that for every disease, there is a cure except death. *Alhamdulillah* (praise be to God), some of the patients we have accompanied have realized this, and it has positively impacted the improvement of their treatment process," stated the Aisyiyah volunteer in the October 2022 interview.

Aisyiyah TB Care volunteers receive training that encompasses medical understanding and religious comprehension to ensure optimal handling of TB cases. TB issues are acknowledged to be not solely medical concerns; they are closely related to societal behaviors that often neglect hygienic lifestyles. According to the volunteer, it is essential to grasp that religious teachings emphasize maintaining a clean and healthy way of life.

From the patient's perspective, an interview was conducted with a TB patient at UPT Garuda. The findings revealed that the patient's perception of the illness transformed. Initially, the patient felt overwhelmed by the prolonged treatment process. However, upon gaining a new perspective, the patient began to view the illness as a test of faith. The patient acknowledged that the introduction of the religious dimension had altered the way they perceived their illness—from something negative to a meaningful spiritual trial. This viewpoint granted the TB patient a sense of tranquility and resilience in facing treatment challenges. "I fulfill my duties by undergoing treatment and praying. The rest I leave to God. I entrust myself to His will," expressed the TB patient in the December 2023 interview at UPT Garuda.

Additionally, the interview outcomes revealed another viewpoint regarding the causes of TB. Some patients believed that TB could be attributed to a lifestyle that deviated from the teachings of religion, which emphasizes healthy living habits. This analysis illustrates how religious beliefs can shape illness perceptions, even extending to its root causes. It is recognized that religion plays a role in instilling healthy living values, and this perspective motivates behavioral changes to achieve improved physical and spiritual well-being.

Discussion

The complexity of TB and the associated stigma are prominent issues discussed by Aisyiyah. The organization highlights the intricate nature of TB as a health concern. However, a significant challenge lies in the social stigma surrounding TB patients in the community. This stigma leads to the isolation of individuals diagnosed with TB due to a lack of awareness regarding the disease and its transmission. Aisyiyah takes on the role of public education to dispel such stigma related to TB. Despite ongoing efforts, the process of eliminating this stigma remains ongoing. The interviewee points out the persistence of certain misconceptions, one of which is the misguided belief that TB is a hereditary disease.

The informant's statements underscore the negative impact of this stigma on TB sufferers. The stigma and discrimination faced by these patients pose obstacles to their treatment process. The situation becomes more complex when this stigma is combined with a religious approach. Consequently, TB patients undergo emotional distress and bear derogatory labels, ranging from being labeled sick to being unfairly associated with curses. These labels inflict an additional psychological burden on patients who did not willingly choose to be afflicted with TB.

The strategy and approach employed by Aisyiyah TB Care cadres to address this stigma are discussed in the interview. Despite some progress in dispelling misconceptions in Bandung, some individuals still cling to such misconceptions due to embarrassment and fear of social exclusion. The cadres assume an educational role in addressing this issue, regularly conducting sermons and discussions. The objective of this approach is to reshape the perceptions of TB sufferers gradually. The cadres remind them that all events, including TB infection, are subject to the will of Allah SWT. They encourage patients to seek divine assistance and healing, fostering a more positive outlook.

Health communication is a technique for conveying messages and information that influences and motivates individuals, institutions, and the public regarding the importance of health issues. Improve their health.

In this study, the focus of the research is on

Table 2 Health Communication and Religious Approach

1	Help sufferers develop and improve their relationship with Allah SWT.
2	Influence the minds of sufferers by giving suggestions and words of encouragement with positive messages based on the teachings and values of the Islamic religion
3	Growing forgiveness, hope, gratitude, and generosity through religious practices based on Islamic values and teachings
4	Improving the relationship of TB sufferers with humans and the universe

how cadres from Aisyiyah TB Care carry out the religious approach and communication strategy to treat TB in Bandung. Other research that supports this research is research on religious concepts in counseling services. This study found that various religious activities carried out the spiritual approach in the counseling process, such as self-reflection, the gratitude approach, the al-Quran recitation approach, and the remembrance approach to repentance.[10]

This research shows that the religious approach and communication strategy adopted by Aisyah's cadres can slowly make TB sufferers change their views and behaviors towards the TB infection they are suffering from.

Stigma and discrimination can cause mental health problems for people with TB. Mental health is operationalized as a measure of distress and dichotomism, life satisfaction, well-being, and quality of life. The link between health communication and a religious approach includes participation in public and private religious activities and support from assembly members or recitation.[11]

The results of the analysis show that there is a link between the religious approach taken by Aisiyah cadres and changes in the views and behavior of the TB sufferers they assist. In the results of an interview with Mrs. Nikmah, one of the cadres from Aisyiyah TB Care said that their usual approach is to visit TB sufferers, hold recitations, and pray together where the recitation activities are usually filled with lectures or studies to approach religion based on the values and teachings of Islam.

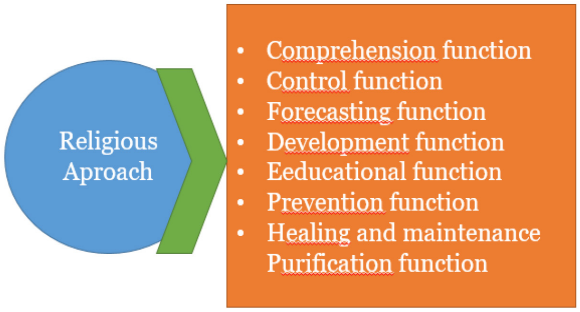

Figure The Function of the Religious Approach in Disease Management

Based on the results of research and interviews, it can also be seen that the inhibiting factors in the treatment process and this religious approach are due to the stigma and discrimination that TB sufferers have received beforehand. Because it makes TB sufferers feel inferior, blame themselves, and isolate themselves because they feel ashamed of their infection.

In fact, in several cases, it was found that stigma and discrimination did not only come from the community where they lived but even from their families and themselves. It is feared that this will make TB patients reluctant to carry out the treatment process. The solution offered by Aisyiyah TB Care cadres in efforts to treat TB is to take a religious approach. The aim of a religious approach based on the values and teachings of Islam is to assist every individual with TB in returning to physical and spiritual health, or what we usually know as spiritual and moral health.

Adz-Dzaky[12] states that a religious approach to disease management has the following functions: understanding, control, forecasting, development, education, prevention, healing and care, and purification (Figure).

He also said that a religious approach based on Islamic values and teachings could be one of the key strategies for helping TB sufferers during the treatment process.[12] Fear and anxiety caused by TB infection, as well as hopelessness and sadness due to illness, are spiritual reactions that require treatment with a religious approach based on Islamic teachings and values.[13,14]

Quoting the statements of Walker and Avant, to predispose the conversion of emotions

originating from fear and sadness into emotions full of confidence and security, as well as behavioral adaptation to illness For problem-focused and emotion-focused adaptation, the disease must be introduced as a challenge through enhancing the patient's relationship with God and by developing courage and optimism.[15,16]

In this study, the researchers observed that the cadres of Aisyiyah TB Care had a practical approach to religion and health communication. Furthermore, the communication process and approach taken can be explained in Table 2.

(1) Help sufferers develop and improve their relationship with Allah SWT. Thinking positively about life's provisions can make TB sufferers hope they will be healthy again. (2) Influence the minds of sufferers by giving suggestions and words of encouragement with positive messages based on the teachings and values of the Islamic religion. For example, the TB infection that is currently being suffered is a form of trial as well as a form of compassion to see and know the extent of the sufferer's faith to continue to try and pray so that they can get through and recover from this TB infection. (3) Growing forgiveness, hope, gratitude, and generosity through religious practices based on Islamic values and teachings. (4) Improving the relationship of TB sufferers with humans and the universe based on the teachings of the Qur'an, maintaining friendship is a form of belief in goodness and the promises mentioned in the Qur'an that can prolong life (Table 2).

It is in line with the advice of Rasulullah SAW to avoid actions that damage faith and how to deal with this disease with a mindset of steadfastness, sincerity, trust, and surrender without blaming Allah SWT. Islamic teachings encourage people to immediately seek treatment when they are sick as a proactive action that must be taken with the belief that Allah SWT will provide healing. Islamic teachings encourage people to immediately go to the doctor when they are sick as a proactive step that must be taken with the belief that Allah SWT will provide healing.[17]

The Qur'an also encourages people to be positive towards Allah's provisions.[18] This has been implemented in the religious approach process carried out by the cadres, namely by always giving encouragement and positive words to TB sufferers. An influential religious approach will present a belief in positive religious values and teachings, where people who believe in them will feel that God will not leave them alone in a painful situation; God will always be with them.[19]

Religion and spirituality are often associated with one another. Religion is service to or worship of God or the supernatural. Faith is often associated with religion and Spirituality. Faith is more personal, subjective, and more profound. While Spirituality is in the form of a relationship with God, nature, other people, and the surrounding environment, Spirituality is associated with quality and meaning in life.[20]

In contrast, the religious approach in this study is a communication activity by carrying out an approach whose other purpose is to introduce the values and teachings of a religion, which in this study are the values and teachings of the Islamic faith that cadres from Aisyiyah TB Care have implemented.

Other research also shows an influence between the religious approach and recovery from TB infection. Mohammed is one of the many survivors who managed to recover. One of the factors in his recovery was the religious approach taken by the nurses at the hospital where he was undergoing treatment. The words of one ward nurse stuck with him: "Whatever you do, don't leave until you have finished treatment; even if you have a stable family at home, you must be mentally and physically fit.[21]

Researchers also hope there will be continuous collaboration between health, religious, and government organizations to treat TB. Suppose religious leaders or cadres already know and strongly believe in the TB handling process through a spiritual approach based on Islamic religious values and teachings. In that case, they can use information dissemination media to disseminate information more broadly.[22]

This is based on an interview with respondents who said the media still lacks reporting on TB infections. The more information that is spread, the more people will know and care about the symptoms of TB or the people around them who are infected with TB instead of giving the sufferers stigma and discrimination. What they Whatis support and prayer.

In addition, it is also said that countries with a high TB burden, such as Indonesia, will need help to routinely implement these new guidelines for HR-TB because easy access to INH resistance testing is a challenge. Although there are WHO-supported technologies (such as line-probe tests and liquid cultures) that can detect INH, these

tools are limited to centralized or reference laboratories.[22]

Conclusions

The conclusion from the results of this study is the discovery of changes in TB sufferers after going through a religious approach and assistance process. They become more optimistic and enthusiastic and always try to pray so they can recover from this TB infection. In addition, it is also known that there are positive effects of a religious approach for TB sufferers.

Conflict of Interest

None declared.

Acknowledgment

The first author extends gratitude to the Rector of the Indonesian Computer University, who provided a scholarship for the first author to pursue doctoral studies at IPB University. The authors also thank the Dean of the Faculty of Human Ecology and the Communication Science Study Program, IPB University Postgraduate Program, for granting the author's research permission.

References

1. Santosa D, Gurnida DA, Sastramihardja HS, Subarnas A. Effect of ESAT-6 on phagocytosis activity, ROS, NO, IFN-γ, and IL-10 in peripheral blood mononuclear cells of pulmonary tuberculosis patients. GMHC. 2022;10(2):97–103.
2. Dinas Kesehatan Kota Bandung. Tuberkulosis: "pandemi" selain COVID-19 [Internet]. Bandung: Dinas Kesehatan Kota Bandung; 2021 [cited 2023 Oct 13]. Available from: https://dinkes.bandung.go.id/tuberkulosis-pandemi-selain-covid-19.
3. Dinas Kesehatan Kota Bandung. Renstra Dinas Kesehatan 2018–2023 [Internet]. Bandung: Dinas Kesehatan Kota Bandung; 2019 [cited 2023 Oct 14]. Available from: https://dinkes.bandung.go.id/profil-kesehatan.
4. Solihin O, Lubis DP, Muljono P, Amanah S. Social and behavior change communication (SBCC) approach in tuberculosis management by Terjang Foundation. Mediator. 2023;16(1):1–13.
5. Machmud R, Medison I, Yani FF. Cultural and religious belief approaches of a tuberculosis program for hard-to-reach populations in Mentawai and Solok, West Sumatra, Indonesia. Kesmas. 2020;15(4):205–11.
6. Oman D, Riley LW. Infectious diseases, religion, and spirituality. In: Oman D, editor. Why religion and spirituality matter for public health: evidence, implications, and resources. Berlin: Springer; 2018. p. 153–63.
7. Dinas Kesehatan Kota Bandung. Profil Dinkes Kota Bandung 2020 [Internet]. Bandung: Dinas Kesehatan Kota Bandung; 2021 [cited 2023 Nov 10]. Available from: https://dinkes.bandung.go.id/profil-kesehatan/id.
8. Irasanti SN, Perdana R, Indriasari D, Yuniarti Y, Kamil A, Merduani W. Religiosity and stress on nurses during COVID-19 pandemic at a hospital in Bandung. GMHC 2022;10(1):13–7.
9. Achmad MK, Harrison J, Davies CL. Cultural sensitivity in health promotion program: Islamic persuasive communication. In: Proceedings of the 6th International Conference on Communication and Mass Media; 2008 May 19–22; Athens, Greece. Athens, Greece: Athens Institute; 2008. p. 1–11.
10. Umarella S, Farid M, Ab Rahman Z. Medicine and al-Quran recital approaches used on COVID-19 patients: a systematic review. Syst Rev Pharm. 2020;11(12):1163–70.
11. Koenig HG. Religion and mental health: research and clinical applications. Cambridge: Academic Press; 2018.
12. Adz-Dzaky HB. Konseling dan psikoretapi Islam. Yogyakarta: Al Manar; 2008.
13. Abdullah F, Hashi AA, Said AH, Mat Nor MB. Medical and Islamic perspectives on human immunodeficiency virus infection and its prevention. IMJM. 2019;18(2):153–9.
14. Asadzandi M. An Islamic religious, spiritual health training model for patients. J Relig Health. 2020;59(1):173–87.
15. Buback L, Kinyua J, Akinyi B, Walker D, Afulani PA. Provider perceptions of lack of supportive care during childbirth: a mixed methods study in Kenya. Health Care Women Int. 2022;43(9):1062–83.
16. Hasmiati H, Rita R, Amiruddin A. Dakwah Aisyiyah melalui kader tuberkulosis (Tb)

care di Kabupaten Sinjai. J Ilmu Dakwah. 2021;41(1):30–42.
17. Koenig HG, Al Shohaib SS. Religiosity and mental health in Islam. In Moffic HS, Peteet J, Hankir AZ, Awaad R, editors. Islamophobia and psychiatry: recognition, prevention, and treatment. Cham, Switzerland: Springer Nature; 2019. p. 55–65.
18. Solaimanizadeh F, Mohammadinia N, Solaimanizadeh L. The relationship between spiritual health and religious coping with death anxiety in the elderly. J Relig Health. 2020;59(4):1925–32.
19. Paul Victor CG, Treschuk JV. Critical literature review on the definition clarity of faith, religion, and spirituality. J Holist Nurs. 2020;38(1):107–13.
20. Linton E, Jayasooriya S. Story from a survivor of tuberculosis. Lancet Respir Med. 2021;9(10):1098–100.
21. Olagoke AA, Olagoke OO, Hughes AM. Intention to vaccinate against the novel 2019 coronavirus disease: the role of health locus of control and religiosity. J Relig Health. 2021;60(1):65–80.
22. Sulis G, Pai M. Isoniazid-resistant tuberculosis: a problem we can no longer ignore. PLoS Med. 2020;17(1):e1003023.
23. Mesman AW, Rodriguez C, Ager E, Coit J, Trevisi L, Franke MF. Diagnostic accuracy of molecular detection of *Mycobacterium tuberculosis* in pediatric stool samples: a systematic review and meta-analysis. Tuberculosis (Edinb). 2019;119:101878.

Authors Index

Subjects Index

The Editor would like to thank you for the effort and expertise of all reviewers, without which it would be impossible to maintain the high standards of peer-reviewed journals.

Dr. Arif Susanto, M.H.M., M.Sc.
Assoc. Prof. Dr. Badrul Hisham Yahaya
Prof. Dr. Budi Setiabudiawan, dr., Sp.A.(K.), M.Kes.
Budiman, dr., M.K.M.
Prof. Cordia Ming-Yeuk Chu, B.Sc., M.A., Ph.D.
Ermi Ndoen, B.Sc.P.H., M.Sc.P.H., Ph.D.
Ferry Efendi, S.Kep.Ns., M.Sc., Ph.D.
Prof. Dr. Hendro Sudjono Yuwono, dr., Sp.B.V.(K.)
Prof. Dr. Herri S. Sastramihardja, dr., Sp.F.K.(K.)
Prof. Hidayat Wijayanegara, dr., Sp.O.G.(K.)
Prof. Dr. Ieva Baniasih Akbar, dr., A.I.F.
Dr. Jerico Franciscus Pardosi, B.P.H., M.I.P.H.
Dr. Lelly Yuniarti, S.Si., M.Kes.
Leri Septiani, dr., Sp.O.G., Ph.D.
Lia Faridah, dr., M.Si., Ph.D.
Prof. Dr. M. Ahmad Djojosugito, dr., Sp.B., Sp.O.T.(K.), M.H.A.
Mas Rizky A.A. Syamsunarno, dr., M.Kes., Ph.D.
Dr. Maya Tejasari, dr., M.Kes.
Dr. Mia Kusmiati, dr., M.Pd.Ked.
Mirasari Putri, dr., Ph.D.
Prof. Dr. Niniek Lely Pratiwi, drg., M.Kes.
Prof. Nuzirwan Acang, dr., DTM&H, Sp.P.D.-K.H.O.M.
Riyadi Adrizain, dr., Sp.A.(K.), M.Kes.
Prof. Dr. Roy Rilero Marzo, M.D., M.P.H., M.B.A.
Dr. Titik Respati, drg., M.Sc.P.H.
Prof. Umar Fahmi Achmadi, dr., M.P.H., Ph.D.
Dr. Ir. Wahyu Widowati, M.Si.
Dr. Wawang S. Sukarya, dr., Sp.O.G.(K.), M.A.R.S., M.H.Kes.
Dr. Wida Purbaningsih, dr., M.Kes.
Dr. Yani Triyani, dr., Sp.P.K., M.Kes.

TABLE OF CONTENTS

RESEARCH ARTICLES

p-ISSN 2301-9123
9 772301 912306

e-ISSN 2460-5441
9 772460 544103