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Accuracy of Selective Postoperative Surgical Site Infection Surveillance Among High-Risk Patients Compared With Traditional Surveillance in a Tertiary University Hospital

Domingo S. Bongala, Jr., MD, MSPH¹

Abstract

Introduction Surgical site infection (SSI) surveillance is resource-intensive, particularly in low-resource settings. This study evaluated whether selective surveillance of high-risk patients can accurately identify postoperative SSI compared with traditional surveillance of all surgical patients.

Methods A cross-sectional study was conducted among 587 patients who underwent selected general surgical procedures from January 2022 to June 2023 in a tertiary university hospital. Patients were classified as high-risk or low-risk for SSI using eight perioperative variables. Logistic regression analysis identified factors independently associated with SSI. The accuracy and agreement of selective surveillance versus traditional surveillance were assessed using sensitivity, specificity, predictive values, and Cohen's kappa.

Results The overall SSI rate was 12% (71/587). Independent predictors of SSI included resident service cases (OR 2.57, 95% CI 1.37–4.83), ASA score 3–5 (OR 6.28, 95% CI 3.30–11.93), clean-contaminated to dirty wounds (OR 21.73, 95% CI 6.26–75.48), operative duration beyond the 75th percentile (OR 2.33, 95% CI 1.24–4.38), and failure to maintain perioperative normothermia (OR 39.49, 95% CI 3.35–465.06). Selective surveillance demonstrated 100% sensitivity, specificity, positive predictive value, and negative predictive value, with perfect agreement with traditional surveillance (Cohen's kappa = 1.00).

Conclusion Selective surveillance focused on high-risk patients demonstrated excellent agreement with traditional surveillance and may serve as a cost-effective alternative for SSI monitoring in resource-limited settings.

Key words: Surgical site infection (SSI), SSI surveillance, Risk stratification, High-risk surgical patients, Healthcare-associated infections; Infection prevention

Surgical site infections (SSIs) rank among the most prevalent hospital-acquired infections worldwide. The United States Centers for Disease Control (2015) reported in their Healthcare-associated infection (HAI) prevalence survey an estimated 110,800 surgical site infections linked to inpatient surgeries. Based on the Hospital Acquired Infection (HAI) data results

published in the National Health Survey Network's (2024) Hospital Associated Infection Progress Report, there was nearly a 4% increase in the SSI standardized infection ratio (SIR) for all NHSN operative procedure categories combined compared to the previous year. Patients who develop SSIs have been shown to experience longer postoperative hospital stays, may require additional surgical procedures or intensive care unit admission, and face a higher risk of mortality (Anderson et al., 2014). Ban et al. (2017), in the 2016 American College of Surgeons Surgical Infection Society Updated Guidelines, estimated that SSIs

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constitute 20% of all HAIs and are associated with a 2- to 11-fold increase in the risk of mortality, with 75% of SSI-related deaths directly attributable to SSI and sepsis.

Monitoring SSI remains an important indicator of healthcare-associated outcomes. Surveillance systems with feedback mechanisms have been shown to improve SSI management and reduce infection rates (NNIS, 2003; Russo et al., 2021). Early detection and management of SSI have also been associated with shorter hospitalization, lower intensive care utilization, and improved patient outcomes (Horgan et al., 2023). SSI surveillance programs provide healthcare institutions with accurate epidemiologic data that may be used to identify trends, evaluate preventive strategies, compare institutional performance with international benchmarks, and support quality improvement and patient safety initiatives (Kasatpibal, 2009; German, 2001).

The accepted gold standard for SSI surveillance is active case finding through direct postoperative patient observation performed by trained personnel such as infection control nurses (Gillespie, 2021). However, active surveillance is resource-intensive and requires monitoring for at least 30 days postoperatively and up to 90 days for procedures involving implants. This challenge is particularly relevant in hospitals with high surgical volume and limited surveillance capability. In the Philippines, the absence of baseline national SSI data and limited manpower have constrained the establishment of sustainable SSI surveillance systems (Rosenthal, 2024).

Selective surveillance strategies focused on high-risk patients may provide a practical alternative to monitoring all postoperative patients. The NHSN Risk Index traditionally stratifies patients according to operative duration, wound classification, and ASA score (NNIS, 2003). However, limitations in its predictive performance across operative categories have been identified, including the use of only three risk factors and equal weighting of variables (Tanner, 2013; Brandt, 2004). Additional perioperative variables such as timely antimicrobial prophylaxis, maintenance of normothermia, glycemic control, and appropriate hair removal may improve patient risk stratification and better identify patients at increased risk for SSI (Pedroso-Fernandez, 2016).

The objective of the study was to evaluate a selective surveillance strategy focused on patients at high risk for developing SSI and determine whether

targeted monitoring provides comparable accuracy to traditional surveillance of all postoperative patients. Specifically, the study aimed to determine the incidence of SSI, describe the profile of patients who developed SSI, identify factors associated with the development of SSI, assess the accuracy of selective surveillance for monitoring postoperative SSI, and determine the degree of agreement between selective surveillance and traditional surveillance systems.

Methods

Ethics Board approval was obtained prior to data collection (RIHS ERC Code 1269/G/2022/079). This was a cross-sectional study of admitted patients at a tertiary university hospital from January 2022 to December 2023. Surgical site infection (SSI) surveillance focused on 15 National Nosocomial Infections Surveillance (NNIS) operative procedure categories in general surgery, including head and neck surgery (NECK), thyroid and parathyroid surgery (THYR), breast surgery (BRST), skin and soft tissue surgery (SST), herniorrhaphy (HERN), esophagogastroduodenal surgery (EGAS), gallbladder surgery (CHOL), hepatopancreatobiliary surgery (BILI), small bowel surgery (SB), appendectomy (APPY), colon surgery (COLO), rectosigmoid surgery (REC), anal surgery (ANAL), and exploratory laparotomy (XLAP).

Pertinent demographic, perioperative, operative, and SSI-related variables were collected using standardized data collection forms. These included age, sex, comorbidities, perioperative normothermia, glycemic control, antimicrobial prophylaxis, urgency and duration of surgery, ASA classification, wound classification, operative approach, and use of implants or drains. Eight pre-specified perioperative variables were used to classify patients as high-risk or low-risk for developing SSI: operative duration, wound contamination classification, ASA risk classification, antimicrobial prophylaxis, duration of antibiotic administration, appropriateness of hair removal, maintenance of perioperative normothermia, and adequacy of perioperative glycemic control (Table 1).

Operative duration was defined as the time from skin incision to skin closure and was compared with the CDC/NHSN 75th percentile cut-off values for each operative category. Surgical wounds were classified according to the Altemeier wound classification system, while the 2014 American Society

Table 1. Classification of procedures according to risk.

Variable	Low Risk	High Risk
ASA classification	1–2	3–5
Wound class	Clean	Clean-contaminated, contaminated, dirty
Duration of procedure	≤75th percentile	>75th percentile
Antimicrobial prophylaxis	Appropriate	Inappropriate
Duration of antimicrobial use	Appropriate	Inappropriate
Hair removal	Appropriate/not indicated	Inappropriate
Perioperative normothermia	Maintained	Not maintained
Perioperative glycemic control	Maintained	Not maintained

of Anesthesiologists (ASA) classification was used to assess preoperative physical status. Appropriate hair removal was defined according to World Health Organization recommendations using electric clippers when indicated. Antimicrobial prophylaxis was evaluated based on antibiotic selection, dosage, timing, and duration according to published evidence-based guidelines. Perioperative normothermia and glycemic control were likewise assessed using predefined criteria. Procedures with no identified risk factors were classified as low risk, while those with at least one risk factor were classified as high risk.

Post-discharge surveillance was performed using multiple standard infection control surveillance techniques, including inpatient chart review, microbiology records, outpatient follow-up records, physician interviews, telephone calls, and text messaging. A standardized questionnaire based on CDC SSI criteria was used to assess postoperative infections. SSI classification followed CDC definitions for superficial incisional, deep incisional, and organ/space SSI occurring within 30 days postoperatively or within 90 days for procedures involving implants.

Descriptive statistics were used to summarize patient characteristics and operative variables using means with standard deviations for numerical variables and frequencies with percentages for categorical variables. Binary logistic regression analysis was performed to determine factors significantly associated with SSI. Measures of diagnostic accuracy, including sensitivity, specificity, positive predictive value, and negative predictive value, were computed to compare selective surveillance among high-risk patients with traditional surveillance of all postoperative patients. Cohen's kappa statistic was used to determine agreement between surveillance methods. Statistical significance was set at $p < 0.05$, and data analysis was performed using Stata version 14 software.

Results

Data were collected from 587 operations performed at the UERM Memorial Medical Center from January 2022 to June 2023. There were 434 procedures performed in 2022 and 153 procedures performed from January to June 2023. A total of 71 SSIs were identified, yielding an overall SSI rate of 12% (Table 2).

Table 2. Distribution of SSI cases by operative category.

Operative Category	Total Cases n (%)	SSI Cases
CHOL	175 (29.8)	3
BRST	82 (13.9)	1
REC	52 (8.9)	20
APPY	50 (8.5)	7
COLO	39 (6.6)	16
HERN	39 (6.6)	0
ANAL	31 (5.3)	0
BILI	25 (4.3)	3
THYR	24 (4.1)	0
EGAS	22 (3.8)	7
SB	22 (3.7)	11
SST	13 (2.2)	1
NECK	8 (1.4)	0
XLAP	5 (0.9)	2
Total	587	71

Overall, the most common surgical procedures were CHOL (30%), BRST (14%), REC (9%), and APPY (9%), which collectively accounted for the majority of operations. Most SSIs occurred in REC (28%), COLO (23%), SB (16%), EGAS (10%), and APPY (10%) procedures. (Table 2).

Patient demographic and operative characteristics are summarized in Table 3. Most patients were female (58%) and younger than 60 years old (65%), with a mean age of 51 years. The majority had comorbidities (63%), most commonly hypertension, malignancy, and diabetes mellitus. Most patients were classified as ASA

1 or 2, and the majority of wounds were classified as clean or clean-contaminated. Most operations were completed within the CDC/NNIS 75th percentile operative duration cut-off time.

Table 3. Baseline characteristics of patients.

Characteristic	n (%)
Female sex	338 (57.6)
Age <60 years	381 (64.9)
Presence of comorbidities	368 (62.7)
ASA 3–5	179 (30.5)
Clean contaminated to dirty wounds	293 (49.9)
Open surgery	436 (74.3)
Exceeds operative duration 75th percentile	265 (45.1)
High-risk classification	434 (73.9)
SSI present	71 (12.1)
Superficial incisional SSI	54 (76.1 of SSI)

Most procedures were managed by consultants and performed on either an elective or semi-elective basis. The open operative approach was used in most procedures, while implants were infrequently utilized. Surgical drains, however, were used in a substantial proportion of operations. Hair removal was either appropriate or not indicated in almost all procedures. Appropriate prophylactic antibiotics in terms of choice, dose, and timing were administered in most operations, although postoperative antibiotic discontinuation within the recommended period was infrequent. Perioperative normothermia was maintained in nearly all patients, while glycemic control was adequately maintained in most patients requiring monitoring.

Based on the eight-variable risk assessment criteria, 74% of procedures were classified as high-risk while 26% were classified as low-risk. Surgical site infections occurred in 71 procedures, with most classified as superficial incisional SSI (76%), followed by organ/space SSI (21%) and deep incisional SSI (3%). The SSI rate among high-risk patients was 16% (Table 4).

Table 4. Distribution of SSI by risk assessment.

Risk Category	SSI	No SSI	Total
Low risk	0	153	153
High risk	71	363	434
Total	71	516	587

Among high-risk patients, SSI rates increased as the number of risk factors increased, with SSI rates of 3%, 15%, 39%, and 67% among patients with 1, 2, 3,

and 4 risk factors, respectively. Higher SSI rates were observed in gastrointestinal operative categories such as SB, COLO, REC, EGAS, and XLAP procedures. Most SSIs occurred among patients with two to three risk factors (Table 5).

Table 5. SSI rates according to number of risk factors.

Number of Risk Factors	SSI Rate
1	2.6%
2	15.6%
3	38.3%
4	66.7%

On crude analysis, gender, age group, provider type, timing of surgery, operative approach, use of drains, ASA classification, comorbidities, wound contamination class, duration of surgery, antibiotic prophylaxis, postoperative antibiotic discontinuation, perioperative normothermia, and glycemic control were significantly associated with SSI ($p < 0.05$) (Table 6). Final logistic regression analysis demonstrated that service as provider, ASA score 3–5, contaminated wound classification, operative duration exceeding the 75th percentile, and failure to maintain perioperative normothermia were independently associated with SSI (Table 7).

Selective surveillance demonstrated 100% sensitivity, specificity, positive predictive value,

Table 6. Crude association between factors and SSI.

Factor	Odds Ratio (95% CI)	p-value
Male sex	1.90 (1.15–3.14)	0.012
Age ≥60 years	1.84 (1.11–3.04)	0.017
Service provider	2.21 (1.33–3.66)	0.002
ASA 3–5	9.14 (5.16–16.18)	<0.001
Wound contamination	28.96 (8.99–93.23)	<0.001
Urgent/emergency surgery	2.87 (1.65–4.99)	<0.001
Open surgery	13.77 (3.33–56.89)	<0.001
Use of drains	4.91 (2.78–8.66)	<0.001
Prolonged operative duration	3.08 (1.81–5.24)	<0.001
Failure to maintain normothermia	10.19 (2.23–46.5)	0.003
Poor glycemic control	3.56 (1.56–8.14)	0.003

Table 7. Final logistic regression model.

Factor	Odds Ratio	95% CI	p-value
Service as provider	2.57	1.37–4.83	0.003
ASA 3–5	6.28	3.30–11.93	<0.001
Clean contaminated to dirty wounds	21.73	6.26–75.48	<0.001
Operative duration >75th percentile	2.33	1.24–4.38	0.008
Failure to maintain normothermia	39.49	3.35–465.06	0.003

and negative predictive value in identifying SSI among high-risk patients (Tables 8 & 9). There was excellent agreement between selective surveillance and traditional surveillance methods for postoperative SSI monitoring (Cohen's kappa statistic = 1.00, 95% CI 0.906–1.094) (Table 10).

Discussion

The accepted gold standard for the diagnosis of surgical site infection (SSI) is in-person postoperative evaluation according to the US Centers for Disease Control and Prevention (2015). However, active surveillance is resource-intensive and may be difficult to sustain in low- and middle-income countries because of geographic, financial, and workforce limitations. These challenges are particularly relevant in healthcare systems with limited infection control manpower and high surgical volume. Branch-Elliman et al. (2014) previously proposed using clinical variables to guide SSI surveillance efforts toward higher-risk patient subsets, while Saunders et al. (2014) utilized multilevel modeling to improve prediction of SSI risk. These studies support the feasibility of targeted surveillance approaches in resource-limited settings.

There were 71 SSIs identified among 587 operations, yielding an overall SSI rate of 12%. The findings demonstrate the complex interaction of

patient-related, procedure-related, and perioperative risk factors in the development of SSI. On multivariable analysis, service as provider, ASA classification 3–5, wound classification, operative duration exceeding the 75th percentile, and failure to maintain perioperative normothermia were independently associated with SSI. These findings are consistent with previous studies and current SSI prevention guidelines identifying physiologic status, wound contamination, operative complexity, and perioperative management as major determinants of postoperative infection risk (Anderson et al., 2014; Ban et al., 2017).

Older age was associated with SSI on univariate analysis but was not retained in the final logistic regression model, likely because of its correlation with higher ASA scores and comorbidities. Similar findings were reported by Kaye et al. (2005), who demonstrated higher SSI risk among older patients. Emergency or urgent procedures and open operative approaches were likewise associated with SSI on crude analysis but were not independently associated with SSI after adjustment for other perioperative variables. The higher SSI risk observed among service cases may reflect the greater complexity and prolonged duration of gastrointestinal procedures frequently managed by residents-in-training. Similar findings were reported by Mujagic et al. (2020), who observed that longer and more technically demanding procedures performed by

Table 8. Validity of selective surveillance.

Selective Surveillance	Traditional Surveillance With SSI	Traditional Surveillance Without SSI
With SSI	71	0
Without SSI	0	363

Table 9. Measures of validity.

Measure	Value
Sensitivity	100%
Specificity	100%
Positive predictive value	100%
Negative predictive value	100%

Table 10. Agreement between surveillance methods.

Statistic	Value
Cohen's kappa	1.00
95% CI	0.906–1.094
p-value	<0.001

less experienced surgeons were associated with higher SSI rates.

ASA classification remained a strong predictor of SSI in this study. Patients with ASA scores of 3–5 were six times more likely to develop SSI compared with those classified as ASA 1–2. Most patients with SSI had significant comorbidities, advanced malignancies, or physiologic impairment. These findings are consistent with the study of Hackett et al. (2015), which demonstrated that ASA physical status independently predicts postoperative morbidity and infectious complications across multiple surgical specialties. The ASA classification therefore remains a valuable perioperative risk stratification tool despite recognized subjectivity in scoring.

Wound classification was also strongly associated with SSI. Procedures classified as clean-contaminated, contaminated, or dirty were associated with substantially higher infection risk than clean procedures, particularly among gastrointestinal operations involving entry into contaminated viscera. Similar findings were reported by Curcio et al. (2019), who demonstrated higher SSI rates among contaminated gastrointestinal procedures. Fukuda (2016) likewise reported substantially increased SSI rates following colorectal and other gastrointestinal procedures compared with clean operations. In the present study, gastrointestinal procedures demonstrated the highest SSI rates, particularly among small bowel, colonic, rectosigmoid, and esophagogastric procedures. These findings are likewise consistent with the CDC Principal Operative Procedure risk rankings for postoperative SSI.

The significantly lower SSI rates observed after laparoscopic surgery are consistent with previous studies demonstrating reduced infection risk associated with minimally invasive techniques. Reduced tissue trauma, smaller incisions, and lower wound contamination likely contribute to this benefit. In the present study, laparoscopic cholecystectomy demonstrated very low SSI rates despite many procedures being performed for acutely inflamed gallbladders. The modified wound classification used in the study allowed selected laparoscopic gallbladder procedures without additional risk factors to be classified as low-risk, supporting the feasibility of limiting active surveillance among carefully selected patients.

Operative duration exceeding the CDC/NHSN 75th percentile cut-off was independently associated

with SSI. Prolonged operative duration likely reflects greater technical complexity, increased tissue exposure, prolonged bacterial contamination, surgeon fatigue, and greater physiologic stress. The findings are consistent with the systematic review by Cheng et al. (2017), which demonstrated a linear relationship between operative time and SSI risk across multiple surgical procedures. The study also highlights the potential importance of establishing locally derived operative duration cut-off points, as operative efficiency and healthcare resource limitations may differ substantially from international benchmarks.

Perioperative normothermia was strongly associated with SSI development and remained significant in the final logistic regression model. Patients in whom normothermia was not maintained were substantially more likely to develop SSI. Hypothermia impairs tissue oxygenation, coagulation, immune response, and wound healing, thereby increasing susceptibility to infection (de Brito Poveda et al., 2020). These findings support the landmark randomized controlled trial by Kurz et al. (1996), which demonstrated significantly lower SSI rates among actively warmed colorectal surgery patients, as well as the findings of Melling et al. (2001), who showed similar benefits even among shorter clean procedures. Current SHEA/IDSA and WHO guidelines therefore continue to recommend maintenance of perioperative normothermia as an essential SSI preventive strategy.

Although antimicrobial prophylaxis, postoperative antibiotic discontinuation, and perioperative glycemic control were significantly associated with SSI on univariate analysis, these variables were not retained in the final logistic regression model. Nevertheless, these perioperative interventions remain important evidence-based preventive measures. The findings may reflect the influence of stronger competing perioperative variables such as wound contamination class, ASA classification, prolonged operative duration, and gastrointestinal procedure complexity. Previous study by Latham et al. (2001) demonstrated that postoperative hyperglycemia independently increases SSI risk even among patients without known diabetes mellitus. Current WHO and SHEA/IDSA guidelines therefore recommend postoperative glucose monitoring and control among all surgical patients.

The study demonstrated that SSI rates progressively increased as the number of perioperative risk factors

increased. Most infections occurred among patients with two to three risk factors, suggesting that accumulation of perioperative risks substantially increases susceptibility to SSI. All SSIs occurred among patients classified as high-risk, while no infections were identified among low-risk patients. Most high-risk patients belonged to gastrointestinal operative categories such as REC, COLO, SB, EGAS, and APPY procedures, which accounted for most postoperative infections.

Selective surveillance focused on high-risk patients demonstrated excellent validity, with 100% sensitivity, specificity, positive predictive value, and negative predictive value compared with traditional surveillance of all postoperative patients. There was also excellent agreement between surveillance methods, with a Cohen's kappa statistic of 1.00. The high accuracy of selective surveillance likely reflects improved patient risk stratification through incorporation of additional perioperative risk variables and refinement of wound and ASA classifications. These findings support previous recommendations by Tomsic et al. (2020), who emphasized the value of targeted surveillance strategies for improving efficiency of infection prevention programs.

The findings also support the use of different surveillance approaches according to patient risk. Patients classified as high-risk may benefit from active face-to-face surveillance because of the greater likelihood of developing SSI and the importance of early diagnosis and management. In contrast, low-risk patients undergoing procedures such as laparoscopic cholecystectomy, thyroidectomy, neck surgery, breast surgery, and hernia repair may be appropriately monitored through passive surveillance methods such as telephone follow-up or patient self-reporting. Since gallbladder surgery represented the most commonly performed operation in the study, limiting active surveillance to higher-risk CHOL procedures may result in substantial reductions in surveillance workload and cost.

In conclusion, selective surveillance focused on high-risk patients demonstrated excellent agreement with traditional surveillance for postoperative SSI monitoring. The identified perioperative risk factors may help guide targeted surveillance and preventive interventions. Selective SSI surveillance may improve allocation of infection control resources while maintaining surveillance accuracy and enabling earlier detection of postoperative infections.

Limitations

The study has several limitations. First, the study was conducted in a single tertiary referral center, which may limit generalizability to other healthcare institutions. Second, some operative categories had relatively small sample sizes. Third, additional risk factors such as smoking and obesity were not independently analyzed. Fourth, the intensity and methods of post-discharge surveillance may vary across institutions and healthcare systems. Despite these limitations, the study provides important local data supporting the feasibility and accuracy of selective SSI surveillance among high-risk surgical patients.

Summary and Conclusions

The study aimed to develop a simple perioperative risk assessment tool to identify surgical patients at high risk of developing surgical site infection (SSI). Eight perioperative variables were used for risk stratification: operative duration exceeding the 75th percentile, wound contamination classification, ASA risk classification, appropriateness of antimicrobial prophylaxis, discontinuation of postoperative antibiotics, appropriateness of hair removal, maintenance of perioperative normothermia, and perioperative glycemic control. By incorporating five additional perioperative variables into the traditional NNIS risk index, patient risk stratification for SSI was improved. Patients without risk factors were classified as low-risk, while those with at least one risk factor were classified as high-risk.

Data from 587 patients who underwent general surgical procedures from January 2022 to June 2023 were analyzed. The overall SSI rate was 12%, with most infections classified as superficial incisional SSI, followed by organ/space and deep incisional SSI. The most common operative categories were CHOL, BRST, REC, and APPY procedures. Based on the eight-variable criteria, 74% of procedures were classified as high-risk, while 26% were classified as low-risk. No SSI developed among low-risk patients. Among high-risk patients, 16% developed SSI, with the highest rates observed in small bowel, colorectal, rectosigmoid, and esophagogastric procedures. SSI rates progressively increased as the number of risk factors increased.

Binary logistic regression analysis identified ASA score 3–5, contaminated wound classification,

operative duration exceeding the 75th percentile, service as provider, and failure to maintain perioperative normothermia as factors independently associated with SSI. These findings demonstrate the relative importance of multiple perioperative variables in SSI development and suggest that weighted multivariable risk prediction may improve risk stratification compared with the traditional NNIS risk index alone. Selective surveillance demonstrated 100% sensitivity, specificity, positive predictive value, and negative predictive value, with excellent agreement compared with traditional surveillance methods. These findings suggest that postoperative SSIs are concentrated among patients identifiable perioperatively as high-risk. The identified perioperative risk factors may therefore guide clinicians in risk assessment, surveillance prioritization, and implementation of preventive interventions.

The study supports the use of selective surveillance focused on high-risk patients as a practical and accurate alternative to traditional active surveillance of all postoperative patients. Given the manpower and resource limitations associated with active SSI surveillance, perioperative risk assessment may improve allocation of surveillance efforts and enhance early identification of postoperative infections while maintaining surveillance accuracy.

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The Accuracy of Ankle-Brachial Index Determination Using the Stethoscope to Screen for Peripheral Arterial Disease Among Adults with Type 2 Diabetes Mellitus in Iloilo City

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Abstract

Introduction Peripheral arterial disease (PAD) is a common macrovascular complication of type 2 diabetes mellitus (T2DM) and is associated with increased cardiovascular morbidity and mortality. The ankle-brachial index (ABI) is a simple, non-invasive method for detecting PAD; however, Doppler devices are not always available in primary care and resource-limited settings. This study aimed to determine the diagnostic accuracy of ABI measurement using a stethoscope compared with the Doppler method among adults with T2DM.

Methods A diagnostic accuracy study was conducted among 200 adults with T2DM recruited through convenience sampling from a private outpatient clinic in Iloilo City. ABI measurements were obtained using both the stethoscope and Doppler methods. An ABI of ≤ 0.90 was considered indicative of PAD. Diagnostic accuracy measures, including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), overall accuracy, and agreement, were calculated.

Results The prevalence of PAD was 30.5% using the stethoscope method and 35.0% using the Doppler method. Compared with Doppler ABI, the stethoscope method demonstrated an overall accuracy of 94.5%, sensitivity of 85.7%, specificity of 99.2%, PPV of 98.4%, and NPV of 92.8%. Agreement between the two methods was excellent (Cohen's $\kappa = 0.88$, $p < 0.001$).

Conclusion Stethoscope-based ABI determination demonstrated high diagnostic accuracy and excellent agreement with Doppler ABI. Given its low cost, accessibility, and non-invasive nature, it may serve as a practical screening tool for PAD among adults with T2DM, particularly in primary care and resource-limited settings where Doppler devices are unavailable.

Key words: diagnostic accuracy, peripheral arterial disease, ankle-brachial index, stethoscope, Doppler ultrasound, type 2 diabetes mellitus

Diabetes mellitus comprises a group of chronic metabolic disorders characterized by impaired insulin secretion, insulin resistance, and increased hepatic glucose production. It remains a major global

health concern and is a significant cause of blindness, cardiovascular disease, stroke, kidney failure, and lower extremity amputation. Established risk factors include advanced age, hypertension, and dyslipidemia. According to the World Health Organization, age-standardized mortality rates due to diabetes increased by 3% between 2000 and 2019.¹

Data from the International Diabetes Federation showed that in 2021, the prevalence of diabetes among Filipinos aged 20 to 79 years was 6.5%.¹

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Studies have consistently demonstrated that patients with diabetes are at significantly higher risk of developing peripheral arterial disease (PAD) compared with the general population.²

Lower extremity PAD affects approximately 5% of Filipinos aged 40 years and older.³

Studies using the ankle-brachial index (ABI), the preferred screening method for PAD, have shown that the prevalence of PAD among patients with diabetes ranges from 20%.⁴

PAD may lead to substantial long-term disability and is associated with symptoms such as intermittent claudication, absent distal pulses, dependent rubor, non-healing ulcers, infection, sepsis, and eventual limb amputation.⁵

According to the American Diabetes Association, approximately one in three individuals with diabetes over 50 years of age has PAD.⁶

However, many patients remain asymptomatic, contributing to delayed diagnosis and treatment. PAD is also associated with increased cardiovascular morbidity and mortality and may significantly impair lower extremity function and quality of life. Patients with diabetes who develop PAD have a significantly increased risk of mortality compared with patients without diabetes.⁷

Various diagnostic modalities, such as computed tomography angiography, magnetic resonance angiography, duplex ultrasound, and digital subtraction angiography, are used to detect PAD. Measuring the ankle-brachial index (ABI) is a simple, non-invasive, and reliable method for diagnosing PAD. Early detection of PAD in the clinical setting may facilitate secondary prevention of cardiovascular disease, reduce complications, lessen hospital admissions, and mitigate the risk of limb amputation.

The ankle-brachial index is one of the clinical tools used to determine the severity of PAD. It is calculated by obtaining the ratio of the systolic blood pressure in the ankle to the systolic blood pressure in the brachial artery.⁸ An ABI of ≤ 0.90 indicates lower extremity PAD.⁹ In several Asian countries, including the Philippines, 17.7% of patients with type 2 diabetes mellitus were diagnosed with PAD using ABI determination.¹⁰ ABI is a straightforward parameter used to objectively evaluate lower extremity arterial perfusion and diagnose peripheral arterial disease.

Most primary care physicians do not routinely use the standard Doppler method because it requires specialized equipment and trained personnel.¹¹ Doppler devices are not readily available in many primary care clinics and remote areas. This limitation creates challenges for patients, particularly those living in geographically isolated and disadvantaged areas, who may have limited access to diagnostic centers capable of performing ABI determination using Doppler ultrasound. Therefore, identifying a simpler and more accessible screening method for PAD remains clinically important. This study aimed to compare the diagnostic accuracy of determining the ankle-brachial index (ABI) using the stethoscope with the Doppler methods among patients with T2DM.

Methods

The study was approved by the Research Institute for Health Sciences Ethics Review Committee (Code 1793/G/2024/160). This diagnostic accuracy study was conducted in a private outpatient clinic from March to May 2025 in accordance with the Standards for Reporting Diagnostic Accuracy Studies (STARD) 2015 guidelines. A total of 200 adults with T2DM were recruited through convenience sampling.

Eligible participants included adults aged 40 to 70 years with T2DM, regardless of the presence or absence of symptoms suggestive of PAD. Patients with arteriovenous fistula, those undergoing lifelong hemodialysis, individuals with leg amputation, and those with lower extremity infection were excluded from the study. The sample size computation was based on the study which investigated the frequency of PAD diagnosed through ankle-brachial index (ABI) determination among patients with diabetes without intermittent claudication.¹² Using an estimated PAD prevalence of 37%, a 5% level of significance, and a target sensitivity of 95%, the minimum required sample size was calculated to be 197 participants.

The index test consisted of ABI determination using a stethoscope. For brachial systolic pressure measurement, the higher value obtained from either arm was used for ABI computation. For ankle systolic pressure measurement, both the dorsalis pedis and posterior tibial arteries of each lower extremity were assessed. The ABI was computed by dividing the highest ankle systolic pressure by the highest brachial systolic pressure.

The reference standard was ABI determination using a vascular Doppler device. Measurements were obtained using the same protocol applied in the stethoscope method. An ABI of ≤ 0.90 was considered indicative of PAD, whereas an ABI of >0.90 was classified as normal. Participants with ABI values >1.40 , suggestive of arterial calcification or vessel stiffening, were excluded from data analysis and referred for further evaluation and management.

Results

A total of 200 patients in a private outpatient clinic participated in the study. Table 1 summarizes the demographic and clinical characteristics of the study participants.

The mean age of the participants was 56.4 ± 8.2 years. Females comprised the majority of the study population (60.5%), while males accounted for 39.5%. Among the participants, 40.5% reported symptoms suggestive of PAD, whereas 59.5% were asymptomatic. Lower extremity pain (55.6%) and cramping (49.4%) were the most commonly reported symptoms. Mean

brachial systolic blood pressure values were higher than mean ankle systolic blood pressure values using both the stethoscope and Doppler methods.

Table 2 shows the number of participants identified to have PAD using ABI determination by the stethoscope and Doppler methods.

The number of true-positive cases was 60, while true-negative cases totaled 129. The prevalence of PAD identified using the stethoscope method was 30.5% (61/200), whereas the prevalence identified using the Doppler method was 35% (70/200). The stethoscope method identified slightly fewer PAD cases compared with the Doppler method.

Table 3 presents the mean ABI values obtained using the stethoscope and Doppler methods, including Cohen's kappa coefficients and p-values for agreement analysis among the overall study population and stratified according to sex and symptom status.

The mean ABI values obtained using the two methods were comparable across all groups. Overall mean ABI values were 0.93 ± 0.08 using the stethoscope and 0.94 ± 0.08 using Doppler. Participants without PAD symptoms demonstrated ABI values within the

Table 1. Demographic and clinical characteristics of participants (n=200).

Variable	Count	Percent
Age (mean $\pm$ SD)	56.4 ± 8.2	
Sex		
Male	79	39.5
Female	121	60.5
Symptoms		
Asymptomatic	119	59.5
With symptoms	81	40.5
Lower extremity pain	45	55.6
Cramping	40	49.4
Discoloration	32	39.5
Hair Loss	11	13.6
Non-Healing Sore	11	13.6
Stethoscope Systolic Blood Pressure		
Brachial (mean $\pm$ SD)	125.6 ± 11.3	
Ankle (mean $\pm$ SD)	115.7 ± 6.8	
Doppler Systolic Blood Pressure		
Brachial (mean $\pm$ SD)	126.8 ± 13.0	
Ankle (mean $\pm$ SD)	118.0 ± 7.6	

Table 2. Comparison of ABI determination using the stethoscope with ABI determination using the Doppler method.

ABI Determination through the Stethoscope	ABI Determination Using the Doppler Method		TOTAL
	(+) PAD	(-) PAD	
(+) PAD	60	1	61
(-) PAD	10	129	139
Total	70	130	200

normal range, whereas symptomatic participants had lower ABI values suggestive of PAD. Cohen's kappa analysis demonstrated almost perfect agreement between the two methods overall ($\kappa = 0.88$), with high agreement observed among both males and females. Agreement between the stethoscope and Doppler methods was statistically significant ($p < 0.001$). For symptom-stratified analysis, Fisher's exact test was used because the assumptions required for Chi-square testing were not met.

Table 4 presents the diagnostic accuracy of the stethoscope method compared with the Doppler method stratified according to symptom status. Overall diagnostic accuracy was 94.5%, with sensitivity of 85.7% and specificity of 99.2%. The positive predictive value (PPV) was 98.4%, while the negative predictive value (NPV) was 92.8%. Among asymptomatic participants, diagnostic accuracy was 98.3%, with high specificity and NPV. Among symptomatic participants, specificity and PPV reached 100%, indicating excellent ability of the stethoscope method to confirm PAD in symptomatic individuals.

Table 5 shows the diagnostic accuracy of the stethoscope method compared with the Doppler method in identifying an ABI of <0.90 , indicative of PAD. The stethoscope method demonstrated an overall accuracy of 94.5%. Sensitivity was 85.7%, while specificity was 99.2%. The PPV was 98.4%, and the NPV was 92.8%.

Table 6 presents the agreement analysis between ABI determination using the stethoscope and Doppler methods. The overall Cohen's kappa coefficient was 0.88, indicating strong agreement between the two methods beyond chance. Agreement between the methods was statistically significant ($p < 0.001$).

Discussion

The study cohort had a mean age of 56.4 years, representing a predominantly middle-aged to older-adult population, which is consistent with the age group at increased risk for vascular complications associated with T2DM. A substantial proportion of participants were asymptomatic, emphasizing the

Table 3. ABI as measured by the stethoscope, doppler, stratified according to sex and the presence or absence of symptoms.

Population	Mean ABI		Cohen's Kappa		
	Stethoscope	Doppler	Agreement	Kappa	p-value
Sex					
Male	0.93 $\pm$ 0.08	0.93 $\pm$ 0.08	92.41	0.8217	< 0.001
Female	0.93 $\pm$ 0.11	0.94 $\pm$ 0.08	95.87	0.9084	< 0.001
Symptoms					
Without	0.97 $\pm$ 0.07	0.98 $\pm$ 0.07	97.48	0.5587	< 0.001
With	0.86 $\pm$ 0.06	0.86 $\pm$ 0.04	90.12	0.7286	< 0.001
Total	0.93 $\pm$ 0.08	0.94 $\pm$ 0.08	94.50	0.8754	< 0.001

Table 4. Measures of diagnostic accuracy for the stethoscope method compared with the Doppler method, stratified by symptom status.

Measure	Total	Without Symptoms	With Symptoms
Accuracy	94.5 (90.4 – 97.2)	98.3 (94.1 – 99.8)	90.1 (81.5 – 95.6)
Sensitivity	85.7 (75.3 – 92.9)	75.0 (19.4 – 99.4)	87.9 (77.5 – 94.6)
Specificity	99.2 (95.8 – 99.9)	99.1 (95.2 – 99.9)	100 (78.2 – 100)
Positive Predictive Value	98.4 (89.5 – 99.8)	75.0 (28.2 – 95.8)	100 (93.84 – 100)
Negative Predictive Value	92.8 (87.9 – 95.8)	99.1 (95.4 – 99.8)	65.2 (49.5 – 78.2)

Note. Accuracy = proportion of correct classifications; Sensitivity = proportion of true positives correctly identified; Specificity = proportion of true negatives correctly identified; PPV = positive predictive value; NPV = negative predictive value.

Table 5. Diagnostic accuracy comparing the stethoscope and the Doppler in recognizing an ankle-brachial index of < 0.90

Measure of Diagnostic Accuracy	Value (%)	95% Confidence Interval (CI)
Accuracy	94.5	90.4 – 97.2
Sensitivity	85.7	75.3 – 92.9
Specificity	99.2	95.8 – 99.9
Positive Predictive Value	98.4	89.5 – 99.8
Negative Predictive Value	92.8	87.9 – 95.8

Table 6. Diagnostic accuracy measures comparing ABI determination by stethoscope and by Doppler.

Stethoscope	Doppler		Row Total	Diagnostic Measure	Value (%)
	(+) PAD	(-) PAD			
(+) PAD	60	1	61	Sensitivity	85.7
(-) PAD	10	129	139	Specificity	99.2
Total	70	130	200	Positive Predictive Value (PPV)	98.4
				Negative Predictive Value (NPV)	92.8
				Cohen's kappa	0.8754
				p-value	< 0.001

importance of PAD screening even in the absence of clinical symptoms. More than half of the participants were asymptomatic (59.5%, $n = 119$), while 40.5% ($n = 81$) reported symptoms suggestive of PAD. Among symptomatic participants, lower extremity pain (55.6%) and cramping (49.4%) were the most frequently reported manifestations, which are recognized clinical features of PAD.¹³

The sex distribution of PAD reported in previous studies has been variable. In the present study, females comprised 60.5% of the study population. This finding may reflect greater health-seeking behavior and participation in healthcare-related activities among women. One study likewise reported that the prevalence of PAD among women was similar to or higher than that observed among men.¹⁴

The prevalence of PAD detected using the stethoscope method was 30.5% (61/200), compared with 35.00% (70/200) using the Doppler method. Previous studies reported a PAD prevalence of approximately 30% among patients with T2DM, which is consistent with the findings of the present study.¹⁵

The stethoscope method demonstrated high diagnostic performance, with an overall accuracy of 94.5%. Sensitivity was 85.7%, indicating good ability to correctly identify patients with PAD, while

specificity was 99.2%, demonstrating strong ability to correctly classify patients without disease. The high specificity observed suggests that ABI determination using a stethoscope may be a useful screening approach for PAD, particularly in primary care and resource-limited settings.

Predictive value analysis further supported the diagnostic utility of the stethoscope method. The positive predictive value was 98.4%, indicating that most participants identified as positive using the stethoscope method were likewise positive using the Doppler method. The negative predictive value was 92.8%, indicating strong ability of the method to identify individuals without PAD.

Stratified analysis according to symptom status demonstrated similarly favorable diagnostic performance. Among asymptomatic participants, the stethoscope method demonstrated high accuracy and negative predictive value, suggesting good screening capability in patients without overt symptoms. Among symptomatic participants, specificity and positive predictive value were notably high, indicating strong confirmatory value among clinically suspected cases. Agreement analysis further demonstrated strong concordance between the stethoscope and Doppler methods. The overall Cohen's kappa coefficient was 0.88, indicating almost perfect agreement beyond

chance. Values greater than 0.80 are generally interpreted as excellent agreement. Agreement between the two methods was statistically significant ($p < 0.001$), supporting the reliability of the stethoscope method in ABI determination.

Taken together, these findings suggest that stethoscope-based ABI determination may serve as a clinically useful and accessible screening tool for PAD among patients with T2DM. Early identification of PAD in primary care settings may facilitate timely intervention and potentially reduce complications such as cardiovascular events, lower extremity amputation, and mortality. Given its low cost, portability, and non-invasive nature, the stethoscope method may be particularly valuable in geographically isolated and resource-limited settings where Doppler devices are not readily available.¹⁶

However, several limitations of the stethoscope method should be acknowledged. Low-flow states and weak arterial signals may result in false-negative findings. Reduced peripheral perfusion, arterial calcification, and examiner-related variability in auscultation may impair accurate detection of arterial flow return, potentially leading to falsely normal ABI values. These limitations highlight the need for careful technique and consideration of confirmatory testing in selected cases.

Overall, the study supports the potential role of stethoscope-based ABI determination as a practical screening and triaging tool for PAD among patients with T2DM. Although Doppler ultrasound remains the preferred reference standard, the stethoscope method demonstrated strong diagnostic performance and may provide a feasible alternative in settings where Doppler assessment is not readily accessible.

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Factors Associated with Preference for Online Learning Modality Among Medical Students of a Private Medical School in Quezon City, Philippines: An Analytical Cross-Sectional Study

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Abstract

Introduction The COVID-19 pandemic accelerated the adoption of alternative instructional approaches, including distance and online learning. This study aimed to determine factors associated with preference for online learning modality among medical students at a private medical school in the National Capital Region (NCR).

Methods An analytical cross-sectional study was conducted among 367 medical students using convenience sampling. Participants completed an online survey assessing preferred learning modality, general anxiety, self-efficacy, and satisfaction with online learning. Factors associated with preference for online learning were identified using logistic regression analysis.

Results Most respondents (79.3%) preferred traditional face-to-face learning, whereas 20.7% preferred online learning. Male students were more likely to prefer online learning than female students (OR = 2.19, $p = 0.003$). Married students were more likely to prefer online learning than unmarried students (OR = 9.71, $p = 0.021$). Students who reported greater satisfaction with their online learning experience were more likely to prefer online learning (OR = 2.28, $p = 0.024$). Self-efficacy demonstrated a borderline association with preference for online learning (OR = 0.42, $p = 0.053$).

Conclusion Sex, civil status, and satisfaction with online learning were significantly associated with preference for online learning modality. Self-efficacy demonstrated a borderline association. Despite the increased use of online learning during the COVID-19 pandemic, most respondents continued to prefer traditional face-to-face instruction.

Key words: Education, online learning, medical students, anxiety, self-efficacy, satisfaction

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The COVID-19 pandemic significantly transformed educational systems worldwide and accelerated the adoption of distance and online learning modalities. Although face-to-face instruction has largely resumed, many educational institutions continue to incorporate online learning because of its flexibility, accessibility, and operational efficiency. A national survey involving 3,813 medical students in the Philippines identified major barriers to online learning, including difficulty adapting learning styles to the new modality, increased household responsibilities, and poor communication or unclear instructions from educators.¹ Additional concerns included limited access to reliable internet connectivity, inadequate learning spaces, lockdown-related restrictions, and sociopolitical issues.¹ Another study reported that students who transitioned from traditional face-to-face instruction to online learning experienced negative emotions such as fear, anger, and helplessness.² Reduced social interaction in online environments was also associated with diminished well-being and increased anxiety among students, while educators encountered challenges in developing effective teaching strategies and adapting course delivery to the online learning environment.²

In 2022, the Commission on Higher Education (CHED) issued Commission Memorandum Order No. 9, which provided guidelines for the resumption of face-to-face classes in higher education institutions (HEIs). The policy allows HEIs, including state and local universities and colleges, to determine the most appropriate learning modality for their respective contexts while ensuring continuity and quality of education.³ Consequently, many institutions have adopted flexible approaches that integrate face-to-face and online learning modalities.

Recent evidence suggests that online and blended learning continue to play a substantial role in medical education even after the resumption of face-to-face classes. A multinational study involving medical students from 15 institutions across seven countries found that blended learning was the most preferred modality because of its flexibility, convenience, reduced travel time, and ability to accommodate diverse learning needs.⁴ However, students also reported persistent challenges, including internet connectivity issues and concerns regarding the adequacy of online learning for clinical skills acquisition and direct patient interaction.⁴ Similarly, studies conducted in higher education settings have shown that students' learning modality preferences are

influenced by perceived educational quality, logistical considerations, prior experiences with online learning, and overall well-being.⁴ These findings highlight the continued relevance of understanding learning modality preferences in the post-pandemic educational environment.

Despite the widespread implementation of blended and flexible learning approaches, students may differ in their preferred learning modality because of factors such as socio-demographic characteristics, anxiety levels, self-efficacy, and satisfaction with online learning. While previous studies have explored the benefits and challenges associated with online learning, limited evidence is available regarding the factors that influence learning modality preferences among medical students, particularly in the post-pandemic educational environment. This study aimed to determine the preferred learning modality among medical students and identify factors associated with preference for online learning.

Methods

The study was approved by the University's ethics review committee. An analytical cross-sectional study was conducted among 367 medical students enrolled in a private medical school during Academic Year 2023–2024. Eligible participants were: (1) 18–34 years of age, (2) enrolled as regular second- or third-year medical students, and (3) had at least one year of online learning experience. Students without prior face-to-face medical learning experience were excluded. For the purposes of this study, online learning included fully online, blended, and hybrid learning modalities.

Participants were recruited through convenience sampling. The sample size was calculated using estimates derived from two previous studies.^{6,7} Calculations were based on formulas for estimating population proportions, testing differences between group means (age, self-efficacy, and satisfaction), and testing differences between group proportions (year level). A significance level of 5%, a precision level of 0.05 for estimation, and a statistical power of 80% were used.

Data were collected over a two-month period through an online survey disseminated via social media platforms, including Facebook, X (formerly Twitter), and Instagram. The survey consisted of an informed consent form, a socio-demographic questionnaire, and

instruments assessing learning modality preference, anxiety, self-efficacy, and satisfaction with online learning.

The study instruments were pilot tested prior to data collection. Evidence supporting their validity and reliability has been established in previous studies. The Generalized Anxiety Disorder-7 (GAD-7) demonstrated excellent internal consistency (Cronbach's $\alpha = 0.92$). The Online Learning Self-Efficacy Scale (OLSES) showed good internal consistency, with Cronbach's α values of 0.890, 0.855, and 0.843 for the learning, time management, and technology subscales, respectively. Satisfaction with online learning was assessed using the Student Critique of Online Course Survey. Participants were asked to rate their overall satisfaction with their online learning experience on a 5-point Likert scale ranging from 1 ("not at all satisfied") to 5 ("extremely satisfied").⁷

Anxiety was measured using the Generalized Anxiety Disorder-7 (GAD-7), a validated 7-item instrument rated on a 4-point Likert scale ranging from 0 ("not at all") to 3 ("nearly every day"). Total scores range from 0 to 21 and are classified as minimal (0–4), mild (5–9), moderate (10–14), or severe (15–21) anxiety.⁸

Data were processed and analyzed using Microsoft Excel (version 16, 2022) and IBM SPSS Statistics version 24. Categorical variables were summarized as frequencies and percentages. Associations between demographic characteristics, anxiety level, self-efficacy, satisfaction with online learning, and preference for online blended learning were assessed using the chi-square test or Fisher's exact test, as appropriate. Variables identified as potential predictors were entered into a multivariable logistic regression model, and backward elimination was used to determine factors independently associated with preference for online blended learning. Crude and adjusted odds ratios (ORs) with corresponding 95% confidence intervals (CIs) were calculated. Statistical significance was set at $p < 0.05$.

Permission to use the study instruments was obtained via email from their respective developers: Spitzer, Kroenke, Williams, and Löwe for the Generalized Anxiety Disorder-7 (GAD-7) scale; Zimmerman and Kulikowich for the Online Learning Self-Efficacy Scale (OLSES); and Artino for the Student Critique of Online Course Survey used to assess satisfaction with online learning.

Results

There were 367 respondents; 61.6% were females, and 38.4% were males. Majority (91%) were less than 30 years old. Forty-five percent were enrolled as second year medical students, and 54.8% were enrolled as third year medical students. A significant proportion (98.6%) were unmarried. Most respondents (79.3%) preferred face-to-face learning compared to 20.7% who chose online as their preferred learning modality (Table 1).

Table 1. Profile of the respondents.

Demographic factors	No. (%)
Sex	
Male	141 (38.4)
Female	226 (61.6)
Age group	
< 30 years old	334 (91.0)
≥ 30 years old	33 (9.0)
Year level	
Second	166 (45.2)
Third	201 (54.8)
Civil status	
Married	5 (1.4)
Unmarried	362 (98.6)
Preferred learning modality	
Face-to-face	76 (79.3)
Online	29 (20.7)

A significant number (74.1%) had minimal to mild anxiety levels. Severe anxiety was reported among 35 (9.5%) respondents. More than half (61.3%) had very low self-efficacy and only 11 (3.0%) had very high self-efficacy. On satisfaction for online learning, 271 (73.8%) were "somewhat" to "quite satisfied" with their current online learning experience. Thirteen (3.5%) respondents were not at all satisfied (Table 2).

More females (84.1%) than males (71.6%) preferred face-to-face learning than online. This was also the preferred learning modality for all age groups and year levels. However, among the married respondents, online was the preferred learning modality. Face-to-face learning was the preferred learning modality regardless of anxiety level and degree of self-efficacy. Whether or not the respondent was satisfied with online learning, face to face learning

Table 2. Anxiety, self-efficacy, and satisfaction levels of the respondents.

Anxiety Level	No. (%)
Minimal	126(34.3)
Mild	146(39.8)
Moderate	60(16.4)
Severe	35 (9.5)
Self-Efficacy	
Very low	225(61.3)
Low	82(22.3)
Medium	37(10.1)
High	12 (3.3)
Very high	11 (3.0)
Satisfaction for Online Learning	
Not at all satisfied	13 (3.5)
Slightly satisfied	77(21.0)
Somewhat satisfied	152(41.4)
Quite satisfied	119(32.4)
Extremely satisfied	6 (1.6)

was still preferred. On crude analysis, sex ($p=0.004$) and level of satisfaction ($p=0.022$) were significantly associated with preference for online learning (Table 3).

In the final logistic regression model, male sex (AOR = 2.19, $p = 0.003$), married status (AOR = 9.71, $p = 0.021$), and greater satisfaction with online learning (AOR = 2.28, $p = 0.024$) were significantly associated with preference for online learning. Higher self-efficacy showed a borderline association with a lower likelihood of preferring online learning (AOR = 0.42, $p = 0.053$) (Table 4).

Discussion

The findings of the present study showed that the majority of medical students preferred face-to-face learning over online learning. Among the sociodemographic factors examined, sex and civil

Table 3. Crude association between demographic factors, anxiety level, self-efficacy, and satisfaction on one's preference for online medical learning modality.

Factors	Preference for online learning No. (%)	Preference for face-to-face learning No. (%)	Total	p-value*
Sex				0.004
Male	40 (28.4)	101 (71.6)	141	
Female	36 (15.9)	190 (84.1)	226	
Age Group				0.539
< 30 years old	71 (21.3)	263 (78.7)	334	
≥ 30 years old	5 (15.2)	28 (84.4)	33	
Year Level				0.605
Second	32 (19.3)	134 (80.7)	166	
Third	44 (21.9)	157 (78.1)	201	
Civil Status				0.062†
Married	3 (60.0)	2 (40.0)	5	
Unmarried	73 (20.2)	289 (79.8)	362	
Anxiety Level				0.623
Minimal to Mild	58 (21.3)	214 (78.7)	272	
Moderate to Severe	18 (18.9)	77 (81.1)	95	
Self- Efficacy				0.059
Very low to Low	69 (22.5)	238 (77.5)	307	
Medium to Very high	7 (11.7)	53 (88.3)	60	
Satisfaction for online learning				0.022
Not at all satisfied to Slightly satisfied	11 (12.2)	79 (87.8)	90	
Somewhat to Quite to Extremely satisfied	65 (23.5)	212 (76.5)	277	

*Chi square test

†Fisher's exact test

Table 4. Final logistic regression on factors associated with preference for online medical learning modality.

Factors	β coefficient	Prevalence ratio (95% CI)	p-value
Sex	0.78	2.19 (1.30, 3.69)	0.003
Civil Status	2.27	9.71 (1.42, 66.61)	0.021
Self-efficacy	-0.86	0.42 (0.18, 1.01)	0.053
Satisfaction for online learning	0.82	2.28 (1.12, 4.65)	0.024

status were significantly associated with preference for online learning modality. These findings are consistent with previous reports indicating that medical students generally favor face-to-face and blended learning over fully online instruction.⁹ Nevertheless, online learning was perceived as an appropriate modality for delivering theoretical content and selected clinically-oriented activities, such as case discussions and history-taking exercises, although it was not considered a substitute for face-to-face learning.⁹

The preference for face-to-face learning has been attributed to challenges encountered during online learning, including difficulties during online examinations, technical issues, and limited opportunities for interaction. Consistent with the present findings, a pre-pandemic study reported that the absence of fixed schedules and reduced external pressure were among the reasons medical students did not favor online learning.¹⁰ Similarly, a study conducted during the COVID-19 pandemic found that approximately half of the students preferred face-to-face learning over online or blended modalities. Students also perceived face-to-face instruction to be substantially more effective than online learning for teaching clinical skills (89% vs. 18%) and developing social competencies (67% vs. 27%).¹¹

A previous study reported that most married respondents preferred online learning because its flexibility allowed them to balance academic responsibilities with household and family obligations.¹² This finding may partly explain the observed preference for online learning among married students in the present study. However, the number of married respondents was small, and the resulting estimate should be interpreted with caution. Furthermore, evidence regarding the influence of marital status on online learning remains limited. A study conducted in Malaysia found insufficient evidence to establish an association between marital status and the effectiveness of online learning.¹³ Differences between the present findings and previous reports may be attributable to

variations in study populations, educational settings, and contextual factors.

Numerous studies have explored the impact of gender on online learning outcomes.^{14,15} Males generally had a more positive attitude than females on technology and its usefulness and self-efficacy (e.g., self-confidence in one's ability to learn and use technology effectively). The results of this study suggested that women generally were less inclined in using technology than males.

Most participants (74.1%) had minimal to mild anxiety but there was no significant association found with preference for online learning. A study conducted in Romania found students who were accustomed to face-to-face learning and were subsequently enrolled in an online platform developed high levels of negative emotions such as fear, anger, or helplessness.² The implementation of online classes also limited students' social interactions with each other, contributing to the negative emotions and reduced well-being of students. Moreover, online classes had a negative impact on students as they experienced anxiety and panic while using online platforms for learning. Overall, females reported higher levels of anxiety in GAD-7, before and after online learning. Medical students reported higher levels of anxiety before online learning compared to non-medical students. Hence, there was no association between anxiety and an online learning setup.¹⁶

The current study also showed that the majority of the respondents preferred face-to-face learning but were also satisfied with their online learning experience. This may be counterintuitive if one assumes that satisfaction for online learning would also skew the results towards online learning. In a study done in a university in Saudi Arabia, only 30% of the student sample were satisfied with online learning.¹⁷ More importantly, high-achieving students with GPA higher than 3.5 were less satisfied. In conclusion, the level of satisfaction for online courses during the COVID-19 pandemic was low, especially among high-achieving students. However, both students and faculty favored

the blended format over a face-to-face setup for future purposes.

Several pre-pandemic studies showed online learning provided many positive learning experiences for online learners and learners were more satisfied with online learning than traditional face-to-face learning.^{18,19} However, some studies showed online learning was not as satisfying as face-to-face learning and that online learners had poorer engagement with online learning.²⁰ Satisfaction with online learning may not necessarily translate to a preference for a learning modality. It is possible that at the specific point in time when the respondents answered the survey, they were satisfied with online learning. But since the one-item question on preference was worded in a way that considered the future, the preference for face-to-face was stronger.

The majority of the medical students surveyed demonstrated very low self-efficacy for online learning. While higher self-efficacy tended to be associated with a lower preference for online learning, the association did not reach statistical significance. Similar findings have been reported in previous studies, in which students generally perceived face-to-face learning to be more effective than online learning for knowledge acquisition.¹¹

Limitations

The study sample was composed of medical students from a single medical school and may not be representative of the broader population of medical students. Consequently, the generalizability of the findings is limited. In addition, the use of convenience sampling may have introduced selection bias. Satisfaction with online learning was assessed using a single-item question derived from the Student Critique of the Online Course Survey, which did not allow for a comprehensive evaluation of the factors influencing student satisfaction. Other determinants of satisfaction, such as perceived ease of use, perceived usefulness, and learner engagement, were not explored.²¹ Similar limitations were present in the assessment of preference for online learning, which was likewise measured using a single-item question, although previous studies have employed similar approaches.^{22,23} Furthermore, the GAD-7 assessed

generalized anxiety symptoms and did not specifically evaluate anxiety related to the online learning environment, thereby limiting the interpretation of anxiety in relation to learning modality preference.

Conclusions

The majority of the surveyed medical students preferred face-to-face learning over online learning. Sex, civil status, and satisfaction with online learning were significantly associated with preference for online learning modality. Male students were more likely than female students to prefer online learning. Although anxiety levels were assessed, no significant association was observed between anxiety and learning modality preference. Notably, many students reported satisfaction with online learning despite expressing a preference for face-to-face instruction.

Recommendations

Future studies should employ probability-based sampling techniques and include participants from multiple medical schools to improve the representativeness and generalizability of the findings. The use of multidimensional and validated instruments to assess preference for online learning and satisfaction with online learning is also recommended to provide a more comprehensive understanding of these constructs. Additionally, future research should consider utilizing instruments that specifically measure anxiety related to online learning environments rather than generalized anxiety symptoms. Further investigation of the individual domains of online learning self-efficacy, including learning, technology use, and time management, may provide deeper insights into their relationship with learning modality preferences.

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COVID-19 Vaccine Literacy, Confidence, and Vaccination Coverage in Two Geographically Isolated and Disadvantaged Areas (GIDAs) in Floridablanca, Pampanga: A Descriptive Cross-Sectional Study

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Abstract

Introduction Effective vaccination campaigns have been instrumental in reducing COVID-19 transmission and severe disease outcomes. Despite efforts to improve vaccine accessibility, vaccine literacy and confidence remain important determinants of vaccine uptake. Rural and geographically isolated communities often experience barriers to healthcare access that may affect vaccination coverage. This study aimed to assess COVID-19 vaccination coverage, vaccine literacy, and vaccine confidence among residents of selected Geographically Isolated and Disadvantaged Areas (GIDAs) in Floridablanca, Pampanga.

Methods A descriptive cross-sectional study was conducted among 211 residents of Barangays San Ramon and Nabuclod. Data were collected through face-to-face interviews using a translated and pretested questionnaire on vaccine literacy and vaccine confidence. Vaccination records obtained from the Rural Health Unit were reviewed to determine COVID-19 vaccination coverage. Descriptive statistics, including frequencies and percentages, were used to summarize the data.

Results The majority of respondents demonstrated an average level of vaccine literacy (75.8%), while 17.5% exhibited high vaccine literacy. Most respondents also demonstrated positive to very positive vaccine confidence (71.6%). Among the eligible population, 80.5% had completed the primary COVID-19 vaccination series, whereas 19.5% remained unvaccinated. Among those who completed the primary series, only 24.2% had received at least one booster dose.

Conclusion Residents of the selected GIDAs generally demonstrated average vaccine literacy, positive vaccine confidence, and relatively high primary COVID-19 vaccination coverage. However, low booster uptake and the persistence of unvaccinated individuals highlight the need for sustained health education, improved healthcare accessibility, and targeted community-based interventions. These findings underscore the importance of strengthening vaccine literacy and confidence to support future immunization programs in geographically isolated communities.

Key words: COVID-19, geographically isolated and disadvantaged areas, rural health, vaccination coverage, vaccine confidence, vaccine literacy

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The coronavirus disease 2019 (COVID-19) pandemic, caused by the novel coronavirus SARS-CoV-2, posed unprecedented challenges to healthcare systems worldwide. Although vaccination remains one of the most effective strategies for controlling the spread of COVID-19, vaccine hesitancy continues to hinder public health efforts.¹ A study among Filipino emerging adults reported that 61% expressed hesitancy toward receiving a COVID-19 vaccine.² Studies in other settings have also shown that predictors of vaccine hesitancy may be more prevalent in rural areas than in urban communities, potentially resulting in lower vaccine uptake in geographically isolated populations.³ Despite the well-documented benefits of vaccination in preventing infectious diseases, Geographically Isolated and Disadvantaged Areas (GIDAs) in the Philippines continue to experience suboptimal vaccination coverage. However, studies examining the factors that influence vaccine literacy, confidence, and uptake in these communities remain limited. Consequently, understanding COVID-19 vaccine literacy and hesitancy in GIDAs remains a critical public health concern that warrants further investigation.

Although the acute phase of the COVID-19 pandemic has passed, understanding the factors that influence vaccine literacy, confidence, and uptake remains highly relevant. Vaccine confidence has emerged as a critical determinant of acceptance not only of COVID-19 vaccines but also of routine immunizations and future outbreak-response vaccines. Geographically Isolated and Disadvantaged Areas (GIDAs) continue to face unique barriers to healthcare access, health information dissemination, and preventive service delivery. Examining vaccine literacy and confidence in these communities provides valuable insights for strengthening health system resilience, improving adult immunization programs, addressing misinformation, and enhancing preparedness for future infectious disease emergencies.

Effective vaccination campaigns have played a vital role in reducing COVID-19-related morbidity and mortality, while also mitigating disease transmission.¹ This is particularly significant in disadvantaged and hard-to-reach communities in the Philippines. Floridablanca, a first-class municipality in Pampanga, is located along the Zambales mountain ranges and is composed of 33 barangays, three of which are classified as GIDAs. As of 2020, the municipality had a population of 135,542 residents,⁴ including

communities situated in remote and underserved areas. In response to the pandemic, the Municipal Health Office of Floridablanca implemented phased vaccination campaigns, beginning with priority groups and eventually extending to the general population.⁵ In this context, assessing vaccine literacy and vaccine confidence is essential in evaluating the effectiveness and acceptance of these public health initiatives.

By determining the sociodemographic profile, vaccination coverage, vaccine literacy, and vaccine confidence among residents of selected barangays, this study aims to provide valuable insights for healthcare professionals, epidemiologists, and policymakers in designing future vaccination programs tailored to the unique needs of GIDAs.

Methods

After obtaining Ethics Review Committee approval (ERC Code: 1716/C/2024/083), a descriptive cross-sectional research design was conducted to look into the sociodemographic characteristics, vaccine literacy and confidence.

This study was conducted in Barangays Nabuclod and San Ramon in Floridablanca, Pampanga, categorized as GIDAs by the Department of Health (DOH) based on DOH-Administrative Order No. 2020-0023.⁷ GIDAs are physically and socioeconomically marginalized communities with limited access to healthcare and basic services due to geographic isolation, transportation barriers, poverty, and vulnerability to crises and armed conflict.⁷

Household members aged 18 years and above, permanently residing for more than a year in any of these barangays were invited to participate in the interview-guided survey. The minimum computed sample size was 169 based on an anticipated vaccination rate of 86% and 5% margin error.⁶ A total of 211 individuals participated in the survey.

The primary data collection instrument was a three-part questionnaire adapted from a previously validated instrument.⁶ The first section collected respondents' sociodemographic characteristics. The second section assessed vaccine literacy using an 8-item questionnaire on COVID-19 vaccines and vaccination, with response options of "Correct," "Incorrect," or "I do not know." Scores ranging from 21 to 24 were classified as high vaccine literacy, 15 to 20 as average vaccine literacy, and ≤ 14 as low or no vaccine literacy.

The third section assessed vaccine confidence using a 12-item, 5-point Likert scale with response options ranging from “Strongly Agree” to “Strongly Disagree.” Total scores of 52 to 60 were classified as very positive, 42 to 51 as positive, 32 to 41 as neutral, 22 to 31 as unfavorable, and ≤ 21 as very unfavorable attitudes toward vaccination. To determine COVID-19 vaccination coverage, data were extracted from Rural Health Unit (RHU) records using a standardized abstraction form. The abstraction form captured information on the number of vaccine doses administered, categorized by vaccine brand and type of dose (primary series and booster doses). Summary data on the number of partially vaccinated individuals, fully vaccinated individuals, and those who received one or more booster doses were also obtained.

With permission from the original authors, the questionnaire was translated from English into Kapampangan and subsequently back-translated into English by bilingual individuals fluent in both languages. Discrepancies between the original and back-translated versions were reviewed and resolved by the research team.

A cognitive interview using the think-aloud technique was conducted among 10 residents of Sitio Camachili, Nabuclod to assess comprehension and clarity of the questionnaire items. Feedback obtained was used to refine selected items.

The translated questionnaire underwent expert review by a panel consisting of Rural Health Unit personnel and faculty members from the Department of Preventive and Community Medicine. No major modifications were required following the review.

Pretesting was conducted among 30 residents of Sitio Camachili, Nabuclod. The questionnaire demonstrated acceptable internal consistency reliability, with a Cronbach’s alpha of 0.71.

The data was collected face to face through a house-to-house approach accompanied by a Barangay Health Worker (BHW).

The data were entered and analyzed using Microsoft Excel software. Descriptive statistics, such as counts and proportions were utilized to summarize the data. Frequency tables were generated to show distribution of the respondents according to vaccine literacy, confidence, and coverage.

Results

A total of 211 respondents participated in the study, of whom 74.9% were female and 25.1% were male.

Nearly half (49.3%) were aged 18–34 years, while 15.2% were aged 60 years and older. The majority were married (58.8%). Approximately one-third (31.8%) had attained some primary education, whereas only 8.5% had completed primary education. Furthermore, only 10.4% had education beyond the secondary level. More than half of the respondents (51.2%) belonged to households comprising four to six members (Table 1). Responses to the vaccine literacy questionnaire indicated that most participants correctly answered several items related to COVID-19 vaccines and vaccination. Specifically, 65.9% correctly identified the statement “Vaccines can harm the immune system” as incorrect. Likewise, 86.7% correctly recognized that COVID-19 vaccines help the body develop immunity against the virus without causing the disease. In addition, 61.6% were aware that some COVID-19 vaccines require more than one dose (Table 2).

In some items, the combined number of respondents who expressed uncertainty and who answered incorrectly was nearly the same as the number of respondents who responded correctly. For instance, although more than half (52.6%) of the participants understood that immunity does not develop immediately post-vaccination and that there is a window of vulnerability, 47.4% were either unsure or thought it wrong. Similarly, 46.5% were either uncertain or thought it incorrect that there is no full protection if it is just less than two weeks from a shot or if there is a need for a second shot. In addition, 38.4% were uncertain about the single-dose requirement and the need to wait for two weeks before being considered fully vaccinated with Janssen COVID-19 vaccine (Johnson & Johnson). For Pfizer-BioNTech and Moderna COVID-19 vaccines, 48.3% were unsure of the two-dose requirement of these vaccines, and the need to wait for two weeks after the second shot before being considered fully vaccinated (Table 2).

Majority of the respondents (75.8%), demonstrated an average score (15 to 20) on literacy concerning COVID-19 vaccines and vaccinations. This was followed by those with a high score (21 to 24) (17.5%) and those with a low score (≤ 14) (6.6%) (Table 3).

A large proportion of respondents (89.1%) agreed that maintaining high vaccination coverage is essential to prevent the emergence of new COVID-19 cases. Additionally, 84.4% maintained that educating parents on the importance of vaccines is a crucial strategy for improving vaccination coverage, and an even higher

Table 1. Sociodemographic profile of respondents.

Characteristics	Frequency (%) n= 211
Gender	
Male	53 (25.1)
Female	158 (74.9)
Age groups (in years)	
18 - 24	42 (19.9)
25 - 29	31 (14.7)
30 - 34	31 (14.7)
35 - 39	11 (5.2)
40 - 44	17 (8.1)
45 - 49	20 (9.5)
50 - 54	14 (6.6)
55 - 59	10 (4.7)
60 and above	32 (15.2)
Unrecalled	3 (1.4)
Civil Status	
Single	72 (34.1)
Married	124 (58.8)
Separated	4 (1.9)
Widow/er	11 (5.2)
Highest Educational Attainment	
No Schooling	37 (17.5)
Some Primary	67 (31.8)
Completed Primary	18 (8.5)
Some Secondary	39 (18.5)
Completed Secondary	28 (13.3)
More Than Secondary	22 (10.4)
No. of Household Members	
1 - 3	55 (26.1)
4 - 6	108 (51.2)
7 - 9	37 (17.5)
10 - 12	11 (5.2)

Table 2. Vaccine literacy towards COVID-19 vaccination per question item.

Items	Frequency (%)		
	Correct	Don't Know	Incorrect
Vaccines are 100% effective	178 (84.4)	22 (10.4)	11 (5.2)
Vaccines can harm the immune system	41 (19.4)	31 (14.7)	139 (65.9)
COVID-19 vaccines help our bodies develop immunity to the virus that causes COVID-19 without us having to get the illness	183 (86.7)	13 (6.2)	15 (7.1)
It is possible that a person could be infected with the virus that causes COVID-19 just before or just after vaccination and then get sick because the vaccine did not have enough time to provide protection	111 (52.6)	60 (28.4)	40 (19.0)
Some COVID-19 vaccines require more than one shot	130 (61.6)	45 (21.3)	36 (17.1)
Pfizer-BioNTech and Moderna COVID-19 vaccines require two shots and you are considered fully vaccinated two weeks after your second shot.	92 (43.6)	102 (48.3)	17 (8.1)
Janssen COVID-19 vaccine only requires one shot and you are considered fully vaccinated two weeks after your shot	118 (55.9)	81 (38.4)	12 (5.7)
If it has been less than two weeks since your shot, or if you still need to get your second shot, you are NOT fully protected	113 (53.6)	55 (26.1)	43 (20.4)

Table 3. Overall vaccine literacy towards COVID-19 vaccination.

Level	Frequency (%) n=211
Low (≤ 14)	14 (6.6)
Average (15 - 20)	160 (75.8)
High (21 - 24)	37 (17.5)

percentage (91.5%) saw a key role for doctors in communicating vaccine importance to parents.

Conversely, there was substantial disagreement with statements that expressed vaccine hesitancy. For instance, 64.9% of respondents disagreed that COVID-19 would naturally disappear without vaccination. Moreover, 69.2% believed that it is safer to avoid vaccination despite the risk of COVID-19. On government mandates, a significant portion (72.5%) supported the right of individuals to decide on vaccination rather than government imposition, although 85.8% still expressed support for the

government's COVID-19 vaccination program. In terms of personal willingness, 71.6% of respondents reported that they would willingly get vaccinated if a COVID-19 vaccine was available.

Items reflective of uncertainty or unfavorable attitude towards vaccination were those concerning vaccine safety and trustworthiness. Specifically, 50.7% of the respondents indicated that the side effects of the vaccine have caused them to question vaccine safety. An equal proportion of respondents (50.7%) believed that there is not enough evidence to prove that immunization effectively prevents infectious diseases. Forty-six per cent (46.4%) argued that pharmaceutical companies promote vaccination for profit despite them being aware of its harmful effects. Finally, 45.9% of respondents thought that vaccines contain substances that have been proven harmful especially to children and senior citizens (Table 4).

Overall, majority had a positive attitude towards COVID-19 vaccination (55.9%), followed by those having a neutral attitude (25.6%) and those with a very positive attitude (15.6%) (Table 5).

All individuals aged 5 to >60 years old in Barangay San Ramon have completed their primary doses of COVID-19 vaccines. However, none of those in the 5 to 11-year-old age group received any booster dose. Only 2.2% (5 out of 225) among those aged 12 to 17

years have received a booster dose. Thirty-two per cent of the 18- to 59-year-olds have received at least one booster dose and 14.0% have received two booster doses. Among those aged 60 years and above, 43% have received at least one booster dose and 7.6% have received two booster doses (Table 6).

Table 4. Vaccine confidence towards COVID-19 vaccination.

Items	Frequency (%)				
	SA	A	N	D	SD
Sometimes after vaccination, the process of building immunity can cause symptoms, such as fever, which have led me to doubt vaccination as a safe method.	51 (24.2)	56 (26.5)	19 (9.0)	39 (18.5)	46 (21.8)
It is important to keep vaccination coverage of the population in order to avoid the emergence of new COVID cases.	101 (47.9)	87 (41.2)	10 (4.7)	8 (3.8)	5 (2.4)
Educating parents about vaccines is an important way to connect vaccination coverage of the population	110 (52.1)	68 (32.2)	12 (5.7)	15 (7.1)	6 (2.8)
The doctor has an important role in, educating parents about the importance of vaccination	119 (56.4)	74 (35.1)	4 (1.9)	7 (3.3)	7 (3.3)
It is not necessary to vaccinate people because coronavirus will be gone naturally.	20 (9.5)	23 (10.9)	31 (14.7)	84 (39.8)	53 (25.1)
Vaccines contain substances that have been proven harmful especially to children and senior citizens.	23 (10.9)	33 (15.6)	41 (19.4)	75 (35.5)	39 (18.5)
It is a safer choice to stay idle with the COVID-19 disease than to be vaccinated against it.	16 (7.6)	27 (12.8)	22 (10.4)	68 (32.2)	78 (37.0)
The government has no right to impose the obligation of vaccination, but everybody should be the ones who bring the decision	77 (36.5)	76 (36.0)	14 (6.6)	34 (16.1)	10 (4.7)
There is not enough evidence that immunization prevents the occurrence of infectious disease	27 (12.8)	53 (25.1)	27 (12.8)	68 (32.2)	36 (17.1)
Pharmaceutical companies promote vaccination for profit, although they are aware that it is harmful	18 (8.5)	33 (15.6)	47 (22.3)	63 (29.9)	50 (23.7)
I support the vaccination program of the government	99 (46.9)	82 (38.9)	16 (7.6)	6 (2.8)	8 (3.8)
If a coronavirus vaccine is available, I would definitely be vaccinated.	98 (46.4)	53 (25.1)	22 (10.4)	22 (10.4)	16 (7.6)

Table 5. Overall vaccine confidence towards COVID-19 vaccination.

Attitude Category	Frequency (%) n=211
Very Unfavorable Attitude (≤ 21)	1 (0.5)
Unfavorable Attitude (22 - 31)	5 (2.4)
Neutral Attitude (32 - 41)	54 (25.6)
Positive Attitude (42 - 51)	118 (55.9)
Very Positive Attitude (52 - 60)	33 (15.6)

Table 6. Administered vaccines per brand in Barangay San Ramon.

Age Group: 5 to 11 years old				
Vaccine Brand	1 st Primary	2 nd Primary	1 st Booster	2 nd Booster
Pfizer	182	182	-	-
Moderna	5	5	-	-
Total	187	187	-	-
Age Group: 12 to 17 years old				
Vaccine Brand	1 st Primary	2 nd Primary	1 st Booster	2 nd Booster
Pfizer	221	221	4	-
Moderna	4	4	1	-
Total	225	225	5	-
Age Group: 18 to 59 years old				
Vaccine Brand	1 st Primary	2 nd Primary	1 st Booster	2 nd Booster
Pfizer	317	317	129	63
Moderna	51	51	65	26
Johnson & Johnson	54	-	-	-
AstraZeneca	317	317	86	41
Sinovac	195	195	27	2
Others	11	11	-	-
Total	945	891	307	132
Age Group: 60 years old and above				
Vaccine Brand	1 st Primary	2 nd Primary	1 st Booster	2 nd Booster
Pfizer	27	27	32	5
Moderna	5	5	4	3
Johnson & Johnson	36	-	-	-
AstraZeneca	23	23	8	-
Sinovac	14	14	1	-
Total	105	69	45	8

Among the vaccinated individuals in Barangay San Ramon, 82.6% completed the primary doses (one dose for Janssen COVID 19 vaccine), two doses for the rest) with no additional booster dose, while 31.7% of them have received one or two booster doses on top of their primary doses (Table 7).

All individuals aged 12 to >60 years old in Barangay Nabuclod have completed their primary doses of COVID-19 vaccines. There is no data on the vaccination status for the 5 to 11-year-old age group. All fully vaccinated 12 to 17-year-olds have received a booster dose. Among those aged 18 to 59 years old, 14.7% have received at least one booster dose and 4.3% have received two booster doses. Among those aged 60 years and above, 22.2% have received at least one booster dose and 5.6% have received two booster doses (Table 8).

Among the vaccinated individuals in Barangay Nabuclod, 49.5% completed their primary doses (one dose for Janssen COVID 19 vaccine, two doses for the rest) with no additional booster dose, while 27.6% of them have received one or two booster doses on top of their primary doses (Table 9).

Out of 2922 eligible vaccinees in the two barangays, 2353 (80.5%) completed the primary vaccination series. Among those fully vaccinated, 569 (24.2%) received at least one booster dose of the applicable vaccine brands; 569 (19.5%) remained unvaccinated.

Discussion

The findings indicate generally favorable COVID-19 vaccination outcomes among residents of the selected

GIDAs. Most respondents demonstrated average to high vaccine literacy and positive vaccine confidence. In addition, 80.5% of the eligible population completed the primary COVID-19 vaccination series. Despite this relatively high coverage, booster uptake remained low, and nearly one-fifth of the eligible population remained unvaccinated. These findings suggest that while acceptance of primary COVID-19 vaccination was generally favorable, gaps in vaccine-related knowledge and persistent barriers to vaccination may continue to influence the uptake of booster doses and contribute to incomplete vaccination in these communities.

The majority of respondents (75.8%) demonstrated an average level of COVID-19 vaccine literacy, while 17.5% exhibited high vaccine literacy and only 6.6% demonstrated low vaccine literacy. This finding suggests a generally adequate level of knowledge regarding COVID-19 vaccines and vaccination among residents of the selected GIDAs. A small proportion of respondents demonstrated limited understanding of some questionnaire items, which may reflect challenges in accessing and understanding health information. Geographic and structural barriers in GIDAs, including limited transportation, inadequate healthcare services, shortages of healthcare personnel, and insufficient resources and facilities, may contribute to reduced access to accurate health information and influence health-seeking behaviors.⁷ These challenges may, in turn, affect community understanding of important health issues, including vaccination. Furthermore, GIDAs often face deficiencies in basic services and infrastructure, including education, sanitation, electricity, and healthcare facilities.^{8,9} These

Table 7. Summary of vaccination status in Barangay San Ramon.

Vaccine Brand	Partially Vaccinated Only	Fully Vaccinated Only	With Booster Doses
Pfizer	-	582	165
Moderna	-	9	70
Johnson & Johnson	-	90	-
AstraZeneca	-	246	94
Sinovac	-	181	28
Others	-	11	-
Total	-	1126	357

Table 8. Administered vaccines per brand in Barangay Nabuclod.

Age Group: 12 to 17 years old				
Vaccine Brand	1 st Primary	2 nd Primary	1 st Booster	2 nd Booster
Pfizer	19	19	81	-
Total	19	19	81	-
Age Group: 18 to 59 years old				
Vaccine Brand	1 st Primary	2 nd Primary	1 st Booster	2 nd Booster
Pfizer	3	27	49	35
Moderna	-	7	15	-
Johnson & Johnson	441	-	-	-
AstraZeneca	1	126	59	-
Sinovac	10	218	-	1
Others	6	17	-	-
Total	461	395	123	36
Age Group: 60 years old and above				
Vaccine Brand	1 st Primary	2 nd Primary	1 st Booster	2 nd Booster
Pfizer	2	2	2	2
Moderna	-	-	1	-
Johnson & Johnson	12	-	-	-
AstraZeneca	6	6	5	-
Sinovac	16	16	-	-
Total	36	24	8	2

Table 9. Summary of vaccination status in Barangay Nabuclod.

Vaccine Brand	Partially Vaccinated Only	Fully Vaccinated Only	With Booster Doses
Pfizer	-	-	132
Moderna	-	-	16
Johnson & Johnson	-	453	-
AstraZeneca	-	68	64
Sinovac	-	234	1
Others	-	17	-
Total	-	772	213

challenges contribute to poorer health outcomes and may limit access to health information and preventive healthcare services. Residents of geographically isolated communities frequently encounter financial and geographic barriers that restrict access to healthcare, including vaccination services.^{8,9} Compared with urban populations, individuals living in GIDAs generally have fewer healthcare resources available and lower utilization of health services, conditions that continue to characterize many GIDA communities in the Philippines.⁷⁻⁹

Socioeconomic challenges, including financial constraints and low levels of formal education, may contribute to limited understanding of the importance of vaccination. These factors can hinder access to and comprehension of accurate health information, increasing susceptibility to misinformation. Limited health literacy has been reported to be more prevalent among individuals with lower educational attainment, placing them at greater risk of misconceptions regarding vaccination.¹⁰ These findings highlight the importance of improving access to understandable and reliable health information in underserved communities. Strengthening community-based health education and deploying healthcare workers to provide accurate vaccine information may help promote informed health decisions and improve vaccine uptake.¹¹

The majority of respondents in the present study demonstrated an average level of vaccine literacy, in contrast to a 2022 study conducted among GIDA communities in Samar, where most respondents exhibited low vaccine literacy.⁶ This difference may reflect improvements in access to health information and vaccination-related education over time, including efforts to strengthen healthcare services in underserved communities.¹¹ Previous studies have shown that higher health literacy is associated with greater vaccine confidence.¹² Consistent with these findings, respondents in the present study generally demonstrated average vaccine literacy and positive vaccine confidence. However, the relationship between these variables was not formally examined and warrants further investigation.

A substantial proportion of respondents demonstrated a positive attitude toward COVID-19 vaccination despite concerns related to fear, anxiety, and vaccine hesitancy.¹³ This finding contrasts with a previous study conducted among GIDA residents in

Samar, where attitudes toward COVID-19 vaccination were generally neutral.⁶ The authors suggested that residents in these communities often prioritized immediate day-to-day concerns over preventive measures such as vaccination.⁶

In the present study, only a small proportion of respondents exhibited unfavorable attitudes toward COVID-19 vaccination. Some respondents expressed doubts regarding the effectiveness of vaccines in preventing infectious diseases. Concerns about vaccine safety were also evident, as more than half of the respondents reported that symptoms experienced after vaccination sometimes led them to question vaccine safety. Previous studies have shown that negative attitudes toward vaccination may be influenced by misinformation, distrust in government vaccination programs, and skepticism regarding vaccine-related policies.¹⁵ These factors may be particularly relevant in geographically isolated and underserved communities, where limited access to health information and healthcare services can affect perceptions of public health interventions.⁷

COVID-19 vaccination coverage in the two barangays was relatively high, with 80.5% of the eligible population aged 5 years and older having completed the primary vaccination series. Nevertheless, nearly one-fifth (19.5%) remained unvaccinated, and booster uptake was low, with only 24.2% of fully vaccinated individuals receiving at least one booster dose.

Current Philippine pediatric guidelines recommend COVID-19 vaccination for eligible age groups, including children aged 5–11 years, using duly approved vaccines.¹⁶ Despite the relatively high vaccination coverage observed in the present study, nearly one-fifth of the eligible population remained unvaccinated. This finding highlights the need to address persistent barriers to healthcare access and strengthen community-based strategies that promote vaccination and other preventive health services in geographically isolated communities.⁷⁻⁹

During the COVID-19 pandemic, the Philippine government implemented nationwide vaccination campaigns to achieve broad population protection and mitigate the health and socioeconomic effects of COVID-19.¹⁷ Although vaccination coverage in the study communities was relatively high, it remains uncertain whether optimal coverage was achieved. Vaccine preference, vaccine hesitancy, vaccine literacy, trust in government, and inequitable access to

vaccination services may have influenced vaccination uptake.¹⁸

Vaccination of susceptible and high-risk groups remains an important strategy for reducing severe COVID-19 outcomes and mortality.¹⁹ Vulnerable populations, including older adults and residents of geographically isolated and disadvantaged areas, should remain a priority for vaccination efforts because of the barriers they face in accessing healthcare services.

Booster doses remain an important component of vaccination programs, particularly for maintaining protection among vulnerable populations and reducing the risk of severe disease.²⁰ In the present study, only 24.2% of fully vaccinated individuals received at least one booster dose. This finding is consistent with the respondents' vaccine literacy scores, particularly regarding knowledge of vaccine dosing schedules. Approximately half of the respondents were uncertain or incorrectly believed that an individual could be fully protected without completing the recommended vaccine series. Similar views were observed during the interview-guided survey, where some participants indicated that a single vaccine dose was sufficient for protection. This misconception may have contributed to incomplete vaccination and low booster uptake. In addition, misinformation regarding COVID-19 vaccines, including beliefs that vaccination could alter an individual's DNA, has been identified as a contributor to vaccine hesitancy and incomplete vaccination.²¹

Low booster uptake has also been reported in rural communities, where booster doses are often perceived as unnecessary.^{22,23} This perception may partly explain the low booster coverage observed in the present study. Addressing misconceptions regarding the role of booster doses through targeted health education and community-based outreach initiatives may help improve vaccine acceptance and uptake in geographically isolated populations.

Among the 211 respondents, 173 were from Barangay Nabuclod and 38 were from Barangay San Ramon. Although both barangays are classified as GIDAs, respondents from Barangay Nabuclod generally had lower levels of educational attainment, with some reporting no formal education. In addition, a larger proportion belonged to indigenous communities compared with respondents from Barangay San Ramon. These sociodemographic characteristics may

have implications for health literacy, access to health information, and perceptions toward vaccination.

One limitation of the study was the potential for miscommunication arising from language differences between the researchers and respondents despite the assistance of translators. In addition, responses obtained through the interview-guided survey may have been influenced by variations in how questions were conveyed or interpreted. The accuracy of vaccination coverage estimates was also dependent on the completeness and accuracy of census and vaccination records obtained from the Rural Health Unit, which may not fully reflect actual vaccination coverage in the study communities. The cross-sectional design precludes the assessment of causal relationships between sociodemographic characteristics, vaccine literacy, vaccine confidence, and vaccination uptake.

The predominance of female respondents in this study contrasts with the larger male population reported in Pampanga.²⁴ This may be explained by the house-to-house survey approach, which favored the inclusion of individuals who were available at home during data collection. Men may have been underrepresented because many were away for work at the time of the survey.⁵

In terms of educational attainment, most respondents had completed only the early years of primary education, while some had reached the secondary level and a notable proportion had no formal education. This educational profile is consistent with the challenges faced by many GIDA communities, where geographic isolation, considerable distances to schools, and limited educational resources and personnel may hinder access to quality education.^{6,25}

Overall, residents of the selected GIDAs demonstrated average vaccine literacy, positive vaccine confidence, and relatively high primary COVID-19 vaccination coverage. However, low booster uptake and the continued presence of unvaccinated individuals highlight the need for sustained health education, improved healthcare accessibility, and targeted community-based interventions. Beyond COVID-19, these findings underscore the importance of strengthening vaccine literacy, addressing misinformation, and fostering trust in immunization programs among geographically isolated populations. Such efforts may support future vaccination initiatives and enhance preparedness

for public health emergencies in underserved communities.

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Association Between Consumption of Halal-Certified Food Groups and Sleep Quality Among Adult Filipino Muslims: An Analytical Cross-Sectional Study

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Abstract

Background Diet is an important modifiable factor that may influence sleep quality, with several foods, nutrients, and dietary patterns reported to affect sleep-related outcomes. However, evidence regarding the relationship between Halal dietary practices and sleep quality remains limited. This study aimed to determine the association between the frequency of consumption of Halal-certified food groups and sleep quality among adult Filipino Muslims.

Methods An analytical cross-sectional study was conducted among 323 adult Filipino Muslim members of the Greenhills Muslim Traders Association in San Juan City, Philippines. Participants were selected using purposive sampling based on predefined inclusion and exclusion criteria. Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI), while dietary intake was measured using a structured questionnaire on the frequency of consumption of Halal-certified food groups. Descriptive statistics were used to summarize participant characteristics, dietary patterns, and sleep quality. Multivariable logistic regression analysis was performed to determine the association between Halal-certified food group consumption and sleep quality.

Results Halal-certified grain products were the most frequently consumed food group (mean = 2.39), while Halal-certified combination foods were the least frequently consumed (mean = 1.21). The mean global PSQI score was 4.62, indicating generally good sleep quality, and 67.8% of participants were classified as good sleepers (PSQI ≤ 5). Sleep efficiency had the highest mean component score (1.16), whereas subjective sleep quality had the lowest (0.00). Multivariable logistic regression showed no significant association between the frequency of consumption of most Halal-certified food groups and sleep quality ($p > 0.05$). However, more frequent consumption of Halal-certified combination foods was significantly associated with lower odds of good sleep quality (OR = 0.697, 95% CI: 0.529–0.919, $p = 0.010$).

Conclusion The frequency of consumption of most Halal-certified food groups was not significantly associated with sleep quality among adult Filipino Muslims. However, increased consumption of Halal-certified combination foods was associated with lower odds of good sleep quality. Further studies should explore other dietary and behavioral factors that may influence sleep outcomes.

Key words: Halal diet, sleep quality, Pittsburgh Sleep Quality Index, Filipino Muslims, dietary patterns.

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Sleep is an important physiological activity required for the restoration of physical systems, facilitating brain repair and recovery, and improving general memory and learning.¹ An insufficient sleep has been associated with multiple physical and mental health risks which have resulted in weakened immunity and impaired cognitive performance.² This highlights the need to identify the modifiable lifestyle factors that may influence in improving sleep quality and duration with diet as the emerging key component of sleep regulation.³⁻⁴ Covering this context, religion and culture also impact dietary preferences and consequently, indirectly contribute to health outcomes especially sleep.⁵⁻⁶ In Islam, Halal certification is implemented to ensure that the food being consumed by the community both adheres to their religious requirements and to the principles of cleanliness, hygiene, and animal welfare.⁷⁻⁸

The Philippines is reported to have one of the highest rates of sleep deprivation in Asia. According to studies, Filipinos sleep with an average of only 6.30 to 6.45 hours per night.¹⁻² Tryptophan, an essential amino acid, is a precursor of melatonin and serotonin, both of which are regulators of the sleep-wake cycle.³ A study has proposed that Halal meat, containing higher levels of amino acids (E.g., Histidine, tyrosine, tryptophan), compared to non-Halal meat may improve sleep regulation.⁹ In spite of this, there is no current research that has looked into the relationship between the Halal-certified food groups and sleep quality among adult Filipino Muslims. The Philippines, being a multicultural nation, includes a significant Muslim community that consistently practices a Halal diet. This population comprises one of the largest communities in the Philippines. This study holds incredible value as this community has 6.98 million members nationwide and 173,346 members in Metro Manila alone.¹⁰ Despite these statistics, there are still no studies evaluating the implications of consumption of Halal food with regards to sleep quality of adult Filipino Muslims, whether favorable or unfavorable. The data regarding sleep quality among Filipinos are merely focused on general dietary practices and non-communicable disease, rarely touching on Halal dietary practices. Thus, a critical gap remains in understanding how the Halal diet interacts with cultural and environmental influences on sleep.

This study aimed to determine the association between the consumption of Halal-certified food groups and sleep quality among adult Filipino Muslim members of the Greenhills Muslim Traders Association in San Juan City from June to July 2025. Specifically, it sought to describe participants' demographic characteristics, dietary consumption patterns, and sleep quality, and to assess the association between Halal-certified food group consumption and sleep quality.

Methods

The study was conducted after receiving ethics committee approval from the University's Ethics Review Committee (Code 1825/C/2025/006). An analytical cross-sectional study design was done to explore the relationship between dietary patterns and sleep quality among adult Filipino Muslim members of the Greenhills Muslim Traders Association. A structured questionnaire collected information on the frequency and type of Halal-certified food groups consumed, together with the PSQI to assess sleep quality.

A sample size of 322 respondents was calculated from an estimated population of 2,000 members of the Greenhills Muslim Traders Association. Participants were required to have adhered to a strict Halal-certified diet for at least one month prior to participation to allow sufficient time for potential dietary effects on sleep quality to manifest.¹⁶ Participants were included regardless of comorbidities and were required to have a basic understanding of English.

Lactating mothers were excluded because physiological and caregiving factors may affect sleep quality and duration.¹² Individuals working night shifts and those taking sleep supplements, such as melatonin, were also excluded because these factors may alter sleep patterns and circadian rhythms, potentially confounding the assessment of sleep quality.¹³⁻¹⁵

The study site was selected based on its accessibility and the high concentration of Muslim traders who actively adhere to a Halal diet.

Data were collected using a structured questionnaire consisting of demographic characteristics, Halal-certified food consumption adapted from a previous study,¹¹ and sleep quality assessed using the Pittsburgh

Sleep Quality Index (PSQI), a validated instrument with scores >5 indicating poor sleep quality.

Descriptive statistics were used to summarize the data. Demographic characteristics, including age, sex, educational attainment, occupation, and monthly income, were presented as frequencies and percentages. The consumption of Halal-certified food groups and PSQI domain scores were summarized using means and standard deviations. Participants were classified as having good sleep quality (PSQI ≤ 5) or poor sleep quality (PSQI >5), and frequencies and percentages were reported for each category. Data were analyzed using SPSS® version 22. Multivariable logistic regression was performed to assess the association between the consumption of Halal-certified food groups and sleep quality. Statistical significance was set at $p < 0.05$, with 95% confidence intervals reported for all estimates.

Results

A total of 323 participants were screened and found eligible for inclusion in the study. Table 1 presents the demographic characteristics of the respondents. Nearly half of the participants were aged 20–29 years (47.06%), whereas 11.76% were aged 50–59 years. Most participants were female (77.40%), with 1.55% preferring not to disclose their sex. Regarding educational attainment, 40.56% had reached the college level, while 1.24% had vocational education. The majority were employed (75.54%), and only 0.62% were retired. In terms of monthly income, 47.37% reported earning less than PhP 40,000 per month, whereas 9.29% reported earnings between PhP 60,000 and PhP 99,999.

Table 2 presents the mean frequency of Halal-certified food consumption among the respondents. The overall mean score of 1.80 indicates that Halal-certified foods were generally consumed 3–4 times per week. Grain products had the highest mean score (2.39), corresponding to consumption more than 5 times per week. Vegetables and fruits (1.94), meats and alternatives (2.07), and other foods (1.76) were consumed 3–4 times weekly, whereas milk products (1.44) and combination foods (1.21) were consumed less frequently, averaging 1–2 times per week.

Table 3 presents the PSQI scores and sleep quality classification of the respondents. The mean global PSQI score was 4.62 out of a possible 21, indicating

generally good sleep quality among respondents. Among the seven PSQI components, sleep efficiency had the highest mean score (1.16), indicating the poorest aspect of sleep, whereas subjective sleep quality had the lowest mean score (0.00), indicating the best aspect. Overall, 67.8% ($n = 219$) of respondents were classified as having good sleep quality (PSQI ≤ 5).

In Table 4, a multivariate logistic regression was conducted to determine the association between the frequency of consumption of Halal-certified food groups and sleep quality. Among the different Halal-certified food groups, only Halal-certified combination foods were significantly associated with sleep quality (OR = 0.697, 95% CI: 0.529–0.919, $p = 0.010$). An odds ratio below 1 suggests that increased consumption of Halal-certified combination foods was associated with reduced odds of having good sleep quality, indicating a greater likelihood of poor sleep quality among participants who consumed these foods more frequently. No statistically significant associations were observed for the other Halal-certified food groups ($p > 0.05$).

Discussion

The demographic profile indicated a predominantly young, female, college-educated, and employed sample within the lower to middle-income brackets. The predominance of females may reflect the active participation of Muslim women in trading and other self-employment activities.^{17–22}

The consumption patterns of Halal-certified food groups observed in this study are consistent with previous findings highlighting the influence of religious beliefs, health consciousness, and product accessibility on Halal food practices.^{23–24} The regular consumption of Halal-certified foods among respondents also reflects the strong preference of Muslim consumers for Halal products.²⁵ Grain products were the most frequently consumed food group, which may be attributed to the central role of rice and meat in the Filipino diet. In predominantly Muslim areas of the Philippines, increasing demand for Halal products has been associated with higher prices for Halal-compliant meat, yet Filipino Muslims remain willing to pay a premium for these products.²⁶ Lower consumption of milk products and combination foods may be related to the limited availability of Halal-certified specialty products and establishments

Table 1. Sociodemographic characteristics of adult Filipino Muslims in the Greenhills Muslim Traders Association.

		Frequency	Percent
Age	20 to 29	152	47.06
	30 to 39	79	24.46
	40 to 49	54	16.72
	50 to 59	38	11.76
	Total	323	100.00
Sex	Male	68	21.05
	Female	250	77.40
	Prefer not to say	5	1.55
	Total	323	100.00
Education	Elementary	17	5.26
	High School	102	31.58
	College	131	40.56
	Bachelor	46	14.24
	Graduate	21	6.50
	Vocational	4	1.24
	No response	2	0.62
	Total	323	100.00
Occupation	Retired	2	0.62
	Student	18	5.57
	Unemployed	58	17.96
	Employed	244	75.54
	Others	1	0.31
	Total	323	100.00
Income	<40,000	153	47.37
	40,000 to 59,999	34	10.53
	60,000 to 99,999	30	9.29
	100,00 to 249,999	47	14.55
	>250,000	56	17.34
	No response	3	0.93
	Total	323	100.00

Table 2. Halal-certified food groups consumed by adult Filipino Muslims in the Greenhills Muslim Traders Association

	Mean	SD	Interpretation
Grain Products	2.39	0.85	5 times a week
Vegetable and Fruit	1.94	0.96	3 to 4 times a week
Milk and Milk Products	1.44	1.01	1 to 2 times a week
Meat and Alternatives	2.07	0.90	3 to 4 times a week
Other Foods	1.76	1.05	3 to 4 times a week
Combination Food	1.21	1.00	1 to 2 times a week
Overall mean	1.80		3 to 4 times a week

Table 3. Pittsburgh Sleep Quality Index (PSQI) results.

	Mean	SD	Rank
Subjective sleep quality	0.71	0.70	4
Sleep disturbance	1.13	0.87	2
Sleep latency	0.72	0.88	3
Daytime dysfunction	0.20	0.63	6
Sleep efficiency	1.16	0.60	1
Overall sleep quality	0.00	0.00	7
Sleep medication use	0.71	0.77	5
Actual Score	4.62	2.63	
	Frequency	Percent	
Good sleep	219	67.80	
Poor sleep	104	32.20	

Table 4. Association of Halal-certified food consumptions and their quality of sleep.

	BC	Odds Ratio	95% CI		p value
			LL	UL	
Grain Products	0.185	1.20	0.89	1.62	0.225
Vegetables and Fruits	-0.015	0.99	0.74	1.31	0.915
Milk and Milk Products	0.240	1.27	0.97	1.68	0.088
Meat and Alternatives	-0.080	0.92	0.67	1.27	0.620
Other certified Foods	-0.196	0.822	0.622	1.09	0.169
Combination Foods	-0.360	0.697	0.529	0.92	0.010

BC = Beta Coefficient; LL = lower limit; UL = upper limit;

in the country.²⁶⁻²⁷ Overall, these findings suggest that cultural, economic, and accessibility factors influence Halal food consumption among Filipino Muslims in the Philippines.

Pittsburgh Sleep Quality Index (PSQI) Results

The PSQI findings suggest generally good sleep quality among the respondents, as reflected by the mean global PSQI score of 4.62, which is below the cutoff score of 5. Furthermore, 67.8% of participants

were classified as good sleepers. Although respondents reported favorable overall sleep quality and minimal daytime dysfunction, higher scores in sleep efficiency, sleep disturbance, and sleep latency indicate difficulties in maintaining efficient and uninterrupted sleep. These findings suggest that while participants generally perceived their sleep positively, specific aspects of sleep may still warrant attention.²⁸

The generally good sleep quality observed among respondents may be partly explained by factors beyond diet. Previous studies have shown that subjective

health is an important determinant of sleep quality, with better perceived health being associated with more favorable sleep outcomes.²⁹ Although religious beliefs and practices were not directly assessed in this study, previous research has suggested that they may be associated with better sleep quality through their potential effects on psychological well-being and relaxation.⁶ Additionally, the predominance of employed participants in this study may have influenced the findings, as employment has been associated with fewer sleep disturbances and complaints, possibly due to more structured daily routines and regular engagement in work-related activities.^{30,31}

Diet is one of the factors known to influence sleep quality. A recent study reported that vegetarians had lower PSQI scores than non-vegetarians, indicating better overall sleep quality, which was attributed to higher serotonin levels among vegetarians.³² While the present study likewise found generally good sleep quality among respondents, direct comparisons should be interpreted with caution because a Halal diet differs substantially from a vegetarian diet in both composition and dietary principles. Nevertheless, the findings support the broader concept that dietary patterns may be associated with sleep quality and warrant further investigation among populations adhering to a Halal diet.

Association of the frequency of Halal-certified food consumption and their quality of sleep

No significant association was observed between the consumption of Halal-certified grain products and sleep quality. Although the direction of the association suggested a tendency toward better sleep quality with more frequent grain consumption, the relationship was not statistically significant. This finding may reflect the dietary habits of Filipinos, who commonly consume processed grains rather than whole grains, the latter of which have been associated with better health outcomes and improved sleep quality.³³⁻³⁴ Moreover, no previous studies have specifically examined the relationship between the consumption of Halal-certified grain products and sleep quality, limiting direct comparison with the present findings.

No significant association was observed between the consumption of Halal-certified vegetables and fruits and sleep quality. Although fruits and vegetables

are generally associated with positive health outcomes, the present findings suggest that frequency of consumption alone may not influence sleep quality. Previous studies have reported higher fruit and vegetable intake among individuals with both short and long sleep durations, while improvements in sleep have been associated more with meeting recommended intake levels than with consumption frequency.³⁵⁻³⁶ To the best of the researchers' knowledge, no previous studies have specifically examined the association between the frequency of consumption of Halal-certified vegetables and fruits and sleep quality, limiting direct comparison with the present findings.

No significant association was observed between the consumption of Halal-certified milk and milk products and sleep quality. Although milk contains tryptophan and other compounds that may influence sleep, current evidence supporting its sleep-promoting effects remains limited.⁴ The lack of association in the present study may be related to the relatively low frequency of consumption among respondents, which may not have provided sufficient amounts of bioactive compounds such as melatonin and tryptophan derivatives to influence sleep regulation.³⁷ Additionally, lactose malabsorption is highly prevalent among Filipino adults and may offset any potential sleep-related benefits of milk consumption.³⁸ The processing of commercial milk products may also reduce melatonin concentrations compared with raw sources, potentially diminishing their effects on sleep.³⁹ To the best of the researchers' knowledge, no published studies have specifically examined the association between the frequency of consumption of Halal-certified milk products and sleep quality, limiting direct comparison with the present findings. No significant association was observed between the consumption of Halal-certified meat and alternatives and sleep quality. This finding contrasts with a recent pilot study suggesting potential sleep-related benefits of Halal meat but is consistent with previous research reporting an association between higher meat consumption and poorer sleep outcomes.^{9,40} The absence of a significant association in the present study may be related to differences in the type and frequency of meat consumed. Among urban Filipino Muslims, meat intake may include preserved or cured Halal products, which contain sodium and nitrates that have been associated with adverse effects on sleep.^{8,41} Additionally, low fruit and vegetable intake

among Filipino adults may limit antioxidant intake, potentially offsetting any benefits associated with nutrients found in meat products.⁴²

Among the food groups studied, only Halal-certified combination foods demonstrated a significant association with sleep quality. More frequent consumption of these foods was associated with lower odds of good sleep quality, suggesting a greater likelihood of poor sleep among participants who consumed them more frequently. This finding is consistent with previous research showing that higher consumption of low-quality carbohydrates and total daily carbohydrates, which are commonly found in combination foods, is associated with an increased risk of poor sleep patterns.⁴¹ Given the cross-sectional design of the study, however, the observed relationship should be interpreted as an association rather than a causal effect.

Overall, no significant association was observed between the consumption of most Halal-certified food groups and sleep quality among adult Filipino Muslims from the Greenhills Muslim Traders Association. However, more frequent consumption of Halal-certified combination foods was associated with lower odds of good sleep quality. These findings suggest that, with the exception of combination foods, the frequency of consumption of Halal-certified food groups was not significantly associated with global PSQI scores.

Limitations

Several limitations should be acknowledged. First, the study assessed only the frequency of consumption of Halal-certified food groups and did not account for other dietary factors that may influence sleep quality, such as food preparation methods, portion sizes, caloric intake, and timing of consumption. Second, other known determinants of sleep quality, including caffeine and alcohol consumption, smoking, stress levels, and screen exposure, were not evaluated. Finally, although the PSQI is a validated instrument, it relies on self-reported responses, which may be subject to recall bias and may not accurately reflect actual sleep patterns.

Despite these limitations, the findings suggest that the frequency of consumption of most Halal-certified food groups was not significantly associated

with sleep quality among adult Filipino Muslims. Although respondents generally demonstrated good sleep quality, the significant association observed for Halal-certified combination foods and the potential influence of other behavioral, dietary, and cultural factors warrant further investigation.

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Demographic and Academic Characteristics of First-Year Medical Students with Low Academic Performance Across Face-to-Face, Online, and HyFlex Learning: A Seven-Year Single-Center Study

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Abstract

Introduction Medical student attrition and poor academic performance have implications for both medical schools and the future healthcare workforce. This study aimed to determine the demographic and academic characteristics of first-year medical students with low academic performance across different instructional modalities—traditional face-to-face, online, and HyFlex learning.

Methods This non-concurrent cohort study included first-year medical students enrolled from School Years (SY) 2018–2019 to 2024–2025. Student characteristics analyzed included sex, pre-medicine degree, pre-medicine general weighted average (GWA), National Medical Admission Test (NMAT) score, and academic performance in annual first-year subjects. Low academic performance was defined as failure in at least one annual subject. Students were grouped according to instructional modality: face-to-face (SY 2018–2020), online (SY 2020–2022), and HyFlex (SY 2022–2025). Demographic and academic characteristics were compared between students with and without low academic performance.

Results A total of 2,936 first-year medical students were included. The proportion of students with low academic performance was 19% during the face-to-face period, 17% during the online period, and 27% during the HyFlex period. Across all instructional modalities, students with low academic performance had significantly poorer pre-medicine GWA than students who passed all annual subjects ($p < 0.05$). During the online and HyFlex periods, students with low academic performance also had significantly lower NMAT scores than students who passed all annual subjects ($p < 0.05$), whereas no significant difference in NMAT scores was observed during the face-to-face period.

Conclusion Pre-medicine GWA was consistently associated with academic performance across face-to-face, online, and HyFlex instructional modalities. Lower NMAT scores were associated with low academic performance during online and HyFlex learning. Early identification of students with poorer pre-medicine academic performance and lower NMAT scores may facilitate timely academic support.

Key words: Medical students, academic performance, National Medical Admission Test (NMAT), Grade point average (GWA), online learning , HyFlex learning

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The increase in demand for medical education has sparked interest in identifying factors associated with academic success among medical students, particularly during the first year of undergraduate medical education. In this connection, traditional criteria for admission may have to be revisited as teaching and assessment modalities have evolved over time. From traditional classroom-based teaching, it was the global pandemic caused by COVID-19 that forced educators to re-think their teaching-learning activities to ensure continuity of formal learning in educational institutions. Delivering content and performing student assessment online provided a viable alternative to ensure the health and safety of teachers and students alike.¹ While technology supported the rapid adaptation of educational institutions to shift to online methods of teaching and assessment, new challenges arose in undergraduate medical institutions.^{2,3}

These newly identified challenges remain to be explored in detail even as the lived in lived experience of teachers and students alike with online teaching and assessment have been described.⁴ The improved health situation brought by population-wide anti-COVID-19 vaccinations and developments in technology facilitated the adoption of HyFlex teaching strategies. A hybrid flexible (HyFlex) teaching model refers to an instructional approach that combines face-to-face instruction with online synchronous or asynchronous content delivery.⁵⁻⁷ In the HyFlex model, teaching-learning activities are conducted either face-to-face or online, thus providing multiple ways to deliver content and interact with students. Consequently, medical students in recent years have experienced three distinct instructional modalities: traditional face-to-face learning, fully online learning, and HyFlex (blended) learning.

There have been several studies on the effectiveness of various instructional modalities, including traditional face-to-face, online, and HyFlex learning.⁸ However, findings remain inconsistent regarding the relationship between student characteristics, admission credentials, and academic performance across different learning environments. Some studies have reported no significant differences in learning outcomes between face-to-face and online instruction in undergraduate medical courses such as anatomy and physiology.^{3,9-10}

Medical student attrition and poor academic performance have implications not only for individual learners but also for the healthcare workforce. The Philippines continues to face a substantial shortage of physicians, with estimates suggesting a national deficit of approximately 73,687 medical doctors.¹¹ Consequently, identifying admission and demographic factors associated with academic success and early academic difficulties may help medical schools develop strategies to support at-risk students and contribute to the training of future physicians.

To date, there is a paucity of local studies examining whether traditional admission criteria remain associated with academic performance across changing instructional modalities, including traditional face-to-face, fully online, and HyFlex learning environments. Accordingly, this study aimed to determine the demographic and academic profile of Year 1 medical students with low academic performance across different instructional modalities—traditional face-to-face, online, and HyFlex (blended) learning—during School Years 2018–2019 to 2024–2025. Specifically, it sought to describe students according to sex, pre-medicine course, pre-medicine general weighted average (GWA), and National Medical Admission Test (NMAT) score, and to compare the academic performance of students with low academic performance and those who successfully passed the annual first-year medical subjects within each instructional modality.

Methods

This is a non-concurrent cohort study. The University's Research Ethics Committee approved the study.

The demographic profile of students was obtained as to sex, undergraduate course (science/health science vs. non-science/non-health science), general weighted average (GWA) in the pre-medicine course, score in the National Medical Admission Test (NMAT), and the final grades of first-year medical students in the three annual subjects, namely Anatomy, Physiology, and Biochemistry, for seven school years (SY 2018–2019 to SY 2024–2025).

Student characteristics were compared between students with low academic performance and those who passed all three annual subjects across three instructional modalities: traditional face-to-face

instruction, fully online instruction, and HyFlex (blended) instruction.

Continuous variables were summarized using means and standard deviations and compared using one-way analysis of variance (ANOVA). Categorical variables were summarized using frequencies and percentages and compared using the chi-square test. Statistical significance was set at $p < 0.05$.

Low academic performance was operationally defined as failure in at least one annual subject (final grade $<75\%$). Student characteristics were compared between students with low academic performance and those who passed all annual subjects.

The study period encompassed several changes in instructional delivery and assessment methods resulting from the COVID-19 pandemic and the subsequent transition to blended learning. Teaching and assessment modalities for each school year are summarized in Table 1.

Based on these modalities, students were exposed to three major learning environments: traditional face-to-face instruction (SY 2018–2019 and SY 2019–2020), fully online instruction (SY 2020–2021 and SY 2021–2022), and HyFlex/blended instruction (SY 2022–2023 to SY 2024–2025).

During SY 2022–2023, Anatomy, Physiology, and Biochemistry employed a blended approach consisting of face-to-face and online (synchronous and asynchronous) instruction, with both online and face-to-face assessments. In contrast, Preventive Medicine, Humanities, and Patient-Doctor Relationship (PDR) were delivered fully online (synchronous and asynchronous), with assessments conducted online using visual proctoring.

Results

A total of 2,936 first-year medical students were included in the study, comprising 882 students during the face-to-face period, 560 during the online period, and 1,494 during the HyFlex period. The proportion

of students who passed all annual subjects was highest during the online period (83%), followed by the face-to-face period (81%) and the HyFlex period (73%). Correspondingly, the proportion of students with low academic performance was lowest during the online period (17%) and highest during the HyFlex period (27%).

Mean NMAT scores decreased across instructional modalities, from 88 ± 7 during the face-to-face period to 85 ± 10 during the online period and 83 ± 8 during the HyFlex period. Mean pre-medicine GWA was 1.88 ± 0.26 during the face-to-face period, 1.93 ± 0.26 during the online period, and 1.63 ± 0.25 during the HyFlex period. Female students constituted the majority of the study population across all instructional modalities, accounting for 63% to 69% of students. Likewise, most students had science-related pre-medicine degrees, comprising 83%, 86%, and 96% of students during the face-to-face, online, and HyFlex periods, respectively (Table 2).

During the face-to-face instructional period, NMAT scores did not differ significantly between students who passed all annual subjects and those with low academic performance (89 ± 7 vs. 88 ± 7 , $p > 0.05$). However, students with low academic performance had significantly poorer pre-medicine GWA than students who passed all annual subjects (2.06 ± 0.25 vs. 1.82 ± 0.26 , $p < 0.05$).

During the online instructional period, students who passed all annual subjects had significantly higher NMAT scores (87 ± 10 vs. 80 ± 7 , $p < 0.05$) and better pre-medicine GWA (1.81 ± 0.26 vs. 2.06 ± 0.23 , $p < 0.05$) than students with low academic performance. Similar findings were observed during the HyFlex instructional period, wherein students who passed all annual subjects had significantly higher NMAT scores (84 ± 8 vs. 80 ± 7 , $p < 0.05$) and better pre-medicine GWA (1.59 ± 0.24 vs. 1.70 ± 0.23 , $p < 0.05$) than students with low academic performance.

Across all instructional modalities, students with low academic performance consistently demonstrated

Table 1. Teaching and assessment modalities by school year.

School Year(s)	Teaching Method	Assessment Method
2018–2019	Face-to-face	Face-to-face
2019–2020	Face-to-face → Online (mid-semester transition)	Face-to-face → Online (without visual proctoring)
2020–2022	Online (synchronous and asynchronous)	Online with visual proctoring
2022–2025	HyFlex/Blended (face-to-face and online)	Face-to-face and online

Table 2. Demographic and academic characteristics of first-year medical students by instructional modality.

Characteristic	F2F (2018–2020)	Online (2020–2022)	Hyflex (2022–2025)
Number of students	N=882	N=560	N=1494
Passed, n (%)	713 (81%)	465 (83%)	1096 (73%)
Failed, n (%)	159 (19%)	95 (17%)	398 (27%)
NMAT score, mean $\pm$ SD	88 $\pm$ 7	85 $\pm$ 10	83 $\pm$ 8
GWA, mean $\pm$ SD	1.88 $\pm$.26	1.93 $\pm$.26	1.63 $\pm$.25
Male, n (%)	321 (36%)	205 (37%)	464 (31%)
Female, n (%)	561 (64%)	355 (63%)	1030 (69%)
Science pre-med degree, n (%)	818 (83%)	484 (86%)	1435 (96%)
Non-science pre-med degree, n (%)	64 (17%)	76 (14%)	59 (4%)

F2F = face-to-face instruction; Online = fully online instruction; Hyflex = blended face-to-face and online instruction

Table 3. Comparison of demographic and academic characteristics between students with and without low academic performance according to instructional modality.

Variable	Face-to-Face (2018–2020)			Online (2020–2022)			Hyflex (2022–2025)		
	Passed	Failed	p-value	Passed	Failed	p-value	Passed	Failed	p-value
NMAT score (mean $\pm$ SD)	89 $\pm$ 7	88 $\pm$ 7	>0.05	87 $\pm$ 10	80 $\pm$ 7	<0.05	84 $\pm$ 8	80 $\pm$ 7	<0.05
GWA (mean $\pm$ SD)	1.82 $\pm$ 0.26	2.06 $\pm$ 0.25	<0.05	1.81 $\pm$ 0.26	2.06 $\pm$ 0.23	<0.05	1.59 $\pm$ 0.24	1.70 $\pm$ 0.23	<0.05
Male, n (%)	261 (81%)	56 (19%)	<0.05	173 (84%)	32 (16%)	<0.05	356 (77%)	108 (23%)	<0.05
Female, n (%)	452 (81%)	109 (19%)	<0.05	260 (73%)	95 (27%)	<0.05	740 (72%)	290 (28%)	<0.05
Science pre-med degree, n (%)	668 (82%)	150 (18%)	<0.05	399 (82%)	85 (18%)	<0.05	1059 (74%)	376 (26%)	<0.05
Non-science pre-med degree, n (%)	45 (83%)	19 (17%)	<0.05	66 (87%)	10 (13%)	<0.05	37 (63%)	22 (37%)	<0.05

poorer pre-medicine GWA than students who passed all annual subjects. In contrast, lower NMAT scores were associated with low academic performance only during the online and HyFlex instructional periods. Although differences in the distribution of sex and pre-medicine degree background were observed between groups, these findings should be interpreted cautiously because female students and those with science-related pre-medicine degrees constituted the majority of the overall study population (Table 3).

Discussion

This study examined the demographic and academic characteristics of first-year medical students with low academic performance across three instructional modalities: traditional face-to-face, fully online, and HyFlex learning. The findings demonstrated that pre-medicine academic performance, as measured by GWA, was consistently associated with academic performance in Year 1 regardless of instructional modality. In contrast, NMAT scores significantly

differentiated students with and without low academic performance during the online and HyFlex periods, suggesting that the predictive value of admission criteria may vary across learning environments.

Medical student attrition and poor academic performance remain important concerns because they affect not only individual students but also the future healthcare workforce. A study among Year 1 Malaysian medical students reported that academic failure contributes substantially to attrition, with an average attrition rate of 11.1% among 40 medical schools worldwide, ranging from 2.4% to 26.2%.¹² In the present study, the proportion of students with low academic performance averaged 21%, ranging from 3% to 36% across the study period. Although the lowest proportion was observed during SY 2019–2020, this finding should be interpreted cautiously because of the unusual educational circumstances brought about by the abrupt transition to online learning during the COVID-19 pandemic.

Previous studies have emphasized the importance of prior academic achievement as a predictor of

success in medical school. An Australian study found that students with lower pre-admission academic performance tended to remain low performers during medical training, although prior academic achievement accounted for only 23% of the variance in undergraduate medical performance.¹³ Similarly, present study findings demonstrated that students with low academic performance consistently had poorer pre-medicine GWA than students who successfully passed all annual subjects. This association was observed across face-to-face, online, and HyFlex instructional modalities, suggesting that prior academic achievement remains a robust predictor of early medical school performance despite changes in teaching and assessment strategies.

The predictive value of admission examinations has been widely investigated. A study from Pakistan reported that the University Admission Index (UAI) was the strongest predictor of academic outcomes, whereas the communication dimension of the interview demonstrated modest predictive value for clinically oriented outcomes.¹⁴ Likewise, a study from Chiang Mai University, Thailand found that previous academic performance and female sex were independent predictors of academic success, while interview scores demonstrated predictive value in the later years of training, particularly in clinically-based courses.¹⁶ These findings support the continued use of multiple admission criteria rather than reliance on a single selection tool.

The role of admission test scores in predicting academic performance remains controversial. A study conducted in Karachi, Pakistan reported that higher admission test scores predicted undergraduate medical school achievement.¹⁷ Similarly, a study from Saudi Arabia found that national achievement examination scores significantly predicted preclinical academic performance, although they were less effective in predicting functional knowledge and progress test outcomes.¹⁸ In the present study, students with low academic performance generally had lower NMAT scores than students who passed all annual subjects, particularly during the online and HyFlex instructional periods. Interestingly, significant differences in NMAT scores were not consistently observed during the face-to-face years. These findings suggest that NMAT performance may be more strongly associated with academic outcomes in learning environments that require greater self-directed learning, adaptability, and independent study skills.

Several studies have also examined the combined predictive value of prior academic performance and admission test scores. Two studies from the University of Western Australia demonstrated that both undergraduate GPA and Graduate Medical School Admissions Test (GAMSAT) scores predicted academic performance throughout medical training.^{19,20} Similarly, a separate Australian study reported that combining prior academic achievement with structured interviews assessing communication skills improved the selection of students likely to succeed in medical school.²¹ In the authors' institution, admission decisions likewise consider pre-medicine GWA, NMAT scores, and interview performance. The present findings support the continued importance of prior academic achievement in the admissions process while suggesting that NMAT scores may provide additional information regarding academic risk under certain instructional conditions.

The interpretation of sex and pre-medicine degree as predictors of academic performance warrants caution. Although a greater number of students with low academic performance were female and had science-related pre-medicine degrees, females and science-degree graduates also constituted the majority of the overall student population throughout the study period. Consequently, these characteristics cannot be considered independent predictors of low academic performance based on the present analyses alone. Additional studies using multivariable analyses are needed to determine whether these factors remain significant after adjustment for academic and demographic variables.

The findings of this study have important implications for student support. Early identification of students at risk for academic difficulty may allow timely intervention before academic problems become severe. One promising strategy is peer-assisted learning (PAL), a widely used educational approach in which students learn from and teach one another. According to Topping, PAL involves individuals from similar social groups helping each other learn while simultaneously reinforcing their own learning.²³ Studies have demonstrated benefits for both academically challenged students and peer tutors, including improvements in academic performance, confidence, communication skills, teaching abilities, and professional development.^{24,25} Given the increasing diversity of instructional

modalities in medical education, PAL may represent a practical and sustainable intervention for supporting students who experience academic difficulties.

The present study contributes local evidence regarding the relationship between admission characteristics and academic performance across face-to-face, online, and HyFlex learning environments. As medical education continues to evolve, further studies are needed to examine additional predictors of success, including resilience, learning strategies, motivation, communication skills, and other non-cognitive factors, as well as their influence on academic and clinical performance in the later years of medical training.

Conclusion and Recommendation

Students with low academic performance in Year 1 consistently demonstrated poorer pre-medicine academic performance than students who successfully passed all annual subjects. Lower NMAT scores were likewise observed among students with low academic performance, particularly during the online and HyFlex instructional periods. These findings suggest that pre-medicine GWA remains a stable predictor of academic performance across different instructional modalities, while NMAT scores may provide additional information regarding academic risk in online and blended learning environments.

While NMAT scores and pre-medicine GWA may be useful in identifying students at risk for academic difficulty, admission decisions should continue to consider multiple cognitive and non-cognitive factors. The interview component of the admissions process may be revisited to further evaluate communication, metacognitive, and meta-affective skills, which are important attributes for patient-centered care and success during the clinical years.²⁶

Early identification of students with lower NMAT scores and poorer pre-medicine academic performance may facilitate timely academic support. Based on evidence from previous studies, peer-assisted learning (PAL) may be considered as a potential intervention strategy for students identified to be at risk for poor academic performance. Future studies should evaluate the effectiveness of PAL and other academic support programs in improving academic outcomes among medical students.

Limitations

This study has several limitations. First, it was conducted in a single medical school, which may limit the generalizability of the findings to other institutions with different admission policies, student populations, and curricular structures. Second, the retrospective and observational nature of the study limits the ability to establish causal relationships between admission characteristics and academic performance. Third, the study focused primarily on selected demographic and academic variables and did not evaluate other factors that may influence student performance, such as socioeconomic status, learning strategies, motivation, resilience, mental health, study habits, and other non-cognitive characteristics. Finally, the analyses did not control for potential confounding variables; therefore, the observed associations should not be interpreted as independent predictors of academic performance. Future studies involving multiple institutions and multivariable analyses are recommended to further clarify the factors associated with academic success in medical education across different instructional modalities.

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Conflict of Interest

Jennifer M. Naites serves as Editor-in-Chief of the UERMMMCI Health Sciences Journal and is a co-author of this manuscript. She had no involvement in the editorial handling, peer review, or publication decision for this article. Editorial responsibility for this manuscript was delegated to an independent editor.

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Knowledge, Attitude, and Practices on Leptospirosis Among the Residents of a Selected Urban Community in Quezon City, Philippines: A Cross-Sectional Study

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Abstract

Introduction Leptospirosis is a zoonotic disease transmitted through exposure to water or soil contaminated with the urine of infected animals, particularly rats. Despite ongoing prevention efforts, leptospirosis remains a public health concern in the Philippines, especially in flood-prone urban communities. This study assessed the knowledge, attitudes, and practices (KAP) regarding leptospirosis among residents of Barangay Doña Imelda, Quezon City, and examined the association of selected sociodemographic factors with KAP.

Methods A cross-sectional design was used with 345 residents of Barangay Doña Imelda. Data were collected using an adapted KAP questionnaire. Open-ended questions were used to probe the responses further. Statistical analyses included descriptive statistics and Spearman's Rho correlation, Independent T-test, One-way and Welch ANOVA, and appropriate post hoc tests. Relationships among KAP domains were evaluated using Spearman's rank correlation coefficient. Statistical significance was set at $p < 0.05$.

Results Respondents demonstrated high levels of knowledge (86.80%) and positive attitudes (90.91%) toward leptospirosis, but comparatively lower practice scores (69.25%). Knowledge scores differed significantly according to household size and civil status, while attitude and practice scores varied significantly across sex, educational attainment, and household income. Weak but significant positive correlations were observed between knowledge and attitude ($r_s = 0.126$, $p = 0.020$), knowledge and practice ($r_s = 0.169$, $p = 0.002$), and attitude and practice ($r_s = 0.170$, $p = 0.001$).

Conclusion Residents of Barangay Doña Imelda demonstrated adequate knowledge and positive attitudes toward leptospirosis; however, preventive practices remained suboptimal. Significant associations between KAP and selected sociodemographic factors were identified. Targeted health education, improved symptom recognition, and increased access to preventive resources may help strengthen leptospirosis prevention in high-risk urban communities.

Key words: Leptospirosis, knowledge, attitudes, practice, urban community, Philippines

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Leptospirosis is a potentially fatal zoonotic disease caused by pathogenic *Leptospira* spirochetes, transmitted primarily through contact with water or soil contaminated by the urine of infected animals, particularly rats (*Rattus norvegicus*). Human infection typically occurs through abraded skin, mucous membranes, or prolonged exposure to contaminated floodwaters. The disease is endemic in tropical regions, including the Philippines, where climatic and environmental conditions favor bacterial survival and transmission.^{1,2} The World Health Organization (WHO) estimates that the incidence of leptospirosis ranges from 10–100 cases per 100,000 population in tropical areas and may exceed 100 per 100,000 among high-risk groups during outbreaks.² Despite ongoing prevention efforts, leptospirosis remains a significant public health concern in the Philippines, particularly in urban centers where poor sanitation and frequent flooding prevail.

Quezon City, located in the National Capital Region (NCR), is highly susceptible to flooding because of its extensive river and watershed systems, including the San Juan River watershed. The Quezon City Epidemiology and Disease Surveillance Unit (QCESU) reported 676 leptospirosis cases and 102 deaths from January to October 2025, representing a substantial increase compared with previous years.³ Nationally, the Department of Health reported a 43.4% increase in leptospirosis cases, from 2,115 cases during January–July 2024 to 3,037 cases during the same period in 2025.^{4,5} These trends highlight the vulnerability of flood-prone communities such as Barangay Doña Imelda, where dense urbanization, inadequate waste management, and recurrent flooding may facilitate disease transmission.

Knowledge, attitudes, and practices (KAP) play an important role in the prevention and control of leptospirosis. Understanding community awareness, perceptions, and preventive behaviors may help identify gaps that contribute to continued disease transmission and guide the development of targeted public health interventions. However, recent data regarding KAP toward leptospirosis among residents of flood-prone urban communities in Quezon City remain limited.

This study aimed to assess the knowledge, attitudes, and practices regarding leptospirosis among residents of Barangay Doña Imelda, Quezon City. Specifically, it sought to determine the association

of selected sociodemographic characteristics with KAP and examine the relationships among the KAP domains. The findings may provide evidence for strengthening community-based health education programs and informing local public health strategies aimed at reducing leptospirosis transmission in high-risk urban communities.

Methods

Ethical approval was granted by the Research Institute for Health Sciences–Ethics Review Committee (RIHS-ERC; Protocol No. 1831/C/2025/012). The study employed a community-based cross-sectional design to assess the knowledge, attitudes, and practices (KAP) regarding leptospirosis among residents of Barangay Doña Imelda, Quezon City. Data were collected through face-to-face household interviews using an adapted KAP questionnaire consisting of closed-ended and open-ended items.

Sample size estimation was based on the 2020 Philippine Census. Given a population of 11,724 residents and an estimated 3,229 households, the required sample size was calculated using the formula for estimating a single population proportion with finite population correction, assuming a 95% confidence level and a 5% margin of error. The minimum required sample size was 344 respondents, and 345 respondents were ultimately recruited.

Respondents were selected through convenience sampling and recruited through house-to-house visits until the target sample size was achieved. Only one eligible respondent was interviewed per household.

Eligible participants were adults aged 18 years or older who had resided in Barangay Doña Imelda for at least one year and stayed in the community for more than three days per week. Individuals who declined participation, withdrew from the study, or submitted incomplete questionnaires were excluded from the final analysis.

Data were collected using an adapted KAP questionnaire derived from instruments developed.^{6,7} The questionnaire was available in both English and Filipino and underwent face validation face validation by subject matter experts and pilot testing among 35 individuals who were not included in the final sample. The pilot test assessed the clarity, readability, comprehensibility, and feasibility of the instrument.

The questionnaire included sections assessing respondents' sociodemographic characteristics, knowledge of leptospirosis, attitudes toward the disease, and preventive practices. Knowledge items covered disease causation, transmission, signs and symptoms, and preventive measures, while attitude and practice items were measured using five-point Likert scales.

Open-ended questions were included to further explore respondents' perceptions of susceptibility to leptospirosis, perceived disease severity, perceived benefits and barriers to preventive behaviors, and awareness of community policies and ordinances related to disease prevention.

Knowledge items were scored as 1 for correct responses and 0 for incorrect or "Don't Know" responses. Total knowledge scores ranged from 0 to 9 and were converted into percentages. Attitude and practice scores were obtained by summing responses to the respective Likert-scale items, with higher scores indicating more favorable attitudes and more appropriate preventive practices. Two practice items were reverse-coded prior to analysis.

Descriptive statistics were used to summarize respondent characteristics and KAP scores. Continuous variables were presented as means $\pm$ standard deviations, while categorical variables were reported as frequencies and percentages.

Associations among knowledge, attitude, and practice scores were assessed using Spearman's rank correlation coefficient.

Differences in mean KAP scores across sociodemographic groups were evaluated using independent t-tests, one-way analysis of variance (ANOVA), or Welch's ANOVA, as appropriate. Homogeneity of variances was assessed using Levene's test, and significant omnibus tests were followed by Tukey's HSD or Games–Howell post hoc comparisons.

All statistical analyses were performed using IBM SPSS Statistics version 29 (IBM Corp., Armonk, NY, USA) and RStudio. Statistical significance was set at a two-tailed p-value of <0.05 .

Results

Table 1 presents the sociodemographic characteristics of the 345 respondents. The mean age was 46.69 ± 15.37 years. Most respondents were male (66%), married (61%), and Roman Catholic (82%). More

than half had completed high school education (51%), while 31% had attained undergraduate or graduate degrees. The majority were employed (59%), had resided in Barangay Doña Imelda for more than 10 years (82%), and belonged to the low-income bracket (83%). Most households consisted of five or fewer members (60%).

Table 1. Sociodemographic characteristics of respondents (N=345)

Characteristic	n (%)
Sex	
Male	228 (66.1)
Female	117 (33.9)
Civil status	
Single	87 (25.2)
Married	212 (61.4)
Others	46 (13.3)
Religion	
Roman Catholic	284 (82.3)
Others	61 (17.7)
Educational attainment	
High school or below	239 (69.3)
College or higher	106 (30.7)
Occupation	
Employed	204 (59.1)
Unemployed/Student	140 (40.6)
Length of residency	
≤ 10 years	62 (18.0)
> 10 years	283 (82.0)
Household size	
≤ 5 members	208 (60.3)
> 5 members	137 (39.7)
Monthly household income	
Low income	287 (83.2)
Middle/High income	39 (11.3)
Undisclosed	19 (5.5)

Table 2 shows the associations between sociodemographic characteristics and KAP scores. Knowledge scores differed significantly according to civil status ($p=0.030$) and household size ($p=0.024$). Attitude scores differed by sex ($p=0.031$) and educational attainment ($p=0.009$). Practice scores differed by sex ($p=0.027$), educational attainment ($p=0.035$), and household income ($p=0.031$). No

significant associations were observed for the remaining sociodemographic variables.

Table 3 summarizes the mean KAP scores of respondents on Leptospirosis. The overall mean scores for knowledge, attitude, and practices are 86.90% (± 14.26), 96.00% (± 0.50), and 69.25% (± 14.27) respectively.

Respondents demonstrated a high level of knowledge regarding leptospirosis, with a mean score of 86.80% (Table 4). Among the knowledge domains, disease prevention had the highest mean score (94.98%), followed by mode of transmission (93.82%), whereas signs and symptoms had the lowest mean score (71.59%). As shown in Table 4, awareness that floodwater can transmit leptospirosis was highest (97.10%), while recognition of red eyes (70.43%),

difficulty urinating (71.59%), and jaundice (72.75%) as symptoms was comparatively lower.

Respondents demonstrated a positive attitude toward leptospirosis, with a mean attitude score of 90.91% (Table 5). Agreement rates ranged from 84.35% to 99.71%. The highest level of agreement was observed for the importance of following health advisories during the rainy season (99.71%), whereas the lowest was for the importance of rat population control (84.35%).

Respondents demonstrated a moderate level of preventive practices against leptospirosis, with a mean practice score of 69.25%. As shown in Table 6, the most commonly reported practices were storing food in sealed or rat-proof containers (95.65%) and avoiding walking barefoot on soil (82.90%). In

Table 2. Association between sociodemographic characteristics and knowledge, attitude, and practice scores.

Variable	Knowledge p-value	Attitude p-value	Practice p-value
Sex	0.183 ^a	0.031 ^{a*}	0.027 ^{a*}
Civil Status	0.030 ^{b*}	0.666 ^b	0.716 ^b
Religion	0.804 ^b	0.506 ^b	0.889 ^b
Educational Attainment	0.345 ^b	0.009 ^{b*}	0.035 ^{b*}
Occupation	0.362 ^b	0.227 ^b	0.216 ^b
Years of Residency	0.308 ^b	0.783 ^b	0.803 ^b
Household Size	0.024 ^{b*}	0.550 ^b	0.674 ^b
Household Income	0.574 ^c	0.318 ^c	0.031 ^{c*}

p < 0.05

^a Independent samples t-test

^b One-way ANOVA

^c Welch ANOVA

Post hoc analyses were performed using Tukey's HSD for homogeneous variances and Games-Howell tests for heterogeneous variances.

Table 3. Summary of knowledge, attitude, and practice scores regarding leptospirosis.

Variables	Mean Score (%)	S.D.
Knowledge	86.80	14.26
Mode of Transmission	93.82	14.61
Signs and Symptoms	71.59	34.92
Disease Prevention	94.98	13.94
Attitude	90.91	0.50
Practice	69.25	14.27
Protective Gears and Safety Measures	65.96	18.24
Pest Control Measures	75.83	18.28

contrast, wearing waterproof boots while wading in floodwater (29.57%) and using rat poison or traps for rodent control (37.10%) were the least frequently practiced preventive measures.

Table 7 presents the correlations among knowledge, attitude, and practice scores. Weak positive correlations were observed between knowledge and attitude ($r_s=0.126$, $p=0.020$), knowledge and practice ($r_s=0.169$, $p=0.002$), and attitude and practice ($r_s=0.170$, $p=0.001$). All correlations were statistically significant.

Discussion

Sociodemographic as Predictors of KAP

Knowledge scores differed according to household size and civil status. Respondents from larger households and those who were separated tended to have lower knowledge scores than their counterparts. Similar findings have been reported in previous leptospirosis studies, where social support, access to information, and socioeconomic factors influenced

Table 4. Knowledge of leptospirosis among respondents.

Knowledge Component	Question	% Correct	% Wrong		
			Wrong Answer	Unsure Answer	Total Wrong
Mode of Transmission	Leptospirosis is caused by bacteria	90.43	3.19	6.38	9.57
	Rat can transmit Leptospirosis	93.91	1.16	4.93	6.09
	Floodwater can transmit Leptospirosis	97.10	2.61	0.29	2.90
Signs and Symptoms	Infected person may have difficulty in urinating	71.59	2.61	25.80	28.41
	Infected person may have jaundice	72.75	5.22	22.03	27.25
	Infected person may have red eyes	70.43	5.22	24.35	29.57
Disease Prevention	Avoiding wading in the floods can prevent Leptospirosis	93.33	4.93	1.74	6.67
	Maintaining clean surroundings can prevent Leptospirosis	94.78	4.93	0.29	5.22
	Wearing boots during floods can prevent Leptospirosis	96.81	2.61	0.58	3.19

Table 5. Attitudes toward leptospirosis among respondents.

Question	% Agree	% Disagree	% Not Sure
I believe Leptospirosis is a serious illness	97.39	2.39	1.16
I believe that medicine can treat Leptospirosis	92.46	2.61	4.93
I believe I can do something to prevent myself from being infected with Leptospirosis	96.23	0.87	1.16
It is important to control rat population	84.35	9.57	6.09
It is important to follow health advisories during rainy season	99.71	0.29	0.00

Table 6. Distribution of preventive practices related to leptospirosis.

Practice Component	Question	% High frequency of activity	% Low frequency of activity
Protective Gears and Safety Measures	Not wading in floodwater	43.77	56.23
	Wearing waterproof boots when wading in flood water	29.57	70.43
	Not walking barefoot on soil	82.90	17.10
	Wearing rubber gloves when leaning/working in muddy water or damp soil	40.29	59.71
Pest Control Measures	Using poison or traps to eradicate rats	37.10	62.90
	Storing food in sealed or rat proof containers	95.65	4.35

Table 7. Correlations among knowledge, attitude, and practice scores.

Variables	Spearman's ρ (rs)	p-value
Knowledge vs Attitude	0.126	0.020*
Knowledge vs Practice	0.169	0.002*
Attitude vs Practice	0.170	0.001*

• p < 0.05

Spearman's rank correlation coefficient was used to assess associations between KAP domains.

disease awareness and preventive behaviors.^{6,8} These groups may therefore benefit from targeted health education interventions.

Female respondents and those with higher educational attainment demonstrated more favorable attitudes toward leptospirosis. This finding is consistent with previous studies reporting better health attitudes among females and individuals with higher levels of education.^{6,9,10,11,12} Higher educational attainment may improve access to health information and facilitate the adoption of favorable health beliefs and attitudes.

Practice scores were significantly associated with sex, educational attainment, and household income. Females, respondents with higher educational attainment, and those with higher household incomes reported better preventive practices. Similar findings

have been reported in previous studies, suggesting that educational and economic resources may influence the adoption of preventive measures, including the use of personal protective equipment.^{6,13,14}

Knowledge

Respondents demonstrated a high level of knowledge regarding leptospirosis, although the overall knowledge score was slightly lower than that reported in a previous study conducted in Quezon City.⁷ Qualitative responses suggested that knowledge was influenced by community experiences and limited exposure to formal health education activities. Previous studies have likewise identified health workers, health facilities, and mass media as important sources of information on leptospirosis.^{15,16}

Mode of Transmission

Knowledge of disease transmission was high, particularly regarding the risks associated with floodwater exposure. Similar findings have been reported in previous Philippine studies, likely reflecting the recurring association between leptospirosis outbreaks and flooding events in the country.^{7,17,18,19}

Signs and Symptoms

Signs and symptoms constituted the lowest-scoring knowledge domain, consistent with previous local studies.^{6,7} Limited recognition of clinical manifestations may delay disease recognition and timely consultation. Future health education programs should place greater emphasis on both the early and severe manifestations of leptospirosis to facilitate prompt diagnosis and treatment.²⁰

Disease Prevention

Disease prevention was the highest-scoring knowledge domain, consistent with findings from a previous study in Quezon City.⁸ Despite this, preventive practices remained only moderate, suggesting that knowledge alone may not be sufficient to influence behavior. Barriers such as limited access to protective equipment, perceived inconvenience, and environmental constraints may contribute to the gap between knowledge and practice.^{13,21,22} These findings highlight the need for interventions that combine health education with practical and community-based preventive measures.

Attitude

Respondents demonstrated a highly positive attitude toward leptospirosis, with an overall attitude score of 90.91%. This score was higher than that reported in a previous study conducted in Laguna and was generally consistent with findings from other Philippine communities, where positive attitudes toward leptospirosis prevention and management were also observed.^{6,16}

Leptospirosis as a Serious, Treatable, and Preventable Disease

Most respondents regarded leptospirosis as a serious, treatable, and preventable disease. Similar findings have been reported in previous studies conducted in the Philippines and other leptospirosis-endemic countries.^{6,13,15,16,23} Qualitative responses suggested that confidence in disease prevention was influenced by awareness of preventive measures, access to prophylactic medication, and prior community experiences with the disease. Despite these positive attitudes, some respondents perceived environmental factors such as recurrent flooding and persistent rodent infestation as barriers to prevention.

Rat Population Control and Health Advisories

Agreement was highest for adherence to health advisories during the rainy season and lowest for rat population control. While respondents recognized the importance of rodent control, qualitative responses indicated that financial constraints, perceived ineffectiveness of control measures, and reliance on community-wide interventions may limit its prioritization. Similar observations have been reported in previous studies in the Philippines and other endemic settings.^{6,7,14, 24}

Practice

Despite high knowledge and attitude scores, respondents demonstrated only moderate preventive practices against leptospirosis. Similar findings have been reported in studies conducted in Quezon City and Laguna, suggesting that awareness of the disease does not necessarily translate into consistent preventive behaviors.^{6,7,25}

Floodwater Exposure and Use of Protective Equipment

The lowest-scoring practices involved avoiding floodwater exposure and the use of protective equipment such as boots and gloves. Qualitative responses indicated that financial constraints, perceived inconvenience, and the belief that protective equipment is ineffective during severe flooding contributed to poor compliance. Similar barriers have

been reported in studies conducted in the Philippines and other leptospirosis-endemic countries.^{6,7,14,24}

Safe Foot Practices and Food Storage

In contrast, safe foot practices and food storage were among the most frequently reported preventive behaviors. Respondents recognized the importance of wearing footwear and protecting food from contamination, findings that are consistent with previous studies reporting good adherence to basic hygiene and food safety practices.^{6,7,25}

Rodent Control

Rodent control was infrequently practiced despite widespread awareness that rats are the primary reservoir of *Leptospira*. Respondents commonly perceived rodent control measures as ineffective because of the rapid recurrence of infestation and the limited resources available for sustained control efforts. Similar observations have been reported in both local and international studies.^{6,25,26}

Overall, the findings suggest that preventive practices are influenced not only by knowledge and attitudes but also by practical, financial, and environmental constraints. Community-based interventions should therefore combine health education with improved access to protective equipment, environmental sanitation programs, and sustainable rodent control initiatives

Correlation Between KAP

The weak positive correlation between knowledge and attitude observed in this study is consistent with findings from a previous study conducted in Quezon City.⁸ However, studies from Malaysia and Laguna have reported differing results, suggesting that the relationship between knowledge and attitudes may vary across populations and settings.^{17,27}

Despite generally positive attitudes, knowledge regarding the signs and symptoms of leptospirosis remained relatively low. This finding highlights the need for health education programs that emphasize symptom recognition and early consultation, particularly among individuals at increased risk of exposure.

Knowledge was also positively correlated with preventive practices, although the association was weak. This finding suggests that greater awareness of leptospirosis may be associated with better preventive behaviors. Nevertheless, the persistence of moderate practice scores despite high knowledge levels indicates that factors beyond knowledge, such as financial, environmental, and contextual barriers, likely influence behavior.

Similarly, attitude demonstrated a weak positive correlation with preventive practices, consistent with findings from previous local studies.⁸ While favorable attitudes may support preventive behaviors, the observed correlations were weak, indicating that attitudes alone may not be sufficient to ensure consistent adoption of preventive measures.

Conclusion

This study assessed the knowledge, attitudes, and practices regarding leptospirosis among residents of Barangay Doña Imelda, Quezon City.

Respondents demonstrated high levels of knowledge and positive attitudes toward leptospirosis; however, preventive practices remained comparatively lower. Significant associations were observed between KAP scores and selected sociodemographic characteristics, including sex, civil status, educational attainment, household size, and household income.

Weak but significant positive correlations were observed among knowledge, attitude, and practice scores. Despite these associations, important gaps remain in knowledge of the signs and symptoms of leptospirosis and in the adoption of preventive practices.

These findings underscore the need for targeted community-based interventions that strengthen awareness of early disease manifestations, promote consistent use of protective measures, and address practical barriers to preventive behaviors. Enhanced health education, improved access to protective equipment, and sustained environmental sanitation and rodent-control programs may contribute to more effective leptospirosis prevention in high-risk urban communities.

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Krugman S, Overby LR, Mushahwar IK, et al. Viral hepatitis type B: studies on the natural history and prevention reexamined. *N Engl J Med* 1979; 300: 101-6.

Nyland LJ, Grimmer KA. Is undergraduate physiotherapy study a risk factor for low back pain? A prevalence study of LBP in physiotherapy students. Retrieved from: <http://www.Biomed-central.com/1471-2474/4/22>. 2003. [Accessed August 27, 2011].

Rankin J, Tennant PW, Stothard KJ, et al. Maternal body mass index and congenital anomaly risk: A cohort study. *Int J Obes* 2010; 34(9): 1371-80. Available from: <http://ncbi.nlm.nih.gov/pubmed/20368710>. [Accessed August 27, 2011].

Books and other monographs

Personal authors

Adams RD, Victor M. *Principles of Neurology*. New York: McGraw-Hill; 1981.

Chapter in a book

Corbett S. Systemic Response to Injury and Metabolic Support. In: Brunnicardi FC (editor). *Schwartz's Principles of Surgery*. 10th ed. New York: McGraw-Hill; 2015: 13-50.

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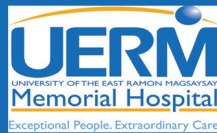
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