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Health Literacy, Patient Activation, and Antibiotic Use Among Hospitalized Patients

Hastanede Yatan Hastalarda Sağlık Okuryazarlığı, Hasta Aktivasyonu ve Antibiyotik Kullanımı

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ABSTRACT

Objective: This study examined the associations of health literacy and patient activation with antibiotic use behavior among hospitalized patients. In addition, the mediating role of patient activation in the relationship between health literacy and antibiotic use behavior was examined.

Methods: A descriptive cross-sectional study was conducted with 237 adult patients admitted to a public hospital. Data were obtained using the "Personal Information Form, Antibiotic Use Scale, Patient Activation Measure, and Health Literacy Scale". Descriptive analyses, Pearson correlation, hierarchical linear regression, and mediation analysis using PROCESS Macro Model 4 were performed.

Results: Greater health literacy ($r = -0.339$, $p < 0.01$) and higher patient activation ($r = -0.293$, $p < 0.01$) were both associated with lower levels of inappropriate antibiotic use. In the adjusted hierarchical regression model, health literacy remained significantly associated with inappropriate antibiotic use ($\beta = -0.155$, $p = 0.049$). Mediation analysis also showed a statistically significant indirect association through patient activation ($B = -0.004$, 95% CI [−0.008, −0.001]), consistent with partial mediation.

Conclusion: The findings indicate that both health literacy and patient activation are associated with more appropriate antibiotic use among hospitalized patients. Strategies aimed at improving these factors may support antimicrobial stewardship by encouraging responsible antibiotic use. Furthermore, the observed indirect association through patient activation suggests that patients' active involvement in healthcare may be relevant to the association between health literacy and antibiotic use behavior.

Keywords: Anti-bacterial agents; drug utilization; health literacy; inpatients; patient activation.

ÖZET

Amaç: Bu çalışma, hastanede yatan hastalarda sağlık okuryazarlığı ve hasta aktivasyonu ile antibiyotik kullanım davranışı arasındaki ilişkileri incelemeyi amaçlamıştır. Ayrıca, sağlık okuryazarlığı ile antibiyotik kullanım davranışı arasındaki ilişkide hasta aktivasyonunun aracılık rolü değerlendirilmiştir.

Yöntem: Tanımlayıcı ve kesitsel tipteki bu araştırma, bir kamu hastanesinde yatarak tedavi gören 237 hasta ile gerçekleştirilmiştir. Veriler, "Kişisel Bilgi Formu, Antibiyotik Kullanım Ölçeği, Hasta Aktivasyon Ölçeği ve Sağlık Okuryazarlığı Ölçeği" kullanılarak toplanmıştır. Verilerin analizinde tanımlayıcı istatistikler, Pearson korelasyon analizi, hiyerarşik doğrusal regresyon analizi ve PROCESS Macro Model 4 ile aracılık analizi kullanılmıştır.

Bulgular: Daha yüksek sağlık okuryazarlığı ($r = -0.339$, $p < 0.01$) ve daha yüksek hasta aktivasyonu ($r = -0.293$, $p < 0.01$), uygunsuz antibiyotik kullanımının daha düşük düzeyleriyle anlamlı şekilde ilişkili bulunmuştur. Düzeltilmiş hiyerarşik regresyon modelinde sağlık okuryazarlığı, uygunsuz antibiyotik kullanımı ile anlamlı ilişkisini korumuştur ($\beta = -0{,}155$, $p = 0{,}049$). Aracılık analizi ayrıca hasta aktivasyonu üzerinden istatistiksel olarak anlamlı bir dolaylı ilişki olduğunu göstermiştir ($B = -0{,}004$, %95 GA [−0,008, −0,001]); bu bulgu kısmi aracılık ile uyumludur.

Sonuç: Bulgular, sağlık okuryazarlığı ve hasta aktivasyonu düzeyleri yükseldikçe hastanede yatan hastalarda uygunsuz antibiyotik kullanım eğiliminin azaldığını göstermektedir. Bu iki faktörü güçlendirmeye yönelik girişimler, sorumlu antibiyotik kullanımını teşvik ederek antimikrobiyal yönetim uygulamalarını destekleyebilir. Ayrıca, hasta aktivasyonu üzerinden gözlenen dolaylı ilişki, hastaların sağlık hizmetlerine aktif katılımının sağlık okuryazarlığı ile antibiyotik kullanım davranışı arasındaki ilişkide önemli olabileceğini düşündürmektedir.

Anahtar Kelimeler: Antibakteriyel ajanlar; ilaç kullanımı; sağlık okuryazarlığı; yatan hastalar; hasta aktivasyonu

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Introduction

Both the prevention and clinical management of bacterial infections continue to rely largely on antibiotic therapy. Current concerns about antimicrobial resistance largely stem from inappropriate patterns of antibiotic use, making this problem one of the greatest challenges facing public health worldwide (1). Irrational antibiotic use promotes the emergence and spread of resistant microorganisms, compromises treatment effectiveness, increases healthcare expenditures, and contributes to higher morbidity and mortality (2). Projections indicate that, if antimicrobial resistance continues unchecked, the annual number of related deaths could rise from roughly 700,000 at present to almost 10 million by 2050 (3). Because antibiotic exposure is common among hospitalized patients, understanding the factors that influence their antibiotic use behavior is essential for supporting antimicrobial stewardship.

Antibiotic use behavior is shaped by more than clinical indications alone. Individual characteristics related to participation in healthcare also play an important role. Patient activation refers to the knowledge, skills, and confidence individuals need to manage their health and participate in healthcare decisions. Individuals with greater patient activation are more likely to manage their health effectively, adopt healthier lifestyle practices, and achieve more favorable clinical outcomes. Patients who exhibit lower levels of engagement in their own care often struggle to manage their conditions effectively and are less likely to use healthcare services appropriately (4,5).

Health literacy represents another key determinant of effective healthcare participation. The ability to make informed healthcare decisions depends largely on individuals' capacity to access, understand, critically assess, and appropriately use health-related information, which is a key feature of adequate health literacy (6). Individuals with adequate health literacy are more likely to understand medication instructions, critically assess available health information, and use healthcare resources appropriately (7). In contrast, inadequate health literacy has been associated with ineffective communication with healthcare professionals, inappropriate use of health services, and poorer health outcomes (8). These findings suggest that health literacy may also be associated with antibiotic use behavior. Health literacy and patient activation may be particularly relevant when considered together in the context of antibiotic use. Understanding medication-related information may support appropriate antibiotic use, but translating this information into behavior may also depend on how actively patients engage in their own care. Previous studies have shown a positive association between health literacy and patient activation (31,32), suggesting that patients who are better able to understand and use health information may also be more engaged in health-related decisions. In this context, patient activation may have an intermediary role in the association between health literacy and antibiotic use behavior. Existing evidence suggests that both health literacy and patient activation are individually associated with antibiotic-related behaviors. However, little is known about how these two constructs are jointly associated with such behaviors or the mechanisms underlying their relationship, especially in hospitalized populations. Antibiotic use behavior among hospitalized patients was examined from the perspective of two key patient-related factors: health literacy and patient activation. The analysis further examined whether patient activation mediated the association between health literacy and antibiotic use behavior.

Accordingly, this study aimed to examine the associations of health literacy and patient activation with antibiotic use behavior among hospitalized patients and to evaluate the mediating role of patient activation in the association between health literacy and antibiotic use behavior.

Material and Method

This research used a cross-sectional design to assess how differences in health literacy and patient activation corresponded to patterns of inappropriate antibiotic use among hospitalized patients. Participants were recruited, and study data were collected at a public hospital in Türkiye from December 2025 to June

Table 1. Patient Descriptive Characteristics

Socio-Demographic Characteristic	Categories	N (%)
Age	18-34 years	41 (17.3)
	35-49 years	87 (36.7)
	50-65 years	109 (46)
Gender	Female	128 (54)
	Male	109 (46)
Marital Status	Married	174 (73.4)
	Single	63 (26.6)
Educational Status	Primary School	41 (17.3)
	Secondary School	69 (29.1)
	High School	89 (37.6)
	University	38 (16)
Chronic Illness	Yes	103 (43.5)
	No	134 (56.5)
Antibiotic Use in the Last 6 Months	Yes	150 (63.3)
	No	87 (36.7)
Self-Rated Health Status	Good	118 (49.8)
	Moderate	91 (38.4)
	Poor	28 (11.8)
Treatment Department	Internal Medicine Service	109 (46)
	Surgical Service	76 (32.1)
	Obstetrics and Gynecology Service	52 (21.9)
Total		**237**

2026. The study sample comprised 237 hospitalized adults aged 18–65 years who were recruited using a convenience sampling approach. Data collection was carried out through face-to-face administration of the questionnaires after written informed consent had been obtained from eligible participants. Each interview lasted about 10–15 minutes.

Study Aim and Hypotheses The research was guided by the following hypotheses:

H1. Health literacy is associated with antibiotic use behavior.

H2. Patient activation is associated with antibiotic use behavior.

H3. Patient activation mediates the association between health literacy and antibiotic use behavior.

Information was obtained using four instruments: a researcher-developed "Personal Information Form", "Antibiotic Use Scale", "Patient Activation Measure (PAM)", and the "Health Literacy Scale–Short Form (HLS-SF12)". Participant characteristics were documented using a researcher-developed Personal Information Form. The form gathered information on age, sex, marital status, education, chronic disease, antibiotic use within the previous six months, self-perceived health, and the clinical department providing treatment. Antibiotic use behavior was evaluated with the 19-item Antibiotic Use Scale developed by Atik and Doğan (9). The scale assesses individuals' general tendencies regarding antibiotic use. Responses are rated on a five-point Likert scale, with higher scores reflecting a stronger tendency toward inappropriate antibiotic use. In this study, the scale was used to evaluate the general antibiotic use tendencies of hospitalized patients. In the current study, the scale demonstrated satisfactory internal consistency (Cronbach's $\alpha = 0.876$). Patient activation was assessed using the 13-item Patient Activation Measure (PAM-13), originally developed by Hibbard et al. (10) and subsequently evaluated for reliability in Turkish by Yayla et al. (11). Raw responses were expressed on a standardized 0–100 scale, allowing higher values to represent greater patient activation. Activation scores were categorized into four levels: Level 1 (≤47.0), Level 2 (47.1–55.1), Level 3 (55.2–67.0), and Level 4

Table 2. Comparison of Antibiotic Use, Patient Activation, and Health Literacy Scores According to Patients' Socio-Demographic Characteristics

Socio-Demographic Characteristic	Categories	n	Antibiotic Use Mean±SD	p	Patient Activation Mean±SD	p	Health Literacy Mean±SD	p
Age	18–34 years	41	2.87 ± 0.46	0.095	60.47 ± 16.05	**<0.001* 1>2,3**	35.31 ± 8.31	**<0.001* 1>2,3**
	35–49 years	87	2.75 ± 0.44		52.63 ± 14.53		31.94 ± 8.51	
	50–65 years	109	2.89 ± 0.52		47.20 ± 17.20		27.55 ± 10.83	
Gender	Female	128	2.83 ± 0.50	0.747	54.88 ± 18.12	**<0.001* 1>2**	31.15 ± 10.14	0.366
	Male	109	2.85 ± 0.47		47.51 ± 13.91		29.96 ± 10.01	
Marital Status	Married	174	2.84 ± 0.51	0.957	50.12 ± 17.16	**0.036* 2>1**	28.76 ± 10.30	**<0.001* 2>1**
	Single	63	2.83 ± 0.43		55.27 ± 14.83		35.71 ± 7.37	
Educational Status	Primary School	41	3.17 ± 0.45	**<0.001* 1>2,3,4**	45.50 ± 16.02	**0.001* 4>3,1**	24.85 ± 10.81	**<0.001* 4>3,2,1**
	Secondary School	69	2.77 ± 0.49		52.15 ± 17.50		30.93 ± 10.22	
	High School	89	2.81 ± 0.46		49.90 ± 16.48		30.29 ± 9.68	
	University	38	2.65 ± 0.44		60.48 ± 12.75		36.97 ± 5.31	
Chronic Illness	Yes	103	2.87 ± 0.52	0.314	48.46 ± 15.92	**0.014* 2>1**	28.21 ± 10.33	**0.001* 2>1**
	No	134	2.81 ± 0.46		53.82 ± 16.97		32.45 ± 9.51	
Antibiotic Use in the Last 6 Months	Yes	150	2.88 ± 0.47	0.083	52.36 ± 15.98	0.294	30.15 ± 10.21	0.359
	No	87	2.76 ± 0.50		49.99 ± 17.86		31.40 ± 9.86	
Self-Rated Health Status	Good	118	2.75 ± 0.42	**0.001* 3>1,2**	55.52 ± 16.45	**<0.001* 1>3**	34.31 ± 7.85	**<0.001* 1>2,3**
	Moderate	91	2.86 ± 0.51		49.38 ± 15.62		28.43 ± 10.01	
	Poor	28	3.13 ± 0.54		41.36 ± 16.11		22.11 ± 11.64	
Treatment Department	Internal Medicine Service	109	2.93 ± 0.48	**0.009* 1>2**	49.18 ± 17.18	**0.022* 3>1**	29.66 ± 10.52	0.399
	Surgical Service	76	2.71 ± 0.48		51.09 ± 15.32		31.24 ± 9.68	
	Obstetrics and Gynecology Service	52	2.81 ± 0.48		56.91 ± 16.69		31.68 ± 9.72	

* Appropriate group comparison tests were applied. Significant ANOVA findings were explored with post hoc tests ($P < 0.05$)

(≥67.1). The reliability of the instrument was supported by a Cronbach's alpha coefficient of 0.880 in the study sample. The 12-item Short-Form Health Literacy Instrument (HLS-SF12), originally developed by Duong et al. (12) and adapted into Turkish by Yılmaz and Eskici (13), was used to assess health literacy. To improve score interpretability, raw responses were converted into a 0–50 standardized index, with increasing values denoting higher health literacy. Internal consistency of the instrument was supported by a Cronbach's alpha coefficient of 0.784 in the current sample.

IBM SPSS Statistics Version 29 (IBM Corp., Armonk, NY, USA) served as the analytical platform for this study. Descriptive statistics were generated first to summarize participant characteristics, reporting categorical data as frequencies (%) and continuous variables as mean ± standard deviation. Distributional assumptions were evaluated using the Kolmogorov–Smirnov and Shapiro–Wilk tests together with skewness and kurtosis coefficients. Associations between continuous variables were estimated using Pearson correlation analysis, whereas group differences were assessed with either independent-samples *t* tests or one-way ANOVA according to the number of groups compared. Hierarchical multiple linear regression was performed as an explanatory model to examine the independent associations of health literacy and patient activation with inappropriate antibiotic use after verification of regression assumptions. Covariates were selected based on the bivariate analyses; sociodemographic and clinical variables significantly associated with inappropriate antibiotic use ($p < 0.05$) were included in the first block of the hierarchical regression model. Accordingly, educational level, self-rated health status, and treatment department were included as covariates, with treatment department represented by dummy variables using the internal medicine service as the reference category.

Mediation analyses were performed with PROCESS Macro Version 5.0 (Model 4), and indirect effects were estimated using 5,000 bias-corrected bootstrap samples. An effect was interpreted as significant when its 95% bootstrap confidence interval did not include zero. All statistical tests were two-sided, adopting an alpha level of 0.05.

The research protocol received approval from the Hatay Mustafa Kemal University Social and Human Sciences Scientific Research and Publication Ethics Committee (Meeting No. 13, Decision No. 40, November 7, 2025), followed by administrative permission from the study hospital. Ethical principles consistent with the Declaration of Helsinki guided every stage of the investigation. Participation was based on voluntary agreement, with written informed consent obtained before enrollment. Participant anonymity and the confidentiality of research data were maintained at all times.

Results

The demographic and descriptive characteristics of the participants are presented in Table 1. The study was completed with 237 hospitalized patients. The largest age group consisted of individuals between 50 and 65 years of age (46.0%). Women accounted for 54.0% of the sample, and 73.4% of participants were married. High school graduates represented the most common educational category (37.6%). More than half of the participants reported having no chronic disease (56.5%). Regarding recent medication history, 63.3% stated that they had used antibiotics within the previous six months. Nearly half of the respondents rated their overall health as good (49.8%). In terms of hospital units, the highest proportion of participants was recruited from internal medicine wards (46.0%).

Table 3. Relationships Between Research Variables

Variables	1	2	3
1. Antibiotic Use Scale	1		
2. Patient Activation Scale	-0.293*	1	
3. Health Literacy Scale	-0.339*	0.581*	1

* indicates a statistically significant correlation at the p < 0.01 level (two-tailed)

The mean score for inappropriate antibiotic use was 2.84 ± 0.49. The average Patient Activation Measure score was 51.00 ± 16.70. Regarding patient activation levels, 55 participants (23.2%) were classified as Level 1, 81 (34.2%) as Level 2, 60 (25.3%) as Level 3, and 41 (17.3%) as Level 4. The mean Health Literacy Index score was 30.00 ± 10.08. Higher scores on the Antibiotic Use Scale indicate a stronger tendency toward inappropriate antibiotic use, whereas higher scores on the Patient Activation Measure and Health Literacy Scale indicate higher levels of patient activation and health literacy, respectively. Thus, negative associations of patient activation or health literacy with antibiotic use scores indicate lower levels of inappropriate antibiotic use. Although the Kolmogorov–Smirnov and Shapiro–Wilk tests indicated statistically significant deviations from normality ($p < 0.05$), the skewness and kurtosis coefficients for all principal variables were within the range of −1 to +1. Considering the sensitivity of formal normality tests to minor deviations in larger samples, the distributions were considered approximately normal, supporting the use of parametric statistical procedures.

Table 2 shows how scores for inappropriate antibiotic use, patient activation, and health literacy varied according to patients' personal and clinical characteristics. According to the analysis results, the tendency for inappropriate antibiotic use was not similar across all variables. Inappropriate antibiotic use scores differed significantly according to educational level, self-rated health status, and treatment department ($p < 0.05$ for all comparisons). Inappropriate antibiotic use scores were higher, particularly among those with lower education levels, those who negatively assessed their health status, and patients hospitalized in internal medicine wards. In contrast, no significant difference was found in terms of age, gender, marital status, presence of chronic disease, and having used antibiotics in the last six months ($p > 0.05$).

When patient activation was examined, several socio-demographic variables were found to be associated with this score ($p < 0.05$ for all comparisons). Younger individuals, women, unmarried

Table 4. Hierarchical Regression Analysis of Factors Associated with Inappropriate Antibiotic Use Behavior

Model	Variables	B	Std. Error	β	t	p
Model 1	Educational Level	−0.126	0.032	−0.247	−3.999	<0.001
	Self-Rated Health Status	0.134	0.044	0.187	3.017	0.003
	Surgical Service[1]	−0.229	0.069	−0.218	−3.341	0.001
	Obstetrics and Gynecology Service[1]	−0.114	0.078	−0.096	−1.454	0.147
	Model statistics	**R^2 = 0.150; Adjusted R^2 = 0.136; ΔR^2 = 0.150; F change = 10.273, p < 0.001; F(4, 232) = 10.273, p < 0.001**				
Model 2	Educational Level	−0.098	0.032	−0.191	−3.051	0.003
	Self-Rated Health Status	0.075	0.047	0.105	1.601	0.111
	Surgical Service[1]	−0.212	0.067	−0.201	−3.148	0.002
	Obstetrics and Gynecology Service[1]	−0.100	0.077	−0.084	−1.303	0.194
	Health Literacy	−0.011	0.003	−0.225	−3.330	0.001
	Model statistics	**R^2 = 0.189; Adjusted R^2 = 0.172; ΔR^2 = 0.039; F change = 11.087, p = 0.001; F(5, 231) = 10.793, p < 0.001**				
Model 3	Educational Level	−0.095	0.032	−0.185	−2.965	0.003
	Self-Rated Health Status	0.072	0.047	0.101	1.550	0.123
	Surgical Service[1]	−0.210	0.067	−0.199	−3.132	0.002
	Obstetrics and Gynecology Service[1]	−0.078	0.077	−0.065	−1.005	0.316
	Health Literacy	−0.008	0.004	−0.155	−1.981	0.049
	Patient Activation	−0.004	0.002	−0.127	−1.728	0.085
	Model statistics	**R^2 = 0.200; Adjusted R^2 = 0.179; ΔR^2 = 0.010; F change = 2.986, p = 0.085; F(6, 230) = 9.570, p < 0.001**				

* B = unstandardized regression coefficient; SE = standard error; β = standardized regression coefficient; *t* = *t* statistic; *p* = probability value. Models 1–3 indicate successive regression models. [1]Treatment department was dummy-coded, with the internal medicine service as the reference category.

individuals, those with higher education, those without chronic diseases, those who positively assessed their health status, and those receiving treatment in the obstetrics and gynecology ward had higher patient activation scores. Patient activation scores did not differ significantly according to antibiotic use within the previous six months (p > 0.05).

Health literacy scores also differed according to certain characteristics (p < 0.05 for all comparisons). Younger age groups, single individuals, university graduates, those without chronic diseases, and those who rated their health status as good had higher health literacy levels. In contrast, gender, recent antibiotic use, and clinical treatment received did not create a significant difference in health literacy scores (p > 0.05).

The correlation analysis findings are shown in Table 3. The analysis results revealed that as health literacy increases, patient activation also increases, and there is a moderate, positive correlation between these two variables (p < 0.01). Furthermore, statistically significant inverse relationships were found between both health literacy and patient activation and inappropriate antibiotic use (p < 0.01). Given that higher Antibiotic Use Scale scores indicate greater inappropriate antibiotic use, the negative correlations indicate that higher levels of health literacy and patient activation are associated with lower levels of inappropriate antibiotic use.

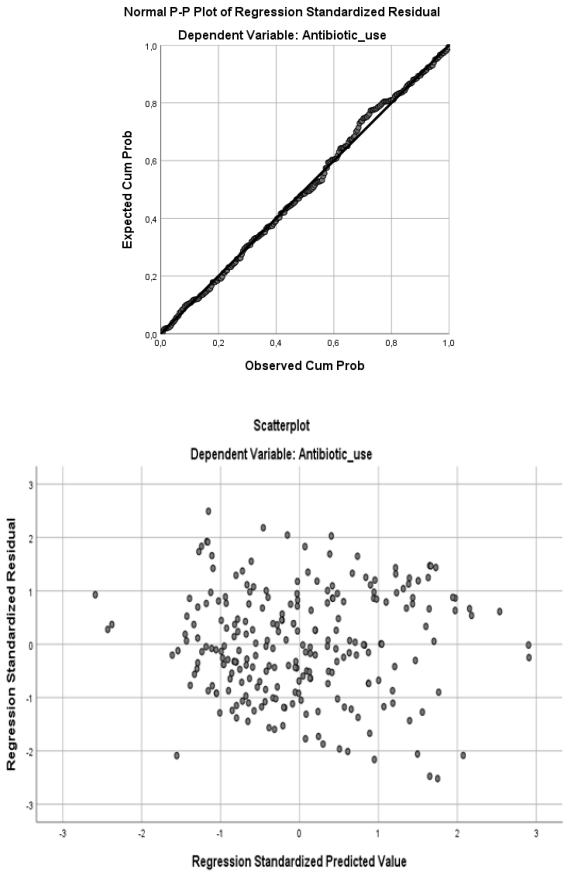
In the hierarchical regression analysis, the covariates entered in Model 1 explained 15.0% of the variance in inappropriate antibiotic use (R^2 = 0.150, p < 0.001) (Table 4). Adding health literacy increased the explained variance by 3.9% (ΔR^2 = 0.039, p = 0.001), whereas the addition of patient activation resulted in a non-significant 1.0% increase (ΔR^2 = 0.010, p = 0.085). In the final model, educational level, surgical service, and health literacy remained significantly associated with inappropriate antibiotic use, whereas self-rated

Table 5. Results of PROCESS Model 4 Examining the Mediating Role of Patient Activation in the Association Between Health Literacy and Inappropriate Antibiotic Use

Path / Effect	B	Std. Error	t	p	95% CI (LLCI–ULCI)
Health Literacy → Patient Activation (path a)	0.963	0.088	10.952	<0.001	0.790 – 1.136
Patient Activation → Antibiotic Use (path b)	-0.004	0.002	-1.919	0.056	−0.009 – 0.000
Health Literacy → Antibiotic Use (direct effect, path c')	-0.013	0.004	-3.410	0.001	−0.020– −0.005
Health Literacy → Antibiotic Use (total effect, path c)	-0.017	0.003	-5.530	<0.001	−0.023 – −0.011
Indirect effect (a × b)	**-0.004**	**0.002**	—	—	**−0.008 – −0.001**

Note: The statistical significance of the indirect effect was determined from the bootstrap confidence interval; an indirect effect was considered statistically significant when the interval did not include zero.

health status, obstetrics and gynecology service, and patient activation were not significantly associated.

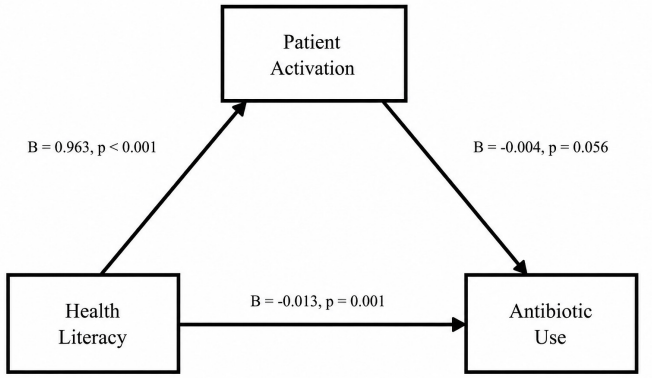


Note. The normal P-P plot and the scatter pattern of the residuals showed that the basic assumptions of the regression model (normality, linearity, and equal variance) were appropriate.

Figure 1. Diagnostic plots evaluating the assumptions of hierarchical linear regression analysis

Regression diagnostics indicated no substantial violations of normality, linearity, homoscedasticity, residual independence, or multicollinearity (Figure 1).

The mediation analysis showed that higher health literacy was associated with higher patient activation (B = 0.963, p < 0.001). Patient activation was not significantly associated with inappropriate antibiotic use after its inclusion in the mediation model (B = −0.004, p = 0.056). When patient activation was included in the model, the direct association between health literacy and inappropriate antibiotic use remained statistically significant (B = −0.013, p = 0.001) (Table 5).



Note. The coefficients presented in the figure represent unstandardized regression coefficients (B).

Figure 2. Indirect association between health literacy and inappropriate antibiotic use through patient activation (PROCESS Model 4)

The bootstrap confidence interval for the indirect association did not include zero (B = −0.004, 95% CI [−0.008, −0.001]), providing evidence of a statistically significant indirect association between health literacy and inappropriate antibiotic use through patient activation. Because the direct association between health literacy and inappropriate antibiotic use remained statistically significant, the findings were consistent with partial mediation. Given the

cross-sectional design, this mediation finding should be interpreted as an indirect statistical association without implying causality.

Discussion

The present study examined patients' tendencies toward inappropriate antibiotic use, patient activation, and health literacy among hospitalized patients. Differences in inappropriate antibiotic use were observed according to educational attainment, perceived health status, and treatment department, whereas patient activation and health literacy varied across several demographic and clinical characteristics. In addition, higher health literacy was associated with greater patient activation, and both variables were linked to lower levels of inappropriate antibiotic use. Mediation analysis further indicated that there was a significant indirect association between health literacy and antibiotic use behavior through patient activation.

The observed inappropriate antibiotic use scores suggest that potentially inappropriate antibiotic-related behaviors remain relevant among hospitalized patients, consistent with previous studies (15). Patients with lower educational attainment exhibited higher inappropriate antibiotic use, consistent with previous studies reporting associations between educational attainment and antibiotic use behaviors (16,17). Similarly, participants reporting poorer health status demonstrated higher inappropriate antibiotic use, possibly reflecting greater symptom burden and increased treatment-seeking behavior (18,19). Patients hospitalized in internal medicine services also showed higher inappropriate antibiotic use, which may be explained by the greater frequency of suspected infections and empirical antibiotic prescribing in these settings compared with protocol-based surgical care (20).

The largest proportion of participants was classified as Level 2 on the Patient Activation Measure (34.2%), indicating basic awareness of health management but limited confidence in maintaining health-related behaviors, consistent with previous findings (11,21). Patient activation was higher among younger, female, single, and more highly educated participants, as well as among those without chronic disease, those reporting better health, and patients treated in obstetrics and gynecology services. These findings suggest that younger age, higher educational attainment, lower disease burden, and healthcare environments that encourage patient participation may facilitate greater engagement in health management (22–25).

The health literacy findings were generally consistent with those reported in previous studies (26). Higher health literacy among younger, single, and university-educated participants, as well as among those without chronic disease and with better self-rated health, is consistent with previous evidence showing that education, access to information, and better perceived health facilitate the acquisition and effective use of health information (27–30).

The moderate positive association between health literacy and patient activation suggests that individuals with better health literacy are more actively involved in managing their health (31,32). Both health literacy and patient activation were inversely associated with inappropriate antibiotic use, although these relationships were modest, indicating that antibiotic use behavior is also influenced by clinical decision-making and healthcare professionals' recommendations (33–35).

After controlling for educational level, self-rated health status, and treatment department, health literacy remained significantly associated with inappropriate antibiotic use. Mediation analysis also identified a significant indirect association between health literacy and inappropriate antibiotic use through patient activation. These findings suggest that higher health literacy is associated with more appropriate antibiotic use and that patient activation may partly account for this relationship. Individuals who are able to understand and evaluate health information are more likely to participate actively in treatment decisions and apply medication-related recommendations appropriately. Nevertheless, because antibiotic therapy among hospitalized patients is primarily guided by physicians and institutional treatment protocols, the associations

with individual behavioral factors should be interpreted within this clinical context (24,33,36–40).

Limitations Regarding the Scope of the Study

Several considerations should be taken into account when interpreting the findings of this study. Because the sample was drawn from a single public hospital, the extent to which the results apply to other healthcare settings may be limited. In addition, the study relied on participants' self-reports, which may have introduced reporting bias. In addition, the Antibiotic Use Scale assesses patients' general antibiotic use behaviors and tendencies and does not provide a clinical assessment of the appropriateness of antibiotic therapy prescribed during the current hospitalization. The inclusion of only individuals who were able and willing to complete the questionnaires may also have reduced the representativeness of the study population. Furthermore, the cross-sectional nature of the research does not allow conclusions about causal relationships among the study variables.

Conclusion

The results suggest that higher health literacy and patient activation are associated with lower levels of inappropriate antibiotic use among hospitalized patients. In addition, a statistically significant indirect association between health literacy and antibiotic use through patient activation was observed. Although antibiotic use is strongly influenced by prescription practices and clinical decision-making, these findings suggest that individual behavioral factors are also associated with antibiotic use behavior.

Interventions to promote appropriate antibiotic use should therefore combine strategies to improve health literacy with approaches that strengthen patient activation. Supporting patient-centered communication and shared decision-making may enhance patients' involvement in treatment and contribute to antimicrobial stewardship efforts aimed at reducing inappropriate antibiotic use.

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