



Article

Assessment of Inappropriate Omeprazole Prescribing, Associated Factors and Financial Impact in the Outpatient Department of a General Hospital in Thailand

Saranporn Srithonrat ¹, Chayanat Pongsathabordee ², Satawat Kulworahathai ³, Chidawan Prapat ²,
Aticha Jamratkittiwan ², Nichakan Jitakson ² and Taniya Paiboonvong ^{2,*}

¹ Faculty of Pharmacy, Pathumthani University, Mueang Pathum Thani 12000, Thailand; saranporn.s@ptu.ac.th

² Department of Pharmacy Practice, College of Pharmacy, Rangsit University, Mueang Pathum Thani 12000, Thailand; chayanat.p@rsu.ac.th (C.P.); chidawan.p64@rsu.ac.th (C.P.); aticha.j64@rsu.ac.th (A.J.); nichakan.j64@rsu.ac.th (N.J.)

³ Pharmacy Department, Rajavithi 2 (Rangsit) Hospital, Mueang Pathum Thani 12000, Thailand; satawat.kul@gmail.com

* Correspondence: taniya.p@rsu.ac.th

Abstract

Background: Proton pump inhibitors (PPIs) are widely used for the treatment of gastrointestinal (GI) disorders. Omeprazole is one of the most commonly prescribed PPIs in Thailand. However, it is frequently overprescribed in hospital settings, increasing the risk of adverse effects. Moreover, such overuse imposes unnecessary healthcare costs. **Objectives:** To determine the prevalence of potentially inappropriate omeprazole prescribing and its associated factors, and to assess the financial impact of its overuse. **Methods:** This retrospective cross-sectional study was conducted in a general hospital in Thailand. Outpatients who received omeprazole between 1 January 2025 and 30 June 2025 were included. Descriptive statistics were used to summarize the data. The Chi-square test and Fisher's exact test were used to compare categorical variables, as appropriate. Factors associated with inappropriate omeprazole prescribing were evaluated using logistic regression analysis. **Results:** A total of 229 patients receiving 347 omeprazole prescriptions were included. The mean age was 61.35 ± 17.17 years, and 59.4% were female. Inappropriate omeprazole prescribing was identified in 58.2% of prescriptions, primarily due to lack of appropriate indications (75.2%), followed by inappropriate duration. Antiplatelet use (OR 0.21, 95% CI 0.11–0.38, $p < 0.001$) and dual antiplatelet therapy (OR 0.05, 95% CI 0.01–0.37, $p = 0.004$) were significantly associated with a lower likelihood of inappropriate prescribing. **Conclusion:** Inappropriate omeprazole prescribing was common and largely driven by the absence of a clear indication, which was the main contributor to excess costs. Targeted interventions focusing on appropriate initiation, GI risk assessment, and regular reassessment may improve prescribing quality and reduce unnecessary healthcare expenditure.

Keywords: omeprazole; proton pump inhibitors; medication overuse; financial impact

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1. Introduction

Proton pump inhibitors (PPIs) are frequently prescribed medications worldwide and are widely used for the management of acid-related gastrointestinal conditions, such as gastroesophageal reflux disease (GERD) and peptic ulcer disease. In addition, PPIs are commonly co-prescribed with nonsteroidal anti-inflammatory drugs (NSAIDs), antiplatelet agents, or anticoagulants for prophylaxis in patients at high risk of gastrointestinal (GI) bleeding. However, their widespread availability has contributed to overuse beyond recommended indications and prolonged therapy due to a lack of evaluation [1].

Although PPIs are generally well tolerated, their overprescription or extended use beyond recommendations has raised concerns regarding safety profiles. An inappropriate long-term PPI prescription across Southeast Asia is widespread, which may have affected clinical outcomes. Implementing PPI rationalization is challenging [2]. Several studies have demonstrated associations between prolonged PPI therapy and adverse outcomes, including renal complications, infections, fractures, and micronutrient deficiencies [3,4].

Omeprazole is listed in the World Health Organization Model List of Essential Medicines [5], underscoring its importance in the management of acid-related gastrointestinal disorders. It remains one of the most commonly used PPIs, particularly in low- and middle-income countries, due to its clinical effectiveness and low cost. In Thailand, omeprazole enteric-coated capsules are also included in the National List of Essential Medicines, making them widely accessible to patients at no cost under public health insurance schemes, including the Universal Coverage Scheme (UCS), Social Security Scheme (SSS), and Civil Servant Medical Benefit Scheme (CSMBS). However, inappropriate PPI use has been reported globally and in several countries across Southeast Asia, resulting in a contributor to unnecessary healthcare costs [2]. According to the literature reports from Thailand, PPIs were the most prescribed potentially inappropriate medication (PIM) at about 20–30% [6,7], and omeprazole was the most prescribed in 20.8% of PIM in one study [8]. Moreover, PPIs were prescribed inappropriately, up to 50% at a tertiary-care hospital, in both inpatient and outpatient settings, in Thailand, which contributed to excessive healthcare costs [9]. In response, concerns regarding irrational medication use have led to the nationwide implementation of the Rational Drug Use policy by the Ministry of Public Health since 2016, aiming to improve patient safety and promote cost-effective prescribing across all levels of healthcare [10].

Although several studies suggest a high prevalence of inappropriate PPI use, most have primarily focused on potentially inappropriate indications. Moreover, available data remain fragmented, limiting a comprehensive assessment of PPI overuse across several aspects, including indication, dose, and duration of treatment in routine clinical practice, as well as avoidable cost at the institutional level. Therefore, this study aimed to determine the prevalence of potentially inappropriate omeprazole prescribing in a general hospital and to estimate the direct financial impact associated with its overuse. Additionally, factors associated with inappropriate prescribing were also investigated. The findings of this study may provide evidence to inform strategies for improving rational drug use in clinical practice.

2. Results

A total of 229 patients were included in this study, accounting for 347 omeprazole prescriptions. The number of prescriptions per patient ranged from 1 to 5 during the study period. Most patients had only one prescription (62.0%), followed by two prescriptions (28.8%). The mean age was 61.35 ± 17.17 years, and the majority of patients were female (59.4%). Omeprazole was predominantly prescribed for GI prophylaxis in patients receiving medications associated with GI bleeding risk (37.8%); antiplatelet agents (18.4%) and NSAIDs (17.6%) were the most commonly co-prescribed medications. Among GI-related conditions, functional dyspepsia was the most common indication (59/347, 17.0%). Base-

line patient and prescription characteristics are presented in Table 1. Comparison of the appropriate and inappropriate prescribing groups showed significant differences in age, antiplatelet use, and dual antiplatelet therapy (DAPT) (Table 2).

Table 1. Baseline characteristics of participants ($n = 229$).

	Patient (%)
Sex	
Female	136 (59.4)
Male	93 (40.6)
Age (mean $\pm$ SD), years	61.35 $\pm$ 17.17
18–65	133 (58.1)
>65	96 (41.9)
Comorbidity	
Hypertension	103 (45.0)
Dyslipidemia	103 (45.0)
Diabetes mellitus	53 (23.1)
Chronic kidney disease	12 (5.2)
Coronary heart disease	5 (2.2)
Cerebrovascular disease	8 (3.5)
Gout	7 (3.0)
Atrial fibrillation	3 (1.3)
Indication of omeprazole	
GI prophylaxis	82 (35.8)
Functional dyspepsia	45 (19.7)
GERD	18 (7.9)
Gastric ulcer disease	1 (0.4)
Erosive esophagitis	1 (0.4)
Concomitant medications-related GI bleeding	
Antiplatelet	37 (16.2)
NSAIDs	42 (18.3)
DAPT	7 (3.1)
Anticoagulants (Warfarin/DOACs)	3 (1.3)
Prednisolone	4 (1.7)
Health insurance schemes	
Direct payment	69 (30.1)
Civil servant medical benefit scheme	55 (24.1)
Self-pay	53 (23.1)
Universal coverage scheme	25 (10.9)
Social security scheme	27 (11.8)

GERD: Gastroesophageal reflux disease, GI: Gastrointestinal, NSAIDs: Non-steroidal anti-inflammatory drugs, DAPT: Dual antiplatelet therapy, DOACs: Direct oral anticoagulants.

Table 2. Comparison of characteristics between the appropriate and inappropriate omeprazole prescribing ($n = 347$).

	Appropriate (%) $n = 145$	Inappropriate (%) $n = 202$	p -Value
Sex			0.428
Female	88 (60.7)	114 (56.4)	
Male	57 (39.3)	88 (43.6)	
Age in years			<0.001
18–65	65 (44.8)	130 (64.4)	
>65	80 (55.2)	72 (35.6)	

Concomitant medications-related GI bleeding			
Antiplatelet	46 (31.7)	18 (8.9)	<0.001
NSAIDs	18 (12.4)	43 (21.3)	0.032
DAPT	11 (7.6)	1 (0.5)	<0.001
Anticoagulants (Warfarin/DOACs)	3 (2.1)	5 (2.5)	1.000
Prednisolone	3 (2.1)	3 (1.5)	0.697
Health insurance schemes			0.788
Direct payment	43 (29.7)	63 (31.2)	
Civil servant medical benefit scheme	37 (25.5)	45 (22.3)	
Self-pay	36 (24.8)	44 (21.8)	
Universal coverage scheme	14 (9.7)	26 (12.9)	
Social security scheme	15 (10.3)	24 (11.8)	

GI: Gastrointestinal, NSAIDs: Non-steroidal anti-inflammatory drugs, DAPT: Dual antiplatelet therapy. DOACs: Direct oral anticoagulants.

2.1. Characteristics of Inappropriate Prescribing

Our findings indicate that 202 of 347 prescriptions (58.2%) were inappropriate. The majority of inappropriate prescribing was related to indication (152/202, 75.2%). Among these, most prescriptions lacked a documented indication or clinical symptoms relevant to rational use (123/152, 80.9%), while approximately 20% represented omeprazole over-use for prophylaxis in patients at low risk of GI bleeding. Inappropriate duration was the second most common issue (38/202, 18.8%), primarily involving prolonged therapy, with a mean excess duration of 40 ± 30.52 days per prescription. These cases were most frequently observed among patients receiving omeprazole for GI prophylaxis (18/38, 47.4%). Inappropriate dosing was less frequently identified (12/202, 5.9%), with patients with functional dyspepsia accounting for the largest proportion of cases (6/12, 50.0%).

According to recommendations for PPI prophylaxis, inappropriate prescribing was observed in 51 of 131 prescriptions (38.9%). When focusing on concomitant medications, NSAIDs were the most frequently identified group of inappropriate co-prescribing (43/61, 70.5%), with the majority lacking an appropriate indication for prophylaxis (32/61, 52.5%). The second most common group was antiplatelet agents (18/64, 28.1%), which were also predominantly prescribed without an appropriate indication (9/64, 14.1%). Characteristics of inappropriate prescribing are presented in Table 3.

Table 3. Characteristics of inappropriate omeprazole prescriptions ($n = 202$).

Indication	Inappropriate Omeprazole Prescription		
	Indication (%) ($n = 152$)	Dose (%) ($n = 12$)	Duration (%) ($n = 38$)
No indication	123 (80.9)	0 (0.0)	0 (0.0)
GI prophylaxis	29 (19.1)	4 (33.4)	18 (47.4)
- Antiplatelet	9 (14.1)	3 (4.7)	6 (9.3)
- NSAIDs	32 (52.5)	2 (3.3)	9 (14.7)
- DAPT	0 (0.0)	0 (0.0)	1 (8.3)
- Anticoagulants (Warfarin/DOACs)	3 (37.5)	0 (0.0)	2 (25.0)
- Prednisolone	1 (16.7)	0 (0.0)	2 (33.3)
Erosive esophagitis	0 (0.0)	1 (8.3)	1 (2.6)
GERD	0 (0.0)	1 (8.3)	8 (21.1)
Gastric ulcer disease	0 (0.0)	0 (0.0)	0 (0.0)
Functional dyspepsia	0 (0.0)	6 (50.0)	11 (28.9)

GERD: Gastroesophageal reflux disease, GI: Gastrointestinal, NSAIDs: Non-steroidal anti-inflammatory drugs, DAPT: Dual antiplatelet therapy, DOACs: Direct oral anticoagulants.

2.2. Factors Associated with Inappropriate Prescribing

In univariate analysis, NSAID use (OR 1.91, 95% CI: 1.05–3.47, $p = 0.034$), antiplatelet use (OR 0.21, 95% CI: 0.12–0.38, $p < 0.001$), and DAPT (OR 0.06, 95% CI: 0.01–0.47, $p = 0.008$) were significantly associated with inappropriate prescribing, whereas age was not statistically significant (OR 0.99, 95% CI: 0.98–1.00, $p = 0.052$).

In multivariate analysis, antiplatelet use (OR 0.21, 95% CI: 0.11–0.38, $p < 0.001$) and DAPT (OR 0.05, 95% CI: 0.01–0.37, $p = 0.004$) remained significantly associated with inappropriate prescribing, while other variables were not statistically significant (Table 4). Overall, antiplatelet use and DAPT were strongly associated with a reduced likelihood of inappropriate prescribing, with DAPT showing a particularly strong effect.

Table 4. Multivariable analysis of factors associated with inappropriate prescribing.

Variable	OR (95% CI)	<i>p</i> -Value
Age	0.99 (0.98–1.01)	0.243
NSAIDs	1.24 (0.66–2.31)	0.504
Antiplatelet	0.21 (0.11–0.38)	<0.001
DAPT	0.05 (0.01–0.37)	0.004

NSAIDs: Non-steroidal anti-inflammatory drugs; DAPT: Dual antiplatelet therapy.

2.3. Cost of Omeprazole Overuse

Regarding health insurance schemes, most patients were covered by direct payment. A total of 10,475 omeprazole tablets were estimated to be overused because of inappropriate prescribing, resulting in an excess direct drug cost of 5657 THB (213 USD). The mean cost of unnecessary use was around 1 USD per prescription. The majority of the financial loss was attributable to inappropriate indication (91.2%).

3. Discussion

Previous studies evaluating the appropriateness of omeprazole prescribing in Thailand have primarily focused on prescribing indications. In contrast, the present study provides a more comprehensive assessment encompassing prescribing indications, dosage, and treatment duration. In addition, this study estimated the avoidable costs of omeprazole overuse and identified factors related to inappropriate prescribing. Our findings provide locally relevant evidence to support rational PPI prescribing within the Thai healthcare system. In the present study, the prevalence of inappropriate omeprazole prescribing was high, accounting for 58.2% of prescriptions, with the majority of inappropriate indications (75.2%). These findings are in line with existing evidence indicating that PPIs are commonly used inappropriately across countries in various healthcare settings, with reported prevalence rates ranging from 40% to 70%, frequently prescribed without a documented indication [9,11–16]. The prevalence observed in our study was higher than that reported among outpatients in Italy (40%) [13] and slightly higher than that reported in an outpatient study from China (50%) [14]. These differences may be attributed to variations in healthcare settings, prescribing practices, patient populations, and the criteria used to assess prescribing appropriateness. Furthermore, the absence of a formal omeprazole drug use evaluation (DUE) program at the study hospital may have contributed to the relatively high prevalence of inappropriate prescribing.

Our findings are also consistent with a previous study in Thailand, which demonstrated that 54–60% of omeprazole prescriptions lacked an appropriate indication over a 5-year period [17]. Although inappropriate dosing and duration were less common in our results, prolonged omeprazole use beyond recommended durations remained prevalent, particularly in prescriptions for GI prophylaxis (47.4%). Potentially inappropriate treatment duration has been

reported in a Thai general hospital, where long-term continuous use of omeprazole for 1–5 years was observed in 21.3% of patients [18]. These findings reflect unnecessary prolonged therapy without regular reassessment. Prolonged PPI use has been associated with several clinically relevant adverse outcomes. Although these outcomes were not assessed in this study, they highlight the importance of avoiding long-term use.

Considering omeprazole use for GI prophylaxis, overuse accounted for approximately 20% of prescriptions. This proportion is lower than that reported in a previous study from Thailand by Chatrattanakulcha et al., which found that 70.6% of patients without risk factors for upper GI bleeding received acid-suppressive therapy inappropriately [19]. Moreover, another study reported that 43.5% of patients received GI prophylaxis without an appropriate indication [20]. In subgroup analyses based on concomitant medications, co-prescription with NSAIDs was frequently inappropriate (approximately 70%), with about half of these cases lacking a clear indication for prophylaxis. Our findings indicate a higher prevalence than that reported in a study by Udomsin et al., in which 30% of omeprazole prescriptions among NSAID users at low risk of GI bleeding were considered inappropriate [21]. The higher prevalence observed in our study may be partly explained by differences in study focus and patient characteristics. While their study specifically evaluated omeprazole use among NSAID users, our study included a broader range of indications, resulting in a relatively smaller NSAID subgroup and limiting direct comparability. However, these findings highlight the importance of appropriate patient selection for GI prophylaxis. Notably, prescribing was largely appropriate among patients receiving antiplatelet and DAPT (91.7%), suggesting better adherence to guideline-based prescribing in high-risk patients. This observation is consistent with our regression analysis, in which antiplatelet use (OR 0.21, 95% CI 0.11–0.38, $p < 0.001$) and DAPT (OR 0.05, 95% CI 0.01–0.37, $p = 0.004$) were significantly associated with a lower likelihood of inappropriate prescribing.

Literature on factors associated with inappropriate PPI prescribing remains limited. A study by Korayem et al. reported that patients not receiving medications associated with a high risk of GI bleeding had higher odds of inappropriate acid-suppressive therapy, most of which were PPIs (OR 4.06; 95% CI 1.09–13.8, $p = 0.027$) [22]. These findings are consistent with our results, in which the use of antiplatelet therapy and DAPT, both associated with increased GI bleeding risk, was linked to a lower likelihood of inappropriate PPI prescribing. Increasing age was also reported to be significantly associated with a reduced likelihood of inappropriate prescribing in their study (OR 0.98, 95% CI 0.95–1.00, $p = 0.025$). In our study, although age was not statistically significant (OR 0.99, 95% CI 0.98–1.01, $p = 0.243$), a similar trend was observed. This consistency in direction suggests that older patients may be less likely to receive inappropriate prescriptions, possibly due to more cautious prescribing practices in this population. The lack of statistical significance in our study may be explained by differences in sample size, patient characteristics, or clinical setting. Additionally, a recent study conducted in an outpatient setting in Thailand reported a similar trend that antiplatelet therapy (OR 0.50, 95% CI 0.31–0.83) and DAPT (OR 0.35, 95% CI 0.14–0.91) were associated with a reduced likelihood of inappropriate PPI use. That study also identified additional protective factors, including concomitant use of antiplatelets with steroids (OR 0.12, 95% CI 0.02–0.58) and NSAIDs (OR 0.16, 95% CI 0.03–0.82), which were not observed in our findings. These discrepancies may be explained by differences in study populations or prescribing contexts. Nevertheless, other determinants may be attributed to both prescribing behaviors and knowledge-related factors, including broad indications, inadequate awareness of appropriate use, and an incomplete understanding of ulcer risk [2,23].

In terms of financial impact, evidence from Thailand also suggests that inappropriate use of PPIs imposes a substantial financial loss on healthcare systems. A study from a

tertiary-care hospital reported that the annual cost of inappropriate PPI prescribing exceeded 300,000 USD; inpatient and outpatient costs were estimated at 118,659 USD and 214,663 USD, respectively [9], highlighting a considerable amount of avoidable expenditure at a larger institutional level. In contrast to our findings, the estimated avoidable cost of omeprazole per prescription was relatively low, with an average of 1 USD (30 THB), attributable to the lower price of generic omeprazole. Nevertheless, this is in line with the estimated cost of previous studies conducted in outpatient settings in Thailand; one study reported an average financial loss of 23.35 ± 18.12 THB per prescription over a 5-year period, with the highest loss observed in the civil servant medical benefit scheme [17]. Another study reported an average cost of 25.31 THB per prescription when omeprazole was co-prescribed with NSAIDs [21]. Although the cost per prescription appears relatively small, the high volume and prolonged use of omeprazole in routine clinical practice may result in considerable cumulative expenditure. These findings highlight that the impact of inappropriate prescribing is driven not only by drug price but also by prescribing volume and duration of therapy, underscoring the need for targeted interventions to optimize PPI use and reduce unnecessary healthcare costs.

From a clinical practice perspective, guideline-based or institutional protocols for omeprazole prescribing should be implemented at the study site to support clinical decision-making. Additionally, the prescribing system should require documentation of an indication for omeprazole use, particularly for prophylaxis of GI bleeding in patients who meet appropriate criteria, with integration of validated risk assessment tools. Therefore, the implementation of a PPI stewardship program is warranted to promote rational drug use, and pharmacist-led interventions could help optimize clinical outcomes [24,25].

4. Materials and Methods

4.1. Study Design and Participants

This retrospective cross-sectional study was conducted at Rajavithi 2 (Rangsit) Hospital. Adult outpatients (aged ≥ 18 years) who received at least one omeprazole prescription between 1 January and 30 June 2025 were screened for eligibility. Patients with incomplete data required for analysis were excluded. The sample size was calculated based on the prevalence of inappropriate omeprazole prescribing reported in a previous study [17], using a 95% confidence level and a margin of error of 5%, resulting in a required minimum sample size of 323 prescriptions. A total of 715 patients were identified during the study period. Because some patients received multiple omeprazole prescriptions during the six-month study period, patient-level sampling was used to provide a comprehensive overview of continuous omeprazole use over time. Systematic random sampling was performed by selecting every third patient from the sampling frame after a random starting point, resulting in 238 selected patients. After excluding nine patients with incomplete data, 229 patients were included in the analysis. All eligible omeprazole prescriptions from the selected patients were reviewed, accounting for a total of 347 prescriptions.

4.2. Data Collection and Analysis

We collected patient data from the electronic medical records (EMR) database of the hospital. Data collection was performed by three trained pharmacy students who received standardized training regarding study procedures and assessment criteria. All collected data and prescribing assessments were reviewed and validated by the supervising investigators, and discrepancies or uncertainties were resolved through discussion. Inappropriate prescribing was categorized as inappropriate indication, dose, or duration of treatment, according to the United States Food and Drug Administration (USFDA) approvals and guideline recommendations (Table 5) [26–31].

Table 5. The recommendations of omeprazole based on USFDA approvals and guidelines.

Indication	Dose	Duration
<i>Helicobacter pylori</i> infection	40 mg/day	2 weeks
Erosive esophagitis	40 mg/day	4–8 weeks
GERD		
Extra-esophageal symptoms	40 mg/day	8–12 weeks
Typical symptoms	20 mg/day (max 40 mg/day)	4–8 weeks
Non-cardiac chest pain	40 mg/day	4–8 weeks
Ulcer of esophagus	20 mg/day	4–8 weeks
Gastric ulcer disease	40 mg/day	4–8 weeks
Duodenal ulcer disease	20 mg/day	4 weeks
Peptic ulcer	20 mg/day	4–8 weeks
Functional dyspepsia	20 mg/day	4–8 weeks
GI prophylaxis (moderate to high risk)	20 mg/day	During risk exposure

The appropriateness of omeprazole indications was assessed using all available clinical information documented in the EMR, including diagnoses, presenting symptoms, concomitant medications, and physician notes when available. Prescriptions were classified as no indication when no documented diagnosis or supporting clinical information consistent with approved indications for omeprazole could be identified. For GI prophylaxis, omeprazole prescribing was considered appropriate in patients receiving NSAIDs, antiplatelet agents, or anticoagulants who met moderate- or high-risk criteria according to ACCF/ACG/AHA 2008, ACG 2009, and ACC2020 recommendations [29–31]. Risk stratification was based on guideline-defined GI bleeding risk factors, including a history of peptic ulcer disease or GI bleeding, advanced age, and concomitant corticosteroid use. Prescriptions were classified as potentially inappropriate if any of the following criteria were met: inappropriate indication, dose, or duration of therapy.

The financial analysis was limited to direct medication costs from the hospital perspective attributable to omeprazole overuse, defined as a prescription without an appropriate indication, excessive dosing, or prolonged duration beyond the guideline recommendation. The cost was estimated by calculating the number of excess tablets resulting from overuse and multiplying this by the unit acquisition cost of omeprazole. Drug costs were based on the hospital procurement price in 2025 (0.54 THB per tablet). Costs were converted to US dollars using an exchange rate of 30 THB per USD.

Categorical variables were presented as frequencies and percentages, while continuous variables were summarized as mean $\pm$ SD. The Chi-square test and Fisher's exact test were used to compare categorical variables, with a significance level of 0.05. The association between potential factors and inappropriate omeprazole prescribing was evaluated using logistic regression analysis. Univariate logistic regression was performed to assess the association between each potential factor and inappropriate omeprazole prescribing. Variables with a p -value < 0.20 in the univariate analysis were included in the multivariate logistic regression model to identify independent factors associated with inappropriate prescribing. Multicollinearity was assessed using variance inflation factors (VIFs), with VIF > 5 indicating significant multicollinearity. Descriptive and comparative analyses were performed using IBM SPSS Statistics version 25.0, whereas univariate and multivariable logistic regression analyses were conducted using Stata version 16.1.

5. Conclusions

The high prevalence of inappropriate omeprazole prescribing observed in this setting was largely driven by the absence of documented indications. Prescribing was more appropriate among patients at high risk of GI bleeding, particularly those receiving antiplatelet therapy. Inappropriate prescribing related to indication was the main contributor to excess costs. Targeted interventions focusing on appropriate initiation, assessment of GI bleeding risk, and regular reassessment of continued use may improve prescribing quality and reduce unnecessary healthcare expenditure.

6. Strengths and Limitations

This study provides a comprehensive evaluation of omeprazole prescribing by applying explicit criteria across indication, dose, and duration in a real-world outpatient setting. The integration of prescribing patterns with associated factors offers deeper insight into the drivers of inappropriate use. In addition, the inclusion of cost analysis highlights the financial impact of omeprazole overuse, based on excess direct medication costs. Importantly, these findings are readily translatable into practice and can inform targeted interventions, including DUE programs and quality improvement initiatives based on the Plan-Do-Study-Act Cycle. However, several limitations should be acknowledged. First, this was a single-center study, which may limit the generalizability of the findings to other healthcare settings. Second, the retrospective design may be subject to potential misclassification of inappropriate prescribing, particularly when clinical indications were not clearly recorded. In addition, the exclusion of patients with incomplete data may have introduced selection bias, and the cross-sectional design precludes causal inference. Third, some subgroups, particularly patients receiving anticoagulants, had relatively small sample sizes, which may limit the statistical power to detect significant associations. Fourth, prescribing appropriateness was assessed at the prescription level because indications and concomitant medications may vary across clinical visits. Although only a small proportion of patients contributed multiple prescriptions during the study period, repeated prescriptions from the same patient may have introduced within-patient correlation, which was not explicitly accounted for in the regression analysis. Finally, the financial impact was estimated using direct medication costs only and did not account for indirect costs or potential cost savings from prevented gastrointestinal complications, which may underestimate the overall economic impact. Despite these limitations, this study provides valuable real-world evidence on prescribing patterns and highlights key targets for improving the rational use of PPIs in Thai clinical practice.

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Informed Consent Statement: Patient consent was waived due to the retrospective observational study from electronic medical records.

Data Availability Statement: The data presented in this study are available on request from the corresponding author due to ethical restrictions involving patient information.

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Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

PPIs	Proton pump inhibitors
GI	Gastrointestinal
GERD	Gastroesophageal reflux disease
NSAIDs	Nonsteroidal anti-inflammatory drugs
UCS	Universal Coverage Scheme
SSS	Social Security Scheme
CSMBS	Civil Servant Medical Benefit Scheme
PIM	Potentially inappropriate medication
EMR	Electronic medical record
USFDA	United States Food and Drug Administration
DAPT	Dual antiplatelet therapy

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