ORIGINAL ARTICLE

Evaluation of Saudi Adults' Knowledge and Awareness Regarding the Risks of Long-term Use of Proton Pump Inhibitors

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Abstract

Introduction: Proton pump inhibitors (PPIs) are among the most prescribed medications for the management of upper gastrointestinal disorders. Although they are generally considered safe and effective for short-term use, prolonged or unsupervised intake has been associated with several adverse health outcomes. In Saudi Arabia, the widespread availability of PPIs without prescription raises significant concerns regarding public awareness and the potential for inappropriate use. **Objectives:** This study aims to assess the awareness and knowledge of Saudi adults concerning the long-term side effects of PPIs. **Materials and Methods:** A cross-sectional online survey was conducted from July to December 2025, targeting Saudi adults aged 18 years and above. Data were collected using a structured and validated questionnaire, with a minimum sample size of 377 participants, as determined by Raosoft's sample size calculator. **Results:** A total of 734 participants completed the survey. Most respondents were female (72.9%) and aged 18–35 years (58.2%). Overall, 62.5% reported prior PPI use, with 14.0% using PPIs without medical consultation. Gastroesophageal reflux disease (20.0%) and heartburn (15.1%) were the most common indications. Knowledge regarding long-term adverse effects was limited, with 76.6% demonstrating low knowledge. Awareness of common side effects, such as nausea (47.4%), was higher than that of serious complications such as pneumonia (6.8%) and osteoporosis (15.7%). Knowledge level was significantly associated with gender, marital status, and working or studying in the medical field ($P \leq 0.05$). Despite limited knowledge, attitudes were generally positive, with strong support for public education (90.8%) and stricter regulation of community pharmacies (85.4%). **Conclusion:** Saudi adults demonstrate limited knowledge but generally positive attitudes regarding long-term PPI use, underscoring the need for targeted educational and regulatory interventions.

Key words: Awareness, inappropriate use, long-term use, proton pump inhibitors, Saudi Arabia

INTRODUCTION

Proton pump inhibitors (PPIs) are commonly prescribed medications used to treat issues related to the upper gastrointestinal tract.[1] These medications effectively inhibit the release of stomach acid by irreversibly blocking the H+/K+ adenosine triphosphatase pumps in parietal cells.[2] Since they have few side effects, they are frequently prescribed; however, research has shown that improper and/or prolonged use can have several adverse effects.[3]

PPIs are widely used globally. In the United States alone, PPIs were prescribed in 4% of outpatients in 2002 and 9.2% in 2009.[4] PPI use has been related with high risks of side

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effects, such as bone fractures, kidney disease, microscopic colitis, and hypomagnesemia.[5]

In Saudi Arabia, the prevalence of PPI prescriptions reached 57.6% in some academic hospitals, and studies show that community pharmacists frequently recommend them to patients even without prescriptions.[6] A 2017 study in Riyadh found that 94.3% of community pharmacists reported prescribing acid suppression medications, with PPIs being the most commonly chosen (65.5%) for conditions like acute gastritis and ulcer prophylaxis.[7]

Similarly, in Greece, a 2019 study by Voukelatou *et al*. found that 61.4% of PPIs prescribed to older adults were for non-evidence-based indications. Approximately 60% of these individuals were taking PPIs without clear medical justification.[8]

A retrospective hospital-based study involving 409 patients showed that 76% of PPIs were misused before admission, raising further concerns over misuse.[9]

In 2023, a study was conducted by Almuzaini *et al*.[10] in Qassim, Saudi Arabia. The study aimed to assess public awareness regarding PPIs and their potential side effects among the population of the Qassim region. The findings revealed that a significant proportion of participants (34.3%) who were familiar with PPIs believed that using them for a short duration wouldn't cause any adverse effects. Overall, 52.6% of respondents considered short-term PPI use unlikely to result in side effects, 14.9% thought it may, and 32.4% were unsure.

Among the 1088 participants in a study conducted in Saudi Arabia in 2022, only 54% reported prior knowledge of PPIs. In addition, a notable association between educational level and knowledge of PPIs was observed, as 43.6% of patients with lower educational levels were unaware of the side effects of PPIs, and only 23.7% knew about PPIs. Among those who had previously used PPIs, the most commonly reported side effects were nausea (27.6%), bloating (22.4%), and diarrhea (17.9%).[11] A different study was done in the UAE and published in 2024, involving a total sample of 348 participants. Patients were asked five questions regarding PPI side effects, and only 22.2% managed to answer at least three out of the five questions correctly. The median knowledge score was 0, with an interquartile range of 0–2.[12]

In Saudi Arabia, despite the common availability and use of PPIs, especially over the counter (OTC), little research has examined public awareness of their long-term risks. Existing studies focus mainly on prescribing patterns and physician practices rather than public knowledge or self-medication. One recent survey found that just 54% of participants had heard of PPIs, and over 10% used them without medical advice. This highlights a gap in public education and regulation, supporting the need for this study to assess awareness of PPI risks and guide future health initiatives.

Objectives

The study aimed to assess population awareness and knowledge of long-term side effects of PPIs in Saudi Arabia.

MATERIALS AND METHODS

Study design, setting, and participants

A cross-sectional study was conducted between July and December 2025. The study population consisted of Saudi adults aged 18 years and above. Participants were invited to complete a structured questionnaire.

Sample size

Based on a population size of 20,000 and a response distribution of 50%, the calculated minimum sample size was 377. This value was obtained using the Raosoft online sample size calculator.

Inclusion and exclusion criteria

The inclusion criteria for this study were Saudi citizens of both genders aged 18 years and above. Individuals younger than 18 years were excluded.

Method for data collection, instrument

Data collection was conducted using an electronic questionnaire translated into Arabic and distributed to the target population. The questionnaire used in this study was adopted from a published study.[13] It included several key components: Sociodemographic information such as age, gender, region, education, and medical background, along with questions assessing participants' knowledge and awareness of PPI, their use, duration, side effects, and perceptions about overuse and the need for public education and regulation.

Scoring system

A total of 33 statements were used to evaluate the participants' awareness and level of knowledge, along with personal questions. Five statements were related to socio-demographic data and did not contribute to the scoring (0 points).

The knowledge level was assessed using 22 statements with a maximum score of 15 points. These were yes/no questions, where "yes" was scored as 1 point and "no" as 0 points. The

knowledge scores were classified into three levels as follows: those with a score of 12 or above (≥12) were classified as having a high level of knowledge, those with scores between 10 and 11 as having a moderate level of knowledge, and those with a score of 9 or below (≤9) as having a low level of knowledge.

Awareness was assessed using 6 statements with a maximum score of 30 points. For these, a 5-point Likert scale was used: 5 for "completely agree," 4 for "agree," 3 for "indifferent," 2 for "disagree," and 1 for "completely disagree." The awareness scores were divided into three levels as follows: those with a score of 24 or above (≥24) were classified as having a high level of awareness, those with scores between 19 and 23 as having a moderate level of awareness, and those with a score of 18 or below (≤18) as having a low level of awareness.

Pilot test

The questionnaire was distributed to 20 individuals as a pilot test to evaluate its simplicity and assess the feasibility of the study. The data collected during this pilot phase were excluded from the final analysis of the study.

Analyses and entry method

The data had been entered into the device using the "Microsoft Office Excel Software" Windows (2021). The collected data were subsequently transmitted to the Statistical Package for the Social Science Software (SPSS) application, version 25 (IBM SPSS Statistics for Microsoft Windows, Version 21.0) for statistical analysis. Descriptive statistics were used to summarize the numerical variables for baseline characteristics. For categorical variables, frequencies and percentages were calculated. The Chi-square test was used to identify associations between categorical variables.

RESULTS

Table 1 shows that most participants were female (72.9%) and mainly young adults aged 18–35 years (58.2%). More than half were married (53.1%) and lived mainly in the Western and Southern regions. Most participants held a bachelor's degree or were university students, indicating a fairly educated group. The majority reported no chronic illnesses (81.6%), and over one-third were employed. Only a small percentage (19.5%) worked or studied in the medical field, suggesting that most participants came from the general population.

Figure 1 illustrates the history of PPI use among the study participants (n = 734). Approximately 37% of participants reported never using PPIs, while 14% used PPIs without prior medical consultation. Nearly half of the respondents (48%) had used PPIs following medical advice.

Table 1: Sociodemographic characteristics of participants (n=734)

Parameter	No.	Percentage
Gender		
Female	535	72.9
Male	199	27.1
Age group		
18–35 years old	427	58.2
36–45 years old	121	16.5
46–75 years old	186	25.3
Marital status		
Widow	6	0.8
Single	319	43.5
Married	390	53.1
Divorced	19	2.6
Residential area		
Southern region	273	37.2
Eastern region	26	3.5
Northern region	10	1.4
Western region	335	45.6
Central region	90	12.3
Educational qualification		
Bachelor	322	43.9
Secondary or less	121	16.5
Diploma	93	12.7
Postgraduate studies	52	7.1
University student	146	19.9
Do u have any chronic illness?		
No	599	81.6
Yes	135	18.4
Job		
Freelancing	34	4.6
Student	213	29.0
Unemployed	214	29.2
Employed	273	37.2
Do you work or study in the medical field?		
No	591	80.5
Yes	143	19.5

The Table 2 shows that nearly two-thirds of participants, 62.5%, had used PPIs before. Most of this usage happened after medical consultation, 48.5%. A smaller group reported using them without consulting a doctor, 14%. The main reasons for using PPIs were gastroesophageal reflux disease (GERD), 20.0%, and heartburn, 15.1%. Gastroenteritis and Helicobacter pylori infection also contributed, indicating that people mainly use PPIs for acid-related gastrointestinal issues in this group.

The Table 3 shows that most PPI use was recommended by doctors, at 73%. This suggests good medical involvement in prescribing. However, the use wasn't optimal. More than half of the participants, 57.1%, reported using PPIs only when needed. Only 30.1% finished the course as prescribed. Most participants, 69.5%, knew that the right time to take PPIs is before meals. Despite this, many stopped taking them too soon. This was mainly due to symptoms getting better, at 37.9%, and worries about side effects, at 11.5%. These results reveal issues in treatment adherence and show that patients need better education on the importance of completing PPI therapy as directed.

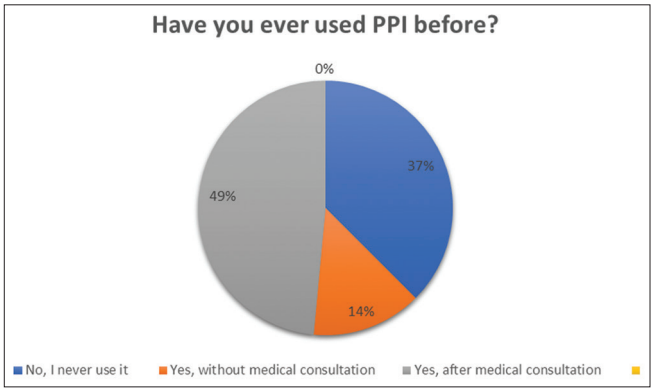

Figure 1: Illustrates if participants have ever used proton pump inhibitors before (*n* = 734)

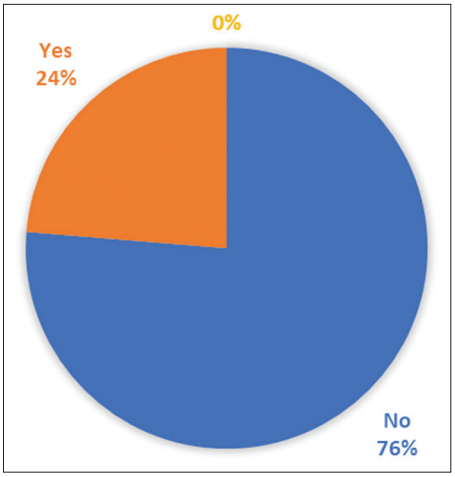

Figure 2: Illustrates if participants have a headache as a side effect of proton pump inhibitor use (*n* = 595)

This pie chart illustrates the prevalence of headaches among the study population, showing that approximately 24% of individuals reported experiencing headaches, while 76% did not [Figure 2].

Table 2: Parameters related to knowledge of participants of PPI in Saudi Arabia (*n*=734)

Parameter	No.	Percentage
Have you ever used PPI before?		
No, I never use it	275	37.5
Yes, without medical consultation	103	14.0
Yes, after medical consultation	356	48.5
If yes, the reason for using PPI?		
Esophagitis	4	0.5
Gastroenteritis	71	9.7
Helicobacter pylori infection	64	8.7
Hiatal hernia	3	0.4
After bariatric surgery.	18	2.5
Heartburn	111	15.1
Gastroesophageal reflux disease	147	20.0
Peptic ulcer	41	5.6

PPI: Proton pump inhibitor

Table 3: Parameters related duration of using the drug among participants who choose yes

Parameter	No.	Percentage
Who recommended using PPI?		
Relatives	34	7.4
Friend	22	4.8
Pharmacist	48	10.5
Physician	335	73.0
other	20	4.4
Duration of using PPI if used		
Regularly more than 4 weeks	67	14.6
Regularly <4 weeks	66	14.4
Not regularly	23	5.0
Used the medication but did not complete the recommended duration.	41	8.9
As needed	262	57.1
What is the appropriate time to take PPI?		
After meal	125	27.2
Before meal	319	69.5
With meal	15	3.3
Did you completed the course		
Not remember	95	20.7
No.	226	49.2
Yes.	138	30.1
If not, why?		
Symptoms disappeared, no longer needed	174	37.9
Fear of side effects	53	11.5
Not available	1	0.2
Due to side effects	24	5.2
Missed	58	12.6
Advice from a friend or relative (outside the medical field	1	0.2
Advice from a friend or relative (in the medical field)	2	0.4

PPI: Proton pump inhibitor

Table 4 summarizes participants' knowledge of the side effects of PPIs. Overall, awareness varied across different adverse effects. The highest recognition was for nausea at 47.4% and abdominal bloating at 36.4%. In contrast, serious complications like pneumonia and osteoporosis were less frequently identified, with recognition rates of 6.8% and 15.7%, respectively. These findings suggest that the study population generally has a limited understanding of both common and serious side effects related to PPIs.

The Table 5 indicate that a substantial proportion of participants recognize the overuse of PPIs in Saudi Arabia, with 66.6% agreeing or completely agreeing that overuse is common. Overuse is perceived to result both from unnecessary prescriptions by healthcare providers (46.2%) and patient self-medication (76.3%). Most participants (74.8%) acknowledge that excessive PPI use increases the risk of adverse drug reactions and healthcare costs. Conversely, only a minority (11.6%) believes long-term PPI use is completely safe, reflecting awareness of potential risks. There is strong consensus on the need for educational interventions regarding rational PPI use (90.8%) and enhanced regulation of community pharmacies (85.4%).

Table 6 shows that the majority of participants (76.6%) had a low level of knowledge, while only a small proportion (4.9%) demonstrated a high level of knowledge. A moderate knowledge level was observed in 18.5% of the sample, indicating an overall limited understanding among the study population.

Table 7 illustrates the attitude scores of the participants (n = 734). The majority demonstrated a moderate level of attitude (51.2%), followed closely by a high level (47.5%), while a very small proportion exhibited a low level of attitude (1.2%). This suggests that overall, participants generally had a favorable or positive attitude.

The data presented in Table 8 reveals participants' knowledge level was significantly related to gender, marital status, and working or studying in the medical field. While it was insignificantly related to age group, residential area, educational level job, and having a chronic illness.

The data presented in Table 9 reveals participants' knowledge level was significantly related to gender. While it was insignificantly related to age group, residential area, educational level job, having a chronic illness, and working or studying in the medical field.

DISCUSSION

The aim of the current study was to evaluate the level of knowledge and awareness by Saudi adults of the risks associated with long-term proton pump inhibitor (PPI) use

Table 4: Parameters related to participants' knowledge of PPIs' side effects (n=734)

Parameter	No	Percentage
Headache		
No	560	76.3
Yes	174	23.7
Bloating		
No	467	63.6
Yes	267	36.4
Nausea		
No	386	52.6
Yes	348	47.4
Diarrhea		
No	484	65.9
Yes	250	34.1
Constipation		
No	515	70.2
Yes	219	29.8
Deterioration of kidney function		
No	578	78.7
Yes	156	21.3
Abdominal pain		
No	456	62.1
Yes	278	37.9
Osteoporosis		
No	619	84.3
Yes	115	15.7
Increased risk of gastroenteritis		
No	557	75.9
Yes	177	24.1
Iron deficiency		
No	549	74.8
Yes	185	25.2
Magnesium deficiency		
No	575	78.3
Yes	159	21.7
Pneumonia		
No	684	93.2
Yes	50	6.8
Clostridium difficile infection		
No	588	80.1
Yes	146	19.9
B12 deficiency		
No	533	72.6
Yes	201	27.4

PPI: Proton pump inhibitor

Table 5: Parameters related to the awareness of participants regarding PPI use (*n*=734)

Parameter	No	Percentage
Overuse of PPI is common in Saudi Arabia		
Completely agree	257	35.0
Agree.	232	31.6
Completely disagree	23	3.1
Disagree	37	5.0
Indifferent.	185	25.2
The main reason for the overuse is that some doctors prescribe PPIs unnecessarily		
Completely agree	123	16.8
Agree.	216	29.4
Completely disagree	20	2.7
Disagree	107	14.6
Indifferent.	268	36.5
The main reason for the overuse is that patients use it without medical consultation		
Completely agree	262	35.7
Agree.	298	40.6
Completely disagree	11	1.5
Disagree	43	5.9
Indifferent.	120	16.3
Overuse of PPI will cause an increase in adverse drug reaction and medical costs		
Completely agree	253	34.5
Agree.	296	40.3
Completely disagree	10	1.4
Disagree	29	4.0
Indifferent.	146	19.9
Long-term use of PPIs is safe		
Completely agree	30	4.1
Agree.	55	7.5
Completely disagree	197	26.8
Disagree	302	41.1
Indifferent.	150	20.4
Necessary to carry out large-scale education on the rational use of PPI for medical staff and public		
Completely agree	478	65.1
Agree.	189	25.7
Completely disagree	5	0.7
Disagree	8	1.1
Indifferent.	54	7.4
Necessary to strengthen the management of community pharmacies		
Completely agree	448	61.0
Agree.	179	24.4
Completely disagree	6	0.8
Disagree	16	2.2
Indifferent	85	11.6

PPI: Proton pump inhibitor

Table 6: knowledge score of participants (*n*=734)

Knowledge level	Frequency	Percentage
High level	36	4.9
Low level	562	76.6
Moderate level	136	18.5
Total	734	100.0

Table 7: Shows attitude score of participants (*n*=734)

Attitude level	Frequency	Percentage
High level	349	47.5
Low level	9	1.2
Moderate level	376	51.2
Total	734	100.0

and to investigate the pattern of use that could predispose to inappropriate long-term therapy. In this sample of the US population (n = 734) overall, exposure to PPIs was high, and awareness about several clinically important long-term safety issues was low, indicating a continuing discrepancy between the widespread availability/consumption of PPIs and public understanding of the appropriate use and times for taking them.

In our results, almost two-thirds of the total participants reported to have used PPIs (62.5%). This high exposure is clinically plausible with respect to common gastroesophageal reflux disease (GERD) symptom and erosive disease, where PPIs remain first choice therapy, and often continued as maintenance treatment in selected high-risk indications. Current guideline recommendations, however, stress the use of the lowest effective dose and the avoidance of prolonged therapy in patients without clear ongoing indications (e.g. severe erosive esophagitis, Barrett's esophagus with indication or in other high risk scenarios) with reassessment in the case of symptoms resolution.[14] The pattern we observed where considerable proportion used PPIs "as needed" (57.1%) and a lot of them stopped when symptoms got disappeared (37.9%) may indicate the episodic symptom-driven use, rather than guideline-directed courses and structured step-down plans. While on-demand PPI strategies will be suitable in some patients with non-erosive reflux disease, without clinician review and structured follow-up, intermittent self-directed escalation, duplication with other acid suppressants, or

Table 8: Relation between knowledge score and sociodemographic parameters of the participants (*n*=734)

Parameters	Knowledge score			Total (*n*=734)	*P*-value*
	High	Low	Moderate		
Gender					
Female	30	390	115	535	0.001
	83.3%	69.4%	84.6%	72.9%	
Male	6	172	21	199	
	16.7%	30.6%	15.4%	27.1%	
Age group					
18–35 years old	26	317	84	427	0.310
	72.2%	56.4%	61.8%	58.2%	
36–45 years old	3	96	22	121	
	8.3%	17.1%	16.2%	16.5%	
46–75 years old	7	149	30	186	
	19.4%	26.5%	22.1%	25.3%	
Marital status					
Widow	1	4	1	6	0.015
	2.8%	0.7%	0.7%	0.8%	
Single	23	225	71	319	
	63.9%	40.0%	52.2%	43.5%	
Married	11	318	61	390	
	30.6%	56.6%	44.9%	53.1%	
Divorced	1	15	3	19	
	2.8%	2.7%	2.2%	2.6%	
Residential area					
Southern region	13	203	57	273	0.833
	36.1%	36.1%	41.9%	37.2%	
Eastern region	0	20	6	26	
	0.0%	3.6%	4.4%	3.5%	
Northern region	1	7	2	10	
	2.8%	1.2%	1.5%	1.4%	
Western region	18	261	56	335	
	50.0%	46.4%	41.2%	45.6%	
Central region	4	71	15	90	
	11.1%	12.6%	11.0%	12.3%	
Educational level					
Bachelor	18	257	47	322	0.150
	50.0%	45.7%	34.6%	43.9%	
Secondary or less	6	90	25	121	
	16.7%	16.0%	18.4%	16.5%	
Diploma	3	68	22	93	
	8.3%	12.1%	16.2%	12.7%	
Postgraduate studies	0	44	8	52	
	0.0%	7.8%	5.9%	7.1%	
University student	9	103	34	146	
	25.0%	18.3%	25.0%	19.9%	

(Contd...)

Table 8: *(Continued)*

Parameters	Knowledge score			Total (*n*=734)	*P*-value*
	High	Low	Moderate		
Do you have chronic illness?					
No	32	458	109	599	0.480
	88.9%	81.5%	80.1%	81.6%	
Yes	4	104	27	135	
	11.1%	18.5%	19.9%	18.4%	
Job					
Freelancing	1	27	6	34	0.153
	2.8%	4.8%	4.4%	4.6%	
Student	12	149	52	213	
	33.3%	26.5%	38.2%	29.0%	
Unemployed	11	164	39	214	
	30.6%	29.2%	28.7%	29.2%	
Employed	12	222	39	273	
	33.3%	39.5%	28.7%	37.2%	
Do you work or study in the medical field?					
No	16	469	106	591	0.0001
	44.4%	83.5%	77.9%	80.5%	
Yes	20	93	30	143	
	55.6%	16.5%	22.1%	19.5%	

**P* value was considered significant if ≤ 0.05

prolonged continuation "just in case," is precisely the same prescribing inertia and patient-led continuation described in de-prescribing guidance.[15]

A notable finding was that 14.0% of participants did not get PPIs prescribed by a doctor, and 10.5% were recommended by a pharmacist thus indicating the importance of access pathways in the community. This is consistent with the general international concern that PPIs are often used for longer than appropriate both in terms of indication and duration, and that in some large health systems estimates suggest that a significant proportion of prescriptions have no clear indication, and duration is often longer than recommended.[16-17] In this context, the positive responses from our participants in support of community-level control measures (e.g. 85.4% in support of stricter management of community pharmacies) and educational initiatives (90.8% in support of public education) would suggest receptiveness to stewardship interventions rather than resistance to regulation. Importantly, de-prescribing best practice advice highlights a need for regular review of the continued indication and stepping down/discontinuing in patients without a definite chronic indication in the majority of cases typically after symptom control has been achieved over a limited course in the context of balancing the risk for relapse and patient preference.[15]

Despite relatively good attitudes towards rational use, the level of objective knowledge was low in our cohort: 76.6% were in the "low knowledge" category. This discrepancy for support of education but lack of specific knowledge on risks is similar to the results of patient-focused surveys in other areas. For instance, 96% of people surveyed about gastroenterology-clinic outpatients in a medically underserved US community were unaware of reported adverse effects of PPIs.[23] The concurrence between our low levels of knowledge and these international data would indicate that poor patient awareness is not a peculiarity of this one health system, and would rather suggest that it is a recurrent outcome when long-term therapy is normalized and inconsistent counselling on duration and risk is provided.

When looking for particular adverse effects, gastrointestinal symptoms (e.g. nausea 47.4%, abdominal pain 37.9%, bloating 36.4%, diarrhea 34.1%) were most oft-recognized among our respondents, while recognition of a few long-term consequences was substantially lower (e.g. pneumonia 6.8%, osteoporosis 15.7%, impairment of kidney function 21.3%). This pattern itself is clinically important in that many of the adverse outcomes, which fuel modern "PPI stewardship" discussions, are not immediate, are often discussed as associations rather than proven, causal harms and as such may not be spontaneously recognised by the public. Further, the American Gastroenterological Association (AGA) expert review stresses that although PPIs are effective and well tolerated, there have been several reported adverse associations and the quality of evidence is highly variable depending on

Table 9: Relation between attitude score and sociodemographic parameters of the participants (*n*=734)

Parameters	Attitude score			Total (*n*=734)	*P*-value*
	High	Low	Moderate		
Gender					
Female	266	3	266	535	0.007
	76.2%	33.3%	70.7%	72.9%	
Male	83	6	110	199	
	23.8%	66.7%	29.3%	27.1%	
Age group					
18–35 years old	207	6	214	427	0.876
	59.3%	66.7%	56.9%	58.2%	
36–45 years old	59	1	61	121	
	16.9%	11.1%	16.2%	16.5%	
46–75 years old	83	2	101	186	
	23.8%	22.2%	26.9%	25.3%	
Marital status					
Widow	5	0	1	6	0.411
	1.4%	0.0%	0.3%	0.8%	
Single	151	6	162	319	
	43.3%	66.7%	43.1%	43.5%	
Married	186	3	201	390	
	53.3%	33.3%	53.5%	53.1%	
Divorced	7	0	12	19	
	2.0%	0.0%	3.2%	2.6%	
Residential area					
Southern region	135	4	134	273	0.393
	38.7%	44.4%	35.6%	37.2%	
Eastern region	15	1	10	26	
	4.3%	11.1%	2.7%	3.5%	
Northern region	3	0	7	10	
	0.9%	0.0%	1.9%	1.4%	
Western region	160	4	171	335	
	45.8%	44.4%	45.5%	45.6%	
Central region	36	0	54	90	
	10.3%	0.0%	14.4%	12.3%	
Educational level					
Bachelor	147	3	172	322	0.432
	42.1%	33.3%	45.7%	43.9%	
Secondary or less	58	0	63	121	
	16.6%	0.0%	16.8%	16.5%	
Diploma	42	2	49	93	
	12.0%	22.2%	13.0%	12.7%	
Postgraduate studies	27	0	25	52	
	7.7%	0.0%	6.6%	7.1%	
University student	75	4	67	146	
	21.5%	44.4%	17.8%	19.9%	

(Contd...)

Table 9: *(Continued)*

Parameters	Attitude score			Total (*n*=734)	*P*-value*
	High	Low	Moderate		
Do you have chronic illness?					
No	286	7	306	599	0.938
	81.9%	77.8%	81.4%	81.6%	
Yes	63	2	70	135	
	18.1%	22.2%	18.6%	18.4%	
Job					
Freelancing	18	1	15	34	0.161
	5.2%	11.1%	4.0%	4.6%	
Student	98	6	109	213	
	28.1%	66.7%	29.0%	29.0%	
Unemployed	105	0	109	214	
	30.1%	0.0%	29.0%	29.2%	
Employed	128	2	143	273	
	36.7%	22.2%	38.0%	37.2%	
Do you work or study in medical field?					
No	275	9	307	591	0.208
	78.8%	100.0%	81.6%	80.5%	
Yes	74	0	69	143	
	21.2%	0.0%	18.4%	19.5%	

**P* value was considered significant if ≤ 0.05

outcomes and therefore decisions on whether to use PPIs should be made on an individualized basis and grounded in the risk versus benefits analyses and dose minimization as opposed to fear-induced abrupt discontinuation.[16] In other words, low public recognition of outcomes like kidney disease, fracture risk and micronutrient deficiency as well as infections is anticipated if these risks are discussed mainly in professional literature and formulated cautiously because of confounding.

However, the specific outcomes that our participants most failed to recognize are also those that were mentioned most in large observational cohorts and systematic reviews. For kidney disease, in a population-based cohort analysis, the use of PPIs was linked to an increased risk of incident chronic kidney disease (CKD), and increased risk was observed in multiple analyses and replicated in an independent health system cohort, but noted the need for future research to determine whether the restriction of use reduces the incidence of CKD.[17] For pneumonia, a systematic review and meta-analysis reported an increased risk of community acquired pneumonia with outpatient PPI therapy (pooled risk estimate 1.49 - higher risk early after initiation), reinforcing that infection related signals had been repeatedly found across study designs.[18,19] Similarly, meta-analytic evidence has shown a link between the use of PPIs and higher risk of fracture in the observational data,[20] and higher risk of Clostridium difficile infection in systematic reviews/meta-analyses.[19] These bodies of evidence while not uniformly causal help explain why there is increasing emphasis in guideline documents and expert reviews on deprescribing and dose reduction and periodic reassessment especially for patients taking PPIs because of uncomplicated symptoms that have resolved.[21-23] Against this backdrop, our result that only a minority had recognized osteoporosis, pneumonia or kidney impairment as potential risks indicates that many Saudi nationals may be incapable of participating fully in the shared decision-making about long-term therapy, even if they may agree in general that overuse is common and expensive.

This predictors of knowledge in our sample also informs targeting of interventions. Knowledge was significantly related to gender, marital and working/studying in a medical field. This pattern is consistent with a plausible "health literacy and exposure" mechanism i.e. individuals with medical training and/or health-related environments may represent a greater exposure to pharmacovigilance discussions and may have a higher exposure to counseling of long-term therapy. At the same time, the presence of statistically significant demographic differences does not guarantee clinically meaningful differences in comprehension; rather, it supports implementing broad public education while also tailoring messaging for groups at higher risk of self-directed long-term use. In our cohort, the belief that self-medication without consultation is a primary driver of overuse (76.3%) suggests that improving community-level counseling and restricting

prolonged OTC-style continuation could be impactful. Structured deprescribing materials and algorithms designed to support gradual tapering and symptom management may be particularly useful in this setting, because they operationalize "what to do next" for patients and clinicians once symptoms are controlled.[24]

This study has limitations. Its cross-sectional design precludes causal inference regarding determinants of knowledge and attitudes. Data were self-reported and may be subject to recall and social desirability biases, particularly for medication-use behaviors and counseling history. The online survey methodology may have introduced selection bias and limits generalizability to individuals with lower digital access or different literacy profiles, and the sample was predominantly female (72.9%) and younger (58.2% aged 18–35), which may not fully reflect the national age–sex structure. Despite these limitations, the study provides actionable evidence of a substantial knowledge gap coexisting with strong public support for education and rational-use policies.

CONCLUSION

This study demonstrates that while PPI use is common among Saudi adults, knowledge regarding the risks of long-term use remains limited. The majority of participants showed poor understanding of serious adverse effects, despite recognizing that PPI overuse is widespread and potentially harmful. Importantly, a substantial proportion of participants reported non-prescription use, highlighting gaps in medication counseling and regulatory enforcement. Although overall attitudes toward rational PPI use were favorable, inadequate knowledge may hinder informed decision-making and appropriate use. These findings emphasize the urgent need for large-scale public education initiatives, improved patient counseling, and strengthened regulation of community pharmacies. Addressing these gaps may reduce inappropriate long-term PPI use and improve medication safety in Saudi Arabia.

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ETHICAL APPROVAL

The study was fully explained to all participants, and it was emphasized that participation was voluntary. Written informed consent was obtained from each participant before enrollment. All collected information was securely stored and used exclusively for research purposes.

INFORMED CONSENT

Written informed consent was obtained from all study participants.

DATA AND MATERIALS AVAILABILITY

All data generated or analyzed during this study are included in this published article.

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