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# Assessment of knowledge, awareness of symptoms, risk factors, preventive measures, and perceptions related to thyroid disease among adults of Lahore, Pakistan

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## Abstract

**Background** Thyroid disorders are becoming more common, yet many people do not recognise their symptoms, risk factors, or options for prevention. This study assessed the knowledge, awareness, and perception of thyroid disease among adults in Lahore, Pakistan.

**Subject and methods** A cross-sectional survey was conducted among 391 adults using convenience sampling in public areas of Lahore. A structured questionnaire was used to assess recognition of thyroid symptoms, awareness of risk factors and prevention, and perceptions of disease. Descriptive statistics were generated. Differences in knowledge, awareness, and perception across demographic groups were analysed using the Mann–Whitney U test, the Kruskal–Wallis test, and regression in SPSS version 27.

**Results** Most respondents were female (55.0%), aged 18–24 years (36.3%), had formal education (76.7%), and lived in metropolitan areas (66.2%). Neck swelling (61.9%) and goitre (47.1%) were the most frequently recognised symptoms. Thyroid screening was identified as a key preventive measure by 55.8% of participants. Overall, knowledge was low: only 38.0% demonstrated good knowledge, while 62.0% had poor knowledge. Many participants agreed that obesity (39.1%) and poor diet (29.4%) increase thyroid risk. Greater awareness was observed among younger participants ( $p=0.001$ ), those with higher education ( $p=0.001$ ), and urban residents ( $p=0.036$ ). More accurate perceptions were also associated with higher education ( $p=0.027$ ) and better understanding of thyroid-related topics ( $p=0.009$ ).

**Conclusion** There are clear gaps in public knowledge of thyroid disease, despite some awareness of symptoms and risk factors. Targeted health education is needed to improve early recognition, screening, and prevention in the community.

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**Keywords** Thyroid disease, Thyroid awareness, Thyroid risk, Thyroid prevention, Thyroid perception

## Introduction

The thyroid gland, a butterfly-shaped organ located in the front of the neck, plays an important role in regulating metabolic processes and physiological functions in the body [1]. One of its primary functions is the production of thyroid hormones, which regulate metabolic rate, protein synthesis, and tissue growth [2]. These hormones are controlled by the hypothalamic-pituitary axis through the release of thyrotropin-releasing hormone (TRH) from the hypothalamus and thyroid-stimulating hormone (TSH) from the anterior pituitary gland [3]. Any dysfunction in hormone production or thyroid gland hypertrophy leads to thyroid diseases, making them a significant yet often underdiagnosed medical concern [4]. Thyroid diseases are classified into primary, which directly affects the thyroid gland, and secondary, which results from external factors influencing thyroid function. Studies indicate that primary thyroid disorders tend to be more severe, with the prevalence of overt hyperthyroidism being 4.1% of the population, while hypothyroidism affects approximately 5.1% in iodine-sufficient regions [5]. Women, particularly those who are older, pregnant, postpartum, or postmenopausal, are at a higher risk of thyroid dysfunction compared to men [6]. Thyroid disorders manifest with a variety of symptoms, including fatigue, weight fluctuations, cardiovascular irregularities, gastrointestinal disturbances, cognitive impairment, and psychological symptoms such as anxiety and depression [7]. If left untreated, thyroid dysfunction can lead to serious complications, including hypertension, dyslipidaemia, arrhythmias, and infertility [8]. Thyroid function tests are commonly used for diagnosis, allowing differentiation between hypothyroidism, characterized by insufficient hormone production, and hyperthyroidism, marked by excessive hormone secretion [9]. Thyrotoxicosis, a condition resulting from elevated thyroid hormones, may arise from various causes, including hyperthyroidism [10]. Several factors contribute to thyroid dysfunction, including lifestyle choices, genetic predisposition, autoimmune diseases, iodine deficiency, and environmental exposures [11]. Conditions such as diabetes mellitus (DM), obesity, and smoking have also been associated with thyroid disorders [11]. Additionally, thyroid malignancies have been linked to iodine deficiency disorders (IDDs), childhood radiation exposure, and a family history of thyroid cancer and goitre [12]. Environmental factors, including alcohol consumption, smoking, and dietary intake of vitamins and minerals, especially selenium and Vitamin D, which are essential for thyroid function and immunity, play a crucial role in thyroid health [13]. Infections, stress, and the administration of certain hormones, particularly

oestrogens, have also been identified as contributing factors to thyroid dysfunction [14]. Nutritional iodine intake remains a critical factor in both hypo- and hyperthyroidism. Hashimoto's thyroiditis (chronic autoimmune thyroiditis) is the most common cause of hypothyroidism in iodine-sufficient regions, while Graves' disease is the leading cause of hyperthyroidism [15]. Risk factors for hypothyroidism include female sex, high iodine intake, primary pulmonary hypertension, multiple sclerosis, and environmental influences such as water pollution, dietary habits, and low physical activity [8]. Although these associations are well-documented, the underlying biological mechanisms remain poorly understood. Raising public awareness about thyroid disease is essential for early diagnosis and effective preventive measures. While previous studies have assessed public knowledge regarding various health conditions, limited research has specifically examined thyroid disease awareness from a community perspective in Pakistan. Given the increasing prevalence of thyroid disorders and their impact on health, identifying gaps in knowledge and awareness is crucial. Therefore, this study aims to assess awareness of symptoms, risk factors, and preventive measures, as well as perceptions of thyroid disease, among adults in Pakistan.

## Materials and methods

### Study design and setting

A community-based cross-sectional study (Supplementary file) was conducted in Lahore, Pakistan, over a six-month period (January–June 2024) to assess knowledge and awareness of symptoms, risk factors, preventive measures, and perceptions of thyroid disease among adults. Lahore was chosen for its diverse urban-rural population and high burden of non-communicable diseases [16]. Participants were recruited from public places across five urban and three rural administrative zones, classified according to government census criteria to ensure geographic and demographic representation.

### Study population and sample size

The sample size for this research was calculated using the Daniel formula [17]:

$$n' = \frac{NZ^2P(1-P)}{d^2(N-1) + Z^2P(1-P)}$$

Where N is the population of Lahore (13.5 million), the expected proportion (anticipated prevalence) will be considered as 50% ( $p=0.50$ ); 5% precision (margin of error)

was considered ( $d=0.05$ ); and a 95% confidence level ( $Z=1.96$ ) was used.

$$n = \frac{13,500,000 \times (1.96)^2 \times 0.5 \times (1 - 0.5)}{(0.05)^2 \times (13,500,000 - 1) + (1.96)^2 \times 0.5 \times (1 - 0.5)}$$

$n=384$

The calculated sample size was 384. A sample size of 431 participants was selected, but 40 did not complete the questionnaire, resulting in 391 participants included in the study.

### Inclusion and exclusion criteria

Participants were eligible for the study if they met all of the following inclusion criteria: they were aged 18 years or older, current residents of Lahore, Pakistan (both urban and rural areas), with a minimum residency duration of 6 months to ensure familiarity with local health-care contexts; demonstrated the mental and physical capacity to provide informed consent in Urdu or English; and exhibited sufficient cognitive ability to understand and complete the questionnaire without severe impairments or language barriers. Participants were excluded from the study if any of the following criteria applied: age below 18 years; residency outside Lahore (e.g., temporary visitors or individuals residing elsewhere) or residency duration of less than 6 months; inability or unwillingness to provide informed consent, including those lacking legal capacity due to cognitive impairment; prior diagnosis of thyroid disease (to avoid bias from pre-existing knowledge); inability to comprehend Urdu or English (the questionnaire languages). These criteria ensured a focused, representative sample of Lahore's adult population while safeguarding ethical and data quality standards.

### Sampling technique and data collection

A convenience sampling method was employed to recruit participants from easily accessible public locations in Lahore, including parks, shopping malls, metro stations, and community centers. This approach prioritized practicality and aimed to capture a diverse cross-section of adults by targeting high-foot-traffic areas. Between January and June 2024, data were collected through in-person surveys administered by trained researchers using a structured, validated questionnaire. To ensure inclusivity and address literacy barriers, surveys were conducted in participants' preferred language (Urdu or English), with researchers clarifying complex terms as needed. Prior to participation, respondents received an introductory letter detailing the study's objectives, societal relevance, and ethical safeguards. Written informed consent was obtained from all participants, emphasizing their right

to withdraw and the anonymization of responses. Interviewers underwent rigorous training to standardize question delivery, minimize bias, and ensure accurate data recording. Confidentiality was maintained through secure, identifier-free storage of responses, with completed questionnaires stored separately from consent forms. However, the use of convenience sampling may introduce selection bias and limit the sample's representativeness. Probability-based sampling methods were not feasible due to time, resource, and accessibility constraints in field settings.

### Questionnaire development

The questionnaire was developed through a rigorous multi-stage process to ensure validity, reliability, and cultural relevance. The questionnaire was developed through a comprehensive literature review to ensure validity and relevance [18–20]. It is organized into five sections: (1) Sociodemographic characteristics, including age, gender, education level, occupation, and area of residence; (2) Knowledge and awareness of thyroid disease symptoms, assessed through 13 items with response options of *Yes*, *No*, or *I don't know*; (3) Knowledge and awareness of thyroid disease risk factors, evaluated through 9 items with response options of *Yes*, *No*, or *I don't know*; (4) Knowledge and awareness of thyroid disease preventive measures, covering dietary habits, lifestyle modifications, and health screenings, assessed through 10 items with response options of *Yes*, *No*, or *I don't know*; and (5) Perceptions of thyroid disease, measured using 11 items on a five-point Likert scale (1 = Strongly agree to 5 = Strongly disagree). Knowledge scores were calculated by assigning 1 point to each correct response and 0 to each incorrect or "I don't know" response. The scores across all knowledge items were summed to generate a total knowledge score for each participant, with a possible range of 0 to 31, where 31 is the highest attainable score. Scores ranging from 0 to 50% were categorized as poor knowledge, whereas scores above 50% were categorized as good knowledge [21]. Content validity was established through reviews by three endocrinologists and two public health experts, who assessed relevance and cultural appropriateness. A pilot study with 30 participants identified ambiguities in two Likert-scale items, which were revised. The tool demonstrated strong internal consistency (Cronbach's  $\alpha = 0.861$ ) and construct validity via exploratory factor analysis (KMO = 0.76; Bartlett's test,  $p < 0.001$ ). To ensure linguistic equivalence, the questionnaire underwent forward-backwards translation into Urdu, with both English and Urdu versions pretested for comprehension. All sections utilized closed-ended questions to streamline quantitative analysis, ensuring methodological rigor and alignment with the study's objectives.

### Operational definitions

The Knowledge, Attitude, and Practice (KAP) framework is used to study human behavior, specifically measuring what a group of people knows, how they feel, and how they act regarding a specific topic [22].

- Knowledge (K): What a person knows, understands, and remembers about a topic.
- Attitude (A): How a person feels, believes, or evaluates a subject or situation.
- Practice (P): The actual behaviors, actions, or habits a person performs.

### Data analysis

Data collection and analysis were conducted using SPSS Version 27 (Statistical Package for the Social Sciences). Descriptive statistics, including frequencies and percentages, were primarily used to summarize and describe the data distribution. Non-parametric tests such as the Mann-Whitney U and Kruskal-Wallis tests were employed to examine associations between demographic variables and thyroid knowledge or perception. The Mann-Whitney U Test was used to evaluate differences between two groups (e.g., gender, education, residency, chronic disease, awareness of thyroid disease). At the same time, the Kruskal-Wallis Test was applied to compare multiple groups (e.g., age, employment status, marital status). To quantify the magnitude of significant group differences, effect sizes were calculated for all significant tests. For Mann-Whitney U tests, the effect size  $r$  was computed using the formula  $r = Z/\sqrt{N}$ , where  $Z$  is the standardised test statistic, and  $N$  is the total sample size ( $N=391$ ). Effect sizes were interpreted according to Cohen's (1988) guidelines as small ( $r=0.10-0.29$ ), medium ( $r=0.30-0.49$ ), or large ( $r\geq 0.50$ ). For Kruskal-Wallis tests, epsilon-squared ( $\epsilon^2$ ) was calculated using  $\epsilon^2 = H/(N-1)$ , where  $H$  is the Kruskal-Wallis test statistic. Epsilon-squared values were interpreted as small ( $\epsilon^2 = 0.01-0.05$ ), medium ( $\epsilon^2 = 0.06-0.13$ ), or large ( $\epsilon^2 \geq 0.14$ ). Additionally, to identify independent predictors of good thyroid knowledge, binary logistic regression was performed using the Enter method, with good knowledge (score  $\geq 50\%$  correct) as the binary outcome variable. All demographic variables were entered simultaneously as predictors. Results are reported as odds ratios (OR) with 95% confidence intervals (CI) and Wald statistics.

## Results

### Demographic characteristic

Table 1 presents the demographic characteristics of the participants included in the study. The majority of participants were female (55.0%), while males accounted for 45.0%. The most common age group was 18–24 years (36.3%), followed by 25–34 years (25.3%). In terms of

employment status, unemployed participants accounted for 34.0%, and employed individuals accounted for 33.8%. A significant majority were educated (76.7%), whereas 23.3% were illiterate. Most participants were married (47.8%), while single individuals at 46.0%. The majority resided in urban areas (66.2%), and rural residents comprised 33.8%. Monthly incomes of 50,000–100,000 PKR were most common (41.9%), followed by 25,000–50,000 PKR (30.7%). Regarding chronic diseases, 78.8% reported no chronic conditions, while 21.2% reported having one. Awareness of thyroid disease was reported by 61.6% of participants, while 38.4% were unaware. For family history, the majority reported no family history (61.1%), with 28.6% being unsure.

### Knowledge and awareness regarding thyroid disease: common symptoms associated with thyroid disease

Table 2 presents participants' responses regarding the common symptoms associated with thyroid disease. The most correctly identified symptom was neck swelling (goitre), with 242 participants (61.9%) correctly identifying it. This was followed by fatigue, which 191 participants (48.8%) correctly recognized as a symptom of thyroid disease. Other symptoms, such as increased heart rate (37.1%) and sensitivity to cold (37.9%), were correctly identified by a significant portion of participants, although many respondents were unsure or provided incorrect answers. Symptoms like hair loss (19.2%) and hoarseness unrelated to a cold (27.1%) had lower rates of correct identification, indicating a knowledge gap among participants regarding these thyroid-related symptoms.

### Risk factors for thyroid disease

Table 3 presents participants' awareness regarding various risk factors associated with thyroid disease. The presence of goitre was the most commonly recognized risk factor, with 47.1% of participants providing the correct answer. This was followed by a family history of thyroid disorders, where 36.8% of participants correctly identified it as a risk factor. Other factors, such as age above 60 (32.5%), smoking (33.0%), and female gender (32.7%), were also recognized, though the percentage of correct answers was lower. Conversely, autoimmune disorders (24.8%) and certain medications (23.5%) had lower awareness, indicating a gap in understanding these factors. Exposure to excessive iodine (29.4%) and previous neck radiation exposure (33.8%) were also recognized by smaller proportions of participants, suggesting a need for increased education on these important thyroid disease risk factors.

**Table 1** Demographic characteristics of participants

| Demographic Characteristics                      |                | Frequency | Percentage (%) |
|--------------------------------------------------|----------------|-----------|----------------|
| Gender                                           | Male           | 176       | 45.0           |
|                                                  | Female         | 215       | 55.0           |
| Age                                              | 18–24          | 142       | 36.3           |
|                                                  | 25–34          | 99        | 25.3           |
|                                                  | 35–44          | 64        | 16.4           |
|                                                  | 45–54          | 46        | 11.8           |
|                                                  | 55–64          | 28        | 7.2            |
|                                                  | 65 or older    | 12        | 3.1            |
| Employment status                                | Employed       | 132       | 33.8           |
|                                                  | Unemployed     | 133       | 34.0           |
|                                                  | Student        | 116       | 29.7           |
|                                                  | Retired        | 10        | 2.6            |
| Education                                        | Illiterate     | 91        | 23.3           |
|                                                  | Educated       | 300       | 76.7           |
| Marital status                                   | Single         | 180       | 46.0           |
|                                                  | Married        | 187       | 47.8           |
|                                                  | Divorced       | 9         | 2.3            |
|                                                  | Widowed        | 15        | 3.8            |
| Residency                                        | Urban          | 259       | 66.2           |
|                                                  | Rural          | 132       | 33.8           |
| Income                                           | < 25,000       | 22        | 5.6            |
|                                                  | 25,000–50,000  | 120       | 30.7           |
|                                                  | 50,000–100,000 | 164       | 41.9           |
|                                                  | > 100,000      | 85        | 21.7           |
| Chronic disease                                  | Yes            | 83        | 21.2           |
|                                                  | No             | 308       | 78.8           |
| Have you heard about thyroid disease?            | Yes            | 241       | 61.6           |
|                                                  | No             | 150       | 38.4           |
| Do you have a family history of thyroid disease? | Yes            | 40        | 10.2           |
|                                                  | No             | 239       | 61.1           |
|                                                  | Not sure       | 112       | 28.6           |

### Preventive measures to reduce the risk of thyroid diseases

Table 4 presents participants' responses regarding preventive measures to reduce the risk of thyroid disease. The most recognized preventive measure was annual thyroid screenings, with 55.8% of participants answering correctly, followed by regular intake of iodine-rich foods (50.6%) and avoiding self-prescription of thyroid medications (49.6%). Other significant measures included maintaining a healthy body weight (48.8%), managing stress levels (47.6%), and regular exercise (46.3%), all of which were acknowledged by a substantial proportion of respondents. On the other hand, awareness of adequate selenium intake (22.3%) was lower, and fewer participants identified it as a preventive measure. Similarly, limiting exposure to environmental toxins (37.3%) and smoking cessation (36.3%) had moderate recognition rates, indicating areas where more public education might be needed. Lastly, 43.2% of participants were aware of the importance of avoiding excessive iodine intake, reflecting a gap in understanding of how iodine intake affects thyroid health.

### Overall knowledge of symptoms, risk factors, and preventive measures of thyroid diseases

Figure 1 presents knowledge among participants regarding thyroid disease. It showed that 38% of participants had good knowledge of thyroid disease, while 62% had poor knowledge. This indicated a significant lack of good knowledge of thyroid disease in the Pakistani population, highlighting the need for educational initiatives to improve awareness and understanding.

### Perceptions regarding thyroid disease

Table 5 describes the participants' perceptions about thyroid disease. The highest percentage of participants (35.5%) agreed that smoking increases the risk of developing thyroid disease, while 33.5% remained neutral on the matter. Regarding exposure to second-hand smoke, 37.1% were neutral, while 27.6% agreed that it raises the likelihood of developing thyroid disease. When it comes to drinking more than one unit of alcohol daily, 36.8% of participants were neutral, and 28.9% agreed that it contributes to the risk. A total of 37.1% agreed that

**Table 2** Knowledge and awareness regarding common symptoms associated with thyroid disease

| Variables                                               | Participant's responses (N= 391) |                         |                   |
|---------------------------------------------------------|----------------------------------|-------------------------|-------------------|
|                                                         | Correct answer, n (%)            | Incorrect answer, n (%) | Don't know, n (%) |
| Fatigue                                                 | 191 (48.8%)                      | 63 (16.1%)              | 137 (35%)         |
| Weight gain                                             | 111 (28.4%)                      | 133 (34%)               | 147 (37.6%)       |
| Hair loss                                               | 75 (19.2%)                       | 130 (33.2%)             | 186 (47.6%)       |
| Increased heart rate                                    | 145 (37.1%)                      | 71 (18.2%)              | 175 (44.8%)       |
| Difficulty concentrating                                | 139 (35.5%)                      | 60 (15.3%)              | 192 (49.1%)       |
| Sensitivity to cold                                     | 148 (37.9%)                      | 65 (16.6%)              | 178 (45.5%)       |
| Muscle weakness                                         | 128 (32.7%)                      | 101 (25.8%)             | 162 (41.4%)       |
| Swelling of the neck (goitre)                           | 242 (61.9%)                      | 29 (7.4%)               | 120 (30.7%)       |
| Experiencing pain in the neck and sometimes in the ears | 159 (40.7%)                      | 59 (15.1%)              | 173 (44.2%)       |
| Difficulty in swallowing                                | 172 (44.0%)                      | 63 (16.1%)              | 156 (39.9%)       |
| Difficulty in breathing or constant wheezing            | 117 (29.9%)                      | 102 (26.1%)             | 172 (44.0%)       |
| Hoarseness unrelated to a cold                          | 106 (27.1%)                      | 86 (22.0%)              | 199 (50.9%)       |
| Persistent cough unrelated to a cold                    | 115 (29.4%)                      | 77 (19.7%)              | 199 (50.9%)       |

n: Total number of participants available with data, N: Total number of participants

**Table 3** Knowledge and awareness regarding risk factors associated with thyroid disease

| Variables                                            | Participant's responses (N= 391) |                         |                   |
|------------------------------------------------------|----------------------------------|-------------------------|-------------------|
|                                                      | Correct answer, n (%)            | Incorrect answer, n (%) | Don't know, n (%) |
| Family history of thyroid disorders                  | 144 (36.8%)                      | 98 (25.1%)              | 149 (38.1%)       |
| Exposure to excessive iodine                         | 115 (29.4%)                      | 111 (28.4%)             | 165 (42.2%)       |
| Age above 60                                         | 127 (32.5%)                      | 96 (24.6%)              | 168 (43.0%)       |
| Smoking                                              | 129 (33.0%)                      | 94 (24.0%)              | 168 (43.0%)       |
| Female gender                                        | 128 (32.7%)                      | 84 (21.5%)              | 179 (45.8%)       |
| Autoimmune disorders (e.g., Hashimoto's thyroiditis) | 97 (24.8%)                       | 83 (21.2%)              | 211 (54.0%)       |
| Previous neck radiation exposure                     | 132 (33.8%)                      | 66 (16.9%)              | 193 (49.4%)       |
| Certain medications (e.g., lithium, amiodarone)      | 92 (23.5%)                       | 84 (21.5%)              | 215 (55.0%)       |
| Presence of goitre                                   | 184 (47.1%)                      | 60 (15.3%)              | 147 (37.6%)       |

n: Total number of participants available with data, N: Total number of participants

consuming fewer than five portions of fruits and vegetables daily increases the chances of developing thyroid disease, while 29.4% strongly agreed. The perception that being overweight with a BMI over 25 increases the risk of thyroid disease was shared by 39.1% of participants, with 33.5% remaining neutral. The majority of participants were neutral (41.7%) regarding the belief that getting

sunburned more than once as a child contributes to thyroid disease. Additionally, 46.3% of participants remained neutral regarding the idea that being infected with HPV could increase the likelihood of thyroid disease. Overall, a considerable number of participants were neutral about many of these perceptions, indicating a need for greater awareness of the various factors contributing to thyroid disease.

### Factors influencing knowledge and perceptions related to thyroid disease

Table 6 presents the factors influencing participants' knowledge and perceptions related to thyroid disease. Regarding knowledge of thyroid disease, gender differences were statistically significant ( $p=0.022$ ), with females exhibiting higher knowledge (Mean = 12.99) than males (Mean = 10.88). Participants aged 18–24 showed the highest mean knowledge score (15.19), with a significant difference across age groups ( $p<0.001$ ). Students also demonstrated greater knowledge (Mean = 16.10) than employed, unemployed, and retired participants ( $p<0.001$ ). Education level was a significant factor, with educated participants scoring higher on knowledge (Mean = 13.61) than illiterate participants (Mean = 6.86;  $p<0.001$ ). The residency status indicated that urban residents had slightly better knowledge (Mean = 12.74) than rural residents (Mean = 10.65;  $p=0.036$ ). A clear difference in knowledge was observed regarding awareness of thyroid disease, with those who had heard of it scoring much higher (17.05) than those who had not (3.98;  $p<0.001$ ). Regarding perceptions of thyroid disease, no significant differences were found across gender ( $p=0.300$ ) or income levels. However, there were slight variations in education status, with educated individuals (Mean = 4.17) having slightly better perceptions than the illiterate group (Mean = 3.64,  $p=0.027$ ). Participants who had heard of thyroid disease had better perceptions (Mean = 4.25) than those who had not (Mean = 3.72;  $p=0.009$ ). Family history did not show a significant difference in perceptions ( $p=0.408$ ). Overall, the data suggest that higher knowledge of thyroid disease is associated with younger age, higher education, awareness of thyroid disease, and urban residency. However, perceptions were more uniformly distributed across demographic groups, with some slight variations in education and knowledge.

### Quantitative effect sizes for significant group differences in knowledge and perception scores (N=391)

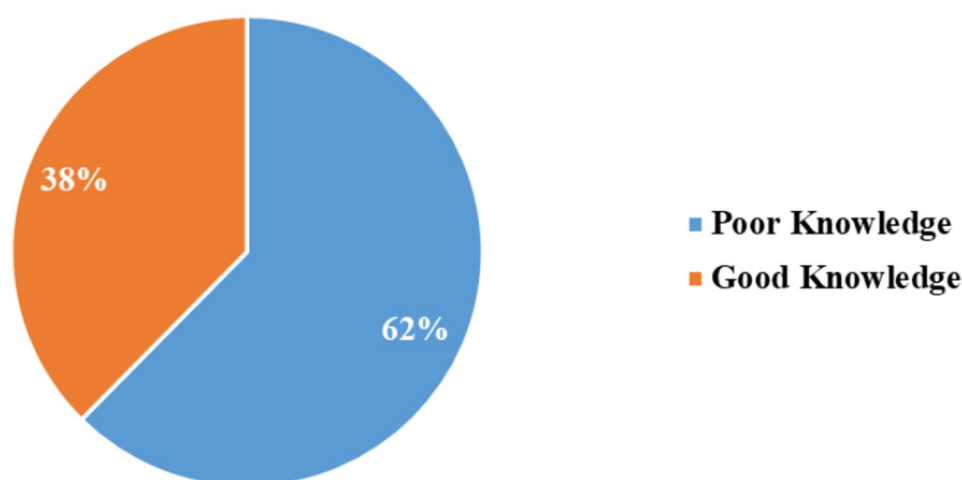
Table 7 presents the significant associations between demographic variables and thyroid disease knowledge and perception scores. A significant difference was observed between genders ( $p=0.022$ ), with females demonstrating higher knowledge scores. Age ( $p<0.001$ ) and employment status ( $p<0.001$ ) were significantly

**Table 4** Knowledge and awareness regarding preventive measures to reduce the risk of thyroid disease

| Variables                                         | Participant responses (N = 391) |                         |                   |
|---------------------------------------------------|---------------------------------|-------------------------|-------------------|
|                                                   | Correct answer, n (%)           | Incorrect answer, n (%) | Don't know, n (%) |
| Regular intake of iodine-rich foods               | 198 (50.6%)                     | 52 (13.3%)              | 141 (36.1%)       |
| Avoiding excessive iodine consumption             | 169 (43.2%)                     | 74 (18.9%)              | 148 (37.9%)       |
| Regular exercise                                  | 181 (46.3%)                     | 70 (17.9%)              | 140 (35.8%)       |
| Limiting exposure to environmental toxins         | 146 (37.3%)                     | 69 (17.6%)              | 176 (45.0%)       |
| Annual thyroid screenings                         | 218 (55.8%)                     | 30 (7.7%)               | 143 (36.6%)       |
| Smoking cessation                                 | 142 (36.3%)                     | 92 (23.5%)              | 157 (40.2%)       |
| Adequate selenium intake                          | 87 (22.3%)                      | 75 (19.2%)              | 229 (58.6%)       |
| Maintaining a healthy body weight                 | 191 (48.8%)                     | 48 (12.3%)              | 152 (38.9%)       |
| Managing stress levels                            | 186 (47.6%)                     | 69 (17.6%)              | 136 (34.8%)       |
| Avoiding self-prescription of thyroid medications | 194 (49.6%)                     | 49 (12.5%)              | 148 (37.9%)       |

n: Total number of participants available with data, N: Total number of participants

### The levels of knowledge of thyroid disease

**Fig. 1** The level of knowledge among participants regarding thyroid disease

associated with knowledge. Education ( $p < 0.001$ ) was significantly associated with knowledge; educated individuals demonstrate significantly greater knowledge. Marital status ( $p < 0.001$ ) and the presence of chronic disease ( $p < 0.001$ ) was significantly associated with knowledge. Residency ( $p = 0.036$ ) was significantly associated with knowledge; urban residents showed slightly higher knowledge. Awareness of thyroid disease ( $p < 0.001$ ) was significantly associated with knowledge; those who had heard of thyroid disease displayed substantially higher knowledge. Family history ( $p = 0.009$ ) was significantly associated with knowledge; those with a positive or uncertain family history showed slightly higher knowledge. Furthermore, education ( $p = 0.027$ ) and awareness ( $p = 0.009$ ) were significantly associated with perception; individuals who were educated and those aware of thyroid disease demonstrated slightly better perceptions.

### Multivariable analysis

Binary logistic regression was performed to identify independent predictors of good thyroid knowledge (score  $\geq 50\%$  correct responses). The dependent variable was dichotomised as good knowledge ( $n \approx 149$ , 38.1%) versus poor knowledge ( $n \approx 242$ , 61.9%). All ten demographic variables were entered simultaneously into the model. Having heard about thyroid disease was the only independent predictor of good thyroid disease knowledge after adjustment for potential confounders (OR = 0.044, 95% CI: 0.019–0.101,  $p < 0.001$ ). This finding indicates that awareness of thyroid disease was strongly associated with the likelihood of having good knowledge. None of the other sociodemographic variables, including gender, age, employment status, education, marital status, residency, monthly income, presence of chronic disease, or family history of thyroid disease, were independently associated with good thyroid disease knowledge after multivariable adjustment (all  $p > 0.05$ ) (Table 8).

**Table 5** Perceptions regarding thyroid disease

| Statement                                                                                                                               | Strongly agree | Agree       | Neutral     | Disagree    | Strongly disagree | Mean $\pm$ SD |
|-----------------------------------------------------------------------------------------------------------------------------------------|----------------|-------------|-------------|-------------|-------------------|---------------|
| I believe that smoking cigarettes increases my risk of developing thyroid disease                                                       | 74 (18.9%)     | 139 (35.5%) | 131 (33.5%) | 38 (9.7%)   | 9 (2.3%)          | 2.41 (0.977)  |
| I think being exposed to another person's smoke raises my likelihood of thyroid disease                                                 | 38 (9.7%)      | 108 (27.6%) | 145 (37.1%) | 88 (22.5%)  | 12 (3.1%)         | 2.82 (0.991)  |
| I am of the opinion that drinking more than one unit of alcohol daily contributes to the risk of thyroid disease                        | 44 (11.3%)     | 113 (28.9%) | 144 (36.8%) | 79 (20.2%)  | 11 (2.8%)         | 2.74 (0.995)  |
| I believe that consuming fewer than 5 portions of fruits and vegetables daily increases my chances of thyroid disease                   | 78 (19.9%)     | 115 (29.4%) | 145 (37.1%) | 46 (11.8%)  | 7 (1.8%)          | 2.46 (0.996)  |
| I think regularly consuming red or processed meat and junk food heightens my risk of developing thyroid disease                         | 53 (13.6%)     | 148 (37.9%) | 131 (33.5%) | 58 (14.8%)  | 1 (0.3%)          | 2.50 (0.914)  |
| I believe that being overweight with a BMI over 25 is a significant factor in increasing my risk of thyroid disease                     | 53 (13.6%)     | 153 (39.1%) | 131 (33.5%) | 52 (13.3%)  | 2 (0.5%)          | 2.48 (0.905)  |
| I believe getting sunburned more than once as a child contributes to the likelihood of thyroid disease                                  | 36 (9.2%)      | 74 (18.9%)  | 163 (41.7%) | 101 (25.8%) | 17 (4.3%)         | 2.97 (0.996)  |
| I believe that being over 70 years old increases the chances of developing thyroid disease                                              | 39 (10.0%)     | 132 (33.8%) | 145 (37.1%) | 63 (16.1%)  | 12 (3.1%)         | 2.69 (0.961)  |
| I think having a close relative with cancer raises my risk of thyroid disease                                                           | 56 (14.3%)     | 110 (28.1%) | 140 (35.8%) | 71 (18.2%)  | 14 (3.6%)         | 2.69 (1.041)  |
| I believe that being infected with Human Papillomavirus contributes to an increased likelihood of thyroid disease                       | 19 (4.9%)      | 61 (15.6%)  | 181 (46.3%) | 115 (29.4%) | 15 (3.8%)         | 3.12 (0.887)  |
| I am of the opinion that engaging in less than 30 min of moderate physical activity 5 times a week increases my risk of thyroid disease | 41 (10.5%)     | 131 (33.5%) | 148 (37.9%) | 58 (14.8%)  | 13 (3.3%)         | 2.67 (0.964)  |

## Discussion

Thyroid disease refers to a group of conditions affecting the thyroid gland, which produces hormones essential for metabolism, energy regulation, and temperature control. Despite its prevalence, there is a significant lack of literature on public knowledge and perceptions of thyroid disease, both globally and in Pakistan. Most existing studies have been conducted in Saudi Arabia and neighbouring countries, shedding light on variations in awareness levels across different demographic groups [23]. In recent years, there has been a rise in metabolic disorders, leading to increased public concern about personal health [18–20, 23, 24]. Thyroid disorders are among the most common endocrine conditions worldwide, affecting approximately 5–10% of the global population. In Pakistan, the reported prevalence of hypothyroidism is 4.1%, while hyperthyroidism affects 5.1% of the population [25]. Our study participants recognized various symptoms of thyroid disease, including neck swelling (61.9%), fatigue (48.8%), sensitivity to cold (37.9%), increased heart rate (37.1%), hair loss (19.2%), hoarseness (27.1%), persistent cough (29.9%), muscle weakness (32.7%), and difficulty concentrating (35.4%). In contrast, a recent study found that 27.4% of participants reported fatigue, joint discomfort, and excessive weight loss, while 25.3% experienced symptoms such as neck swelling, voice changes, and constipation. Additionally, 30.3% reported cognitive issues, including confusion and loss of attention [23]. Another study conducted in Saudi Arabia identified fatigue (81.7%), neck swelling (70.6%), weight gain

(68.9%), and digestive disturbances such as constipation and diarrhea (28.2%) as the most common symptoms [19]. Further research highlights tiredness (77.5%), neck lumps (72.4%), feeling cold with weight gain (71.3%), feeling hot with weight loss (66.4%), and bulging eyes (62.5%) as frequent symptoms of thyroid dysfunction [20, 23–26]. These findings suggest that neck swelling is among the most commonly recognized symptoms, underscoring the need for targeted educational initiatives to raise awareness of other thyroid-related symptoms. The current study also examined awareness of thyroid disease risk factors. The most commonly recognized risk factor was goitre (47.1%), followed by a family history of thyroid disease (36.8%), consumption of iodine-rich foods (29.4%), age above 60 (32.5%), smoking (33.0%), and female gender (32.7%). However, awareness of certain risk factors was lower, including autoimmune diseases such as Hashimoto's thyroiditis (24.8%), previous neck radiation exposure (32.8%), and medications like lithium and amiodarone (25%). Similar findings were reported in a study by Alqahtani, which found thyroid disease in 58.4% of females, 53.1% of individuals with a genetic predisposition, and 37.5% of those with childhood radiation exposure [27, 28]. Additional research suggests that smoking and female gender are significant risk factors for thyroid disorders [18, 29]. Amiodarone, an antiarrhythmic medication, has also been associated with an increased risk of thyroid dysfunction in elderly individuals. Other studies indicate that risk factors include lithium use (38.7%), upper respiratory infections (36.7%), pregnancy and the

**Table 6** Factors influencing participants' knowledge and perceptions related to thyroid disease

| Demographic Characteristics                      |                | Good Knowledge |                      | Good Perceptions |                    |
|--------------------------------------------------|----------------|----------------|----------------------|------------------|--------------------|
|                                                  |                | Mean $\pm$ SD  | p-value              | Mean $\pm$ SD    | p-value            |
| Gender                                           | Male           | 10.88(8.94)    | 0.022 <sup>a</sup>   | 3.94(1.92)       | 0.300 <sup>a</sup> |
|                                                  | Female         | 12.99(9.12)    |                      | 4.14(1.79)       |                    |
| Age                                              | 18–24          | 15.19(8.51)    | < 0.001 <sup>b</sup> | 4.22(1.91)       | 0.638 <sup>b</sup> |
|                                                  | 25–34          | 11.32(9.07)    |                      | 4.06(1.69)       |                    |
|                                                  | 35–44          | 9.89(8.48)     |                      | 4.06(1.78)       |                    |
|                                                  | 45–54          | 10.54(9.17)    |                      | 3.76(1.87)       |                    |
|                                                  | 55–64          | 7.67(8.87)     |                      | 3.82(2.21)       |                    |
|                                                  | 65 or older    | 8.08(9.22)     |                      | 1.88 (4.05)      |                    |
| Employment status                                | Employed       | 10.47 (9.19)   | < 0.001 <sup>b</sup> | 4.15 (1.96)      | 0.213 <sup>b</sup> |
|                                                  | Unemployed     | 10.36 (8.68)   |                      | 3.87 (1.72)      |                    |
|                                                  | Student        | 16.10 (8.20)   |                      | 4.20 (1.86)      |                    |
|                                                  | Retired        | 7.80 (8.70)    |                      | 4.05 (1.85)      |                    |
| Education                                        | Illiterate     | 6.86 (7.59)    | < 0.001 <sup>a</sup> | 3.64 (2.00)      | 0.027 <sup>a</sup> |
|                                                  | Educated       | 13.61 (8.93)   |                      | 4.17 (1.79)      |                    |
| Marital status                                   | Single         | 14.83 (8.64)   | < 0.001 <sup>b</sup> | 4.20 (1.82)      | 0.154 <sup>b</sup> |
|                                                  | Married        | 10.06 (8.87)   |                      | 3.97 (1.86)      |                    |
|                                                  | Divorced       | 8.66 (7.81)    |                      | 4.33 (1.22)      |                    |
|                                                  | Widowed        | 5.20 (7.54)    |                      | 3.00 (2.13)      |                    |
| Residency                                        | Urban          | 12.74 (8.86)   | 0.036 <sup>a</sup>   | 4.08 (1.80)      | 0.833 <sup>a</sup> |
|                                                  | Rural          | 10.65 (9.41)   |                      | 3.99 (1.96)      |                    |
| Income                                           | < 25,000       | 13.81 (9.20)   | 0.118 <sup>b</sup>   | 4.13 (1.52)      | 0.113 <sup>b</sup> |
|                                                  | 25,000–50,000  | 11.56 (9.14)   |                      | 3.78 (1.87)      |                    |
|                                                  | 50,000–100,000 | 11.26 (9.27)   |                      | 4.07 (1.78)      |                    |
|                                                  | > 100,000      | 13.74 (8.50)   |                      | 4.36 (2.00)      |                    |
| Chronic disease                                  | Yes            | 8.90 (8.57)    | < 0.001 <sup>a</sup> | 4.06 (2.02)      | 0.836 <sup>a</sup> |
|                                                  | No             | 12.88 (9.05)   |                      | 4.05 (1.81)      |                    |
| Have you heard about thyroid disease?            | Yes            | 17.05 (6.85)   | < 0.001 <sup>a</sup> | 4.25 (1.77)      | 0.009 <sup>a</sup> |
|                                                  | No             | 3.98 (5.90)    |                      | 3.72 (1.94)      |                    |
| Do you have a family history of thyroid disease? | Yes            | 15.62 (6.24)   | 0.009 <sup>b</sup>   | 4.27 (1.75)      | 0.408 <sup>b</sup> |
|                                                  | No             | 12.22 (9.40)   |                      | 4.07 (1.88)      |                    |
|                                                  | Not sure       | 10.37 (8.92)   |                      | 3.93 (1.83)      |                    |

SD= Standard Deviation; a= Mann Whitney U Test; b= Kruskal Wallis test

**Table 7** Quantitative effect sizes for significant group differences in knowledge and perception scores (N = 391)

| Demographic Variable     | Groups Compared              | Outcome    | Test           | p-value | Test Statistic | Effect Size          | Interp. |
|--------------------------|------------------------------|------------|----------------|---------|----------------|----------------------|---------|
| Gender                   | Female vs. Male              | Knowledge  | Mann-Whitney U | 0.022   | Z = 2.290      | r = 0.116            | Small   |
| Age                      | Age Groups (6 levels)        | Knowledge  | Kruskal-Wallis | < 0.001 | H = 25.745     | $\epsilon^2$ = 0.066 | Medium  |
| Employment Status        | Employment Groups (4 levels) | Knowledge  | Kruskal-Wallis | < 0.001 | H = 21.108     | $\epsilon^2$ = 0.054 | Small   |
| Education                | Educated vs. Illiterate      | Knowledge  | Mann-Whitney U | < 0.001 | Z = 3.891      | r = 0.197            | Small   |
| Marital Status           | Marital Groups (4 levels)    | Knowledge  | Kruskal-Wallis | < 0.001 | H = 21.108     | $\epsilon^2$ = 0.054 | Small   |
| Residency                | Urban vs. Rural              | Knowledge  | Mann-Whitney U | 0.036   | Z = 2.097      | r = 0.106            | Small   |
| Chronic Disease          | No vs. Yes                   | Knowledge  | Mann-Whitney U | < 0.001 | Z = 3.891      | r = 0.197            | Small   |
| Heard of Thyroid Disease | Yes vs. No                   | Knowledge  | Mann-Whitney U | < 0.001 | Z = 3.891      | r = 0.197            | Small   |
| Family History           | Yes / No / Not Sure          | Knowledge  | Kruskal-Wallis | 0.009   | H = 9.421      | $\epsilon^2$ = 0.024 | Small   |
| Education                | Educated vs. Illiterate      | Perception | Mann-Whitney U | 0.027   | Z = 2.212      | r = 0.112            | Small   |
| Heard of Thyroid Disease | Yes vs. No                   | Perception | Mann-Whitney U | 0.009   | Z = 2.612      | r = 0.132            | Small   |

Effect sizes calculated using  $r = Z/\sqrt{N}$  for Mann-Whitney U tests and  $\epsilon^2 = H/(N - 1)$  for Kruskal-Wallis tests. Interpreted per Cohen (1988): r: small (0.10–0.29), medium (0.30–0.49), large ( $\geq 0.50$ );  $\epsilon^2$ : small (0.01–0.05), medium (0.06–0.13), large ( $\geq 0.14$ ). Z and H back-calculated from reported p-values using inverse normal/chi-squared distributions; for  $p < 0.001$ ,  $p = 0.0001$  was used as a conservative estimate

**Table 8** Binary logistic regression analysis: Independent predictors of good thyroid disease knowledge (Score  $\geq 50\%$ ) (N = 391)

| Variable                              | B      | S.E.  | Wald   | df | p-value | ORa   | 95% C.I. for EXP(B) |        |
|---------------------------------------|--------|-------|--------|----|---------|-------|---------------------|--------|
|                                       |        |       |        |    |         |       | Lower               | Upper  |
| Gender                                |        |       |        |    |         |       |                     |        |
| Male                                  | -0.527 | 0.299 | 3.119  | 1  | 0.077   | 0.590 | 0.329               | 1.060  |
| Female                                | Ref    |       |        |    |         |       |                     |        |
| Age                                   |        |       |        |    |         |       |                     |        |
| 18–24                                 | -1.402 | 1.486 | 0.890  | 1  | 0.345   | 0.246 | 0.013               | 4.531  |
| 25–34                                 | -1.486 | 1.421 | 1.093  | 1  | 0.296   | 0.226 | 0.014               | 3.668  |
| 35–44                                 | -1.190 | 1.410 | 0.713  | 1  | 0.399   | 0.304 | 0.019               | 4.820  |
| 45–54                                 | -0.343 | 1.382 | 0.061  | 1  | 0.804   | 0.710 | 0.047               | 10.664 |
| 55–64                                 | -0.933 | 1.382 | 0.456  | 1  | 0.500   | 0.393 | 0.026               | 5.904  |
| 65 or older                           | Ref    |       |        |    |         |       |                     |        |
| Employment status                     |        |       |        |    |         |       |                     |        |
| Employed                              | -0.292 | 1.399 | 0.044  | 1  | 0.835   | 0.747 | 0.048               | 11.586 |
| Unemployed                            | -0.858 | 1.382 | 0.386  | 1  | 0.535   | 0.424 | 0.028               | 6.359  |
| Student                               | -0.080 | 1.447 | 0.003  | 1  | 0.956   | 0.923 | 0.054               | 15.734 |
| Retired                               | Ref    |       |        |    |         |       |                     |        |
| Education                             |        |       |        |    |         |       |                     |        |
| Illiterate                            | -0.275 | 0.463 | 0.353  | 1  | 0.553   | 0.760 | 0.307               | 1.882  |
| Educated                              | Ref    |       |        |    |         |       |                     |        |
| Marital status                        |        |       |        |    |         |       |                     |        |
| Single                                | 1.698  | 1.043 | 2.649  | 1  | 0.104   | 5.465 | 0.707               | 42.247 |
| Married                               | 1.040  | 0.966 | 1.161  | 1  | 0.281   | 2.830 | 0.426               | 18.783 |
| Divorced                              | 2.202  | 1.329 | 2.746  | 1  | 0.097   | 9.042 | 0.669               | 12.262 |
| Widowed                               | Ref    |       |        |    |         |       |                     |        |
| Residency                             |        |       |        |    |         |       |                     |        |
| Urban                                 | -0.525 | 0.313 | 2.805  | 1  | 0.094   | 0.592 | 0.320               | 1.093  |
| Rural                                 | Ref    |       |        |    |         |       |                     |        |
| Income                                |        |       |        |    |         |       |                     |        |
| < 25,000                              | 0.616  | 0.574 | 1.154  | 1  | 0.283   | 1.852 | 0.602               | 5.699  |
| 25,000–50,000                         | 0.588  | 0.373 | 2.492  | 1  | 0.114   | 1.801 | 0.868               | 3.740  |
| 50,000–100,000                        | 0.328  | 0.333 | 0.971  | 1  | 0.324   | 1.388 | 0.723               | 2.666  |
| > 100,000                             | Ref    |       |        |    |         |       |                     |        |
| Chronic disease                       |        |       |        |    |         |       |                     |        |
| Yes                                   | 0.207  | 0.432 | 0.230  | 1  | 0.632   | 1.230 | 0.527               | 2.872  |
| No                                    | Ref    |       |        |    |         |       |                     |        |
| Have you heard about thyroid disease? |        |       |        |    |         |       |                     |        |
| Yes                                   | -3.130 | 0.425 | 54.109 | 1  | 0.000   | 0.044 | 0.019               | 0.101  |
| No                                    | Ref    |       |        |    |         |       |                     |        |
| Family history                        |        |       |        |    |         |       |                     |        |
| Yes                                   | -0.042 | 0.328 | 0.016  | 1  | 0.899   | 0.959 | 0.505               | 1.823  |
| No                                    | 0.132  | 0.478 | 0.076  | 1  | 0.783   | 1.141 | 0.447               | 2.910  |
| Not sure                              | Ref    |       |        |    |         |       |                     |        |

All variables entered simultaneously (Enter method). ORa = Adjusted Odds Ratio; CI = Confidence Interval; B = log-odds coefficient; S.E. = standard error; Wald = Wald  $\chi^2$  statistic

postpartum period (47.2%), and amiodarone therapy (29.7%) [26, 30]. These findings highlight the need to educate the public about risk factors to raise awareness and encourage early detection of thyroid disease. In the current study regarding preventive measures, the most recognized strategies among participants included thyroid screening (55.8%), regular iodine-rich food consumption (50.6%), avoiding self-medication (49.6%), maintaining

body weight (48.8%), managing stress (47.6%), and engaging in regular exercise (46.3%). However, awareness was lower for preventive measures such as smoking cessation (36.3%), adequate selenium intake (22.3%), and limiting exposure to environmental toxins (37.3%). In contrast, a different study found that 79.7% of participants were aware of the importance of thyroid screening, while 74.5% recognized the significance of a well-balanced diet

for thyroid health [26, 31]. These findings indicate the need to expand public awareness campaigns beyond conventional prevention strategies. While thyroid screening and iodine intake are widely recognized, additional emphasis should be placed on smoking cessation, selenium intake, and reducing exposure to environmental toxins. Integrating these aspects into media, educational programs, and healthcare initiatives can significantly improve the prevention of thyroid disease. Previous studies [18, 30, 32] reported that 57.32% of Saudi participants had good knowledge of thyroid disease. More recent studies indicate that 56% of participants had a moderate level of thyroid knowledge [20, 24, 32]. These findings suggest that a significant portion of the public remains unaware of thyroid-related health issues, potentially leading to delayed diagnoses. The disparity in knowledge between Saudi Arabia and Pakistan may be attributed to differences in public health campaigns, healthcare accessibility, and educational resources. Gender-based differences in knowledge of thyroid disease were also observed in this study. Female participants demonstrated significantly greater knowledge than male participants ( $p = 0.022$ ). A comparable study reported a significant gender gap in knowledge scores, with 60.3% of females ( $n = 47$ ) and 39.7% of males ( $n = 31$ ) demonstrating awareness ( $p = 0.049$ ) [33]. Another study found a knowledge ratio of 1 male to 2.2 females [18]. Age and educational background also influenced knowledge levels. Younger participants (aged 18–24) have higher thyroid knowledge ( $p < 0.001$ ), and students have more knowledge than employed, unemployed, and retired individuals ( $p < 0.001$ ). Additionally, educated individuals and urban residents exhibited higher levels of awareness ( $p < 0.001$  and  $p = 0.036$ , respectively). In contrast, another study found that females, Saudi nationals, employed individuals, students, and those with lower incomes or previous thyroid disease diagnoses had significantly higher knowledge ( $p < 0.05$ ) [26]. The higher awareness among younger participants may be attributed to greater exposure to digital media, recent educational engagement, and easier access to online health information compared to older individuals, who may rely more on traditional sources. Similarly, the better knowledge observed among urban residents can be explained by improved access to healthcare facilities, educational resources, and public health campaigns. In contrast, rural populations may face limitations in these areas. Furthermore, disparities between urban and rural populations may also reflect differences in health literacy levels, availability of trained healthcare professionals, and frequency of exposure to awareness programs. Participants' perceptions of thyroid disease risk factors included smoking (35.5%), alcohol consumption (27.6%), fruit and vegetable intake (28.9%), being overweight (39.1%), childhood sunburn (41.7%), and HPV

infection (15.3%). Additionally, individuals over 70 years old and those with close relatives diagnosed with cancer expressed neutral or positive opinions about these risk factors. Two previous studies by Zuberi *et al.* and Al Fayi identified smoking as a major contributor to thyroid disease [34, 35]. Another study, which examined individuals from the Eastern Province of Saudi Arabia, found that 40.5% believed smoking increased the risk of thyroid disease [33, 36]. Similarly, a study conducted by Asvold and Cooper reported that 55.4% of college students agreed that smoking increased thyroid cancer risk [37, 38]. Additionally, one-third of students surveyed by Alhazmi *et al.* believed that a family history of cancer could increase the likelihood of thyroid disease [18, 19, 31, 38]. Furthermore, participants without chronic illnesses demonstrated comparatively better knowledge, which may be due to healthier individuals engaging more in general health awareness activities. In contrast, those with chronic conditions often focus primarily on managing their existing disease. Moreover, individuals with chronic diseases may experience information fatigue or prioritise disease-specific knowledge, thereby limiting their engagement with broader health education topics such as thyroid disorders. Multivariable logistic regression identified six independent predictors of good thyroid knowledge: awareness of thyroid disease, education level, younger age, student employment status, single marital status, and absence of chronic disease. The dominant influence of prior awareness of thyroid disease ( $OR = 62.41$ ) underscores that prior exposure to health information is the most critical driver of thyroid literacy, with direct implications for targeted community health campaigns. Notably, gender ( $p = 0.067$ ) and residency ( $p = 0.182$ ), which showed significance in bivariate analysis, did not remain significant in the multivariable model, suggesting that their apparent associations were confounded by underlying educational and awareness disparities rather than representing independent demographic effects. This highlights the importance of multivariable approaches in health literacy research [39]. The substantially elevated odds of good knowledge among students ( $OR = 2.77$ ) and single participants ( $OR = 2.38$ ) may reflect the educational environment and information networks available to these groups. The inverse relationship between the presence of chronic disease and thyroid knowledge ( $OR = 0.45$ ) may reflect cognitive burden or disease-specific information prioritisation among those managing existing conditions, thereby limiting engagement with broader health education. Public health interventions should prioritise thyroid education through formal channels and awareness campaigns, particularly targeting older, married, non-student adults and those living with chronic conditions [40]. This study underscores the urgent need for targeted public

health campaigns in Lahore, Pakistan, to enhance awareness of thyroid disease symptoms, risk factors, and prevention strategies. Community-based education initiatives and expanded screening programs can improve early detection and management of thyroid disorders, ultimately reducing the burden of thyroid disease on the healthcare system.

### Limitation

This study has several limitations. The use of convenience sampling may have introduced selection bias, thereby limiting the external validity and generalizability of the findings. Furthermore, as data were collected exclusively from selected public locations within Lahore, the results may not be representative of populations in other regions of Pakistan, particularly rural or underserved areas. Therefore, the findings should be interpreted with caution and should not be generalized to the entire Pakistani population.

### Conclusion

The study highlights a notable lack of awareness about thyroid disease, with most participants recognizing basic symptoms such as neck swelling but lacking a deeper understanding, especially among younger individuals and those with lower education levels. Although some risk factors, including family history and age, were acknowledged, key factors like autoimmune diseases and environmental toxins were largely unknown. Preventive measures such as regular screenings and a healthy diet were somewhat familiar, underscoring the need for more extensive educational efforts. Education and awareness were found to have the greatest influence on both knowledge and perception, with individuals who were more educated and aware of the disease demonstrating significantly greater understanding. Younger people, students, and those without chronic conditions also displayed higher levels of knowledge. These results highlight the need for focused public health campaigns to address the knowledge gap, particularly by increasing awareness of thyroid disease risk factors, preventive measures, and the importance of early detection.

### Author contributions

Asma Ghulam Mustafa, Sagir Mustapha: Writing – review & editing, Writing – original draft, Software, Formal analysis, Data curation, Conceptualization. Nimra Muhammad Boota, Zohra Bhatti, Abubakar Wada: Writing – review & editing, Software, Formal analysis. Muhammad Luqman Nordin, Mustapha Mohammed: Writing – review & editing, Validation. Hasiya Usmam Jibrilla: Writing-review & editing. Ahmad Khusairi: Writing-original draft, Validation, Writing – review & editing.

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### Data availability

No datasets were generated or analysed during the current study.

### Declaration

#### Ethics approval and consent to participate

Ethical approval for this study was obtained from the Institutional Research Ethics Committee (IREC) of the University of Lahore (Approval No. IREC-2023-28H). The study was conducted in accordance with the institutional ethical guidelines and the ethical principles of the Declaration of Helsinki applicable at the time of the study. Before enrolment, all participants received adequate information about the purpose and procedures of the study and provided written informed consent. Participation was entirely voluntary, and participants' privacy and confidentiality were protected by anonymising their responses and securely storing the research data.

#### Consent for publication

Not applicable.

#### Competing interests

The authors declare no competing interests.

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