

Cancer Knowledge and Environmental Exposure Awareness Among Healthcare Workers and the General Public in Istanbul: A Cross-Sectional Study

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Abstract

Objectives: A substantial proportion of cancers are preventable, yet awareness of risk factors and screening remains limited. This study assessed disparities in knowledge of cancer epidemiology, screening, and environmental risk factors between healthcare workers (HCWs) and the general public (GP) in two urban districts of Istanbul, and identified associated sociodemographic and behavioral determinants. **Methods:** A cross-sectional survey was conducted with 309 participants using a structured 42-item questionnaire covering cancer epidemiology (15 items), screening (9), and environmental risk factors (18). Each correct response scored one point. Internal consistency was high (Cronbach's alpha = 0.944). Knowledge levels were analyzed across subgroups. **Results:** HCWs scored significantly higher than the GP in all domains: epidemiology (7.7 ± 3.6 ; 6.4 ± 2.8), screening (5.2 ± 2.7 ; 2.6 ± 2.1), and environmental risks (12.5 ± 5.0 ; 10.7 ± 5.7). Higher education, better income, and health-promoting behaviors were associated with increased knowledge. Despite this, notable gaps persisted. Breast cancer was widely recognized (86.1% HCWs; 81.9% GP), whereas awareness of lethal cancers like liver cancer was low (12.2% HCWs; 4.6% GP). Screening knowledge varied: HCWs were more aware of breast cancer screening; prostate and lung cancer screening were poorly recognized, particularly by the GP. While radiation risks were commonly known, links between smoking and non-lung cancers were largely unknown. **Conclusion:** Despite national programs, critical gaps in knowledge persist across all domains, including among HCWs. These disparities, shaped by education, income, and behavior, undermine prevention efforts. Tailored education strategies are needed to improve knowledge, especially environmental cancer literacy, and promote early detection in both groups.

Keywords: Cancer awareness- Cancer epidemiology- Cancer screening- Environmental risk factors- Public knowledge

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Introduction

Cancer remains a critical global public health concern and is among the leading causes of mortality from non-communicable diseases. According to the World Health Organization (WHO), approximately 10 million cancer-related deaths occurred in 2020, accounting for one in every six deaths globally [1]. In Turkey, cancer ranks as the second most common cause of death after cardiovascular diseases, with its incidence rising steadily in recent years. Based on 2019 national cancer statistics, the age-standardized overall incidence rate was 229.2 per 100,000 population, 264.9 per 100,000 among men and

193.4 per 100,000 among women [2]. These data clearly illustrate the burden of cancer on public health, both globally and in Turkey.

The most prevalent cancer types in Turkey differ by sex. Among men, lung, prostate, and colorectal cancers are most common, whereas breast, thyroid, and colorectal cancers predominate among women. Lung cancer is the leading cause among men, with more than half of the cases (54.9%) diagnosed at advanced stages, indicating a critical need for improved early detection strategies. Breast cancer accounts for approximately one-quarter of all cancers in women, and colorectal cancer ranks third in incidence for both sexes [2].

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Cancer develops through a multistep process involving genetic mutations that disrupt cellular regulation and promote uncontrolled proliferation. While some mutations arise spontaneously during DNA replication, a significant proportion result from environmental exposures. Epidemiological evidence suggests that 90–95% of cancers are attributable to modifiable environmental factors, while hereditary predisposition accounts for only 5–10% of cases [3-5]. Environmental risk factors encompass a wide range of exposures, including tobacco use, excessive body weight, sedentary behavior, unhealthy diets, alcohol consumption, poor housing conditions (e.g., residence near industrial zones), and air pollution [4, 5]. In addition, chronic infections such as *Helicobacter pylori*, human papillomavirus (HPV), and hepatitis B and C viruses are established contributors to the etiology of various cancers [5-7]. Given the established role of environmental exposures in cancer development, as classified by IARC Monographs and aligned with WHO's global environmental health strategies, assessing public and professional awareness of such risks remains a critical public health priority [1, 8].

Cancer treatment is often lengthy, expensive, and burdensome, highlighting the critical role of prevention and early detection in cancer control. While evidence-based screening programs reduce morbidity and mortality, particularly in low- and middle-income countries, primary prevention targeting modifiable risk factors and environmental exposures is equally essential. The effectiveness of both strategies largely depends on the knowledge level of the general public and healthcare professionals. Greater awareness of cancer risks is linked to higher participation in screening and healthier behaviors [6]. Enhancing healthcare providers' understanding of environmental carcinogens can further strengthen public health education and inform preventive policies [9].

In Turkey, cancer screening services are coordinated by the Cancer Early Diagnosis, Screening, and Education Centers (KETEM), in collaboration with Healthy Life Centers, District Health Directorates, and family physicians. The national screening program currently targets breast, cervical, and colorectal cancer types that are not only among the most common in the country but also highly suitable for early detection through clinical examinations and cost-effective laboratory tests. Despite the existence of these structured programs, evidence suggests that participation rates remain suboptimal, often due to limited awareness, misperceptions, or lack of knowledge regarding cancer risk factors and the benefits of early screening. This highlights the critical need for evaluating cancer-related knowledge across different segments of the population, particularly in the context of health promotion and public engagement efforts [6, 9, 10].

Against this backdrop, the present study aims to evaluate the level of knowledge regarding primary prevention and environmental risk factors associated with cancer, with a particular focus on breast, cervical, and colorectal cancers included in the national screening program. The study includes both healthcare professionals and members of the general public recruited from two urban districts in Istanbul Fatih and Silivri not for

comparison purposes but to ensure diverse representation from different service delivery settings.

Materials and Methods

Study Design

This study employed a cross-sectional survey design, conducted between July 1, 2024, and October 1, 2024, in the Fatih and Silivri districts of Istanbul. Fatih, located in the city center, and Silivri, the most peripheral district included in the protocol, were deliberately chosen to represent contrasting urban and peripheral settings, allowing for the comparison of knowledge levels across different socio-geographic contexts. These districts were selected as they are included in the SEAB protocol (Health Education and Research Region Establishment Protocol), which was established through a collaboration between Istanbul University Faculty of Medicine and the Istanbul Provincial Health Directorate of the Ministry of Health, Republic of Turkey. The SEAB protocol aims to enhance health services in designated regions through scientific research and collaboration between universities and affiliated institutions of the Ministry of Health. Additionally, it provides a framework for supporting student education through practical training and research opportunities.

Study Population

The required sample size was calculated as 384 participants using the OpenEpi software, based on a 95% confidence level, a $\pm 5\%$ margin of error, and a design effect of 1. Stratification was performed according to the mid-year population estimates of the districts, with planned recruitment targets of 154 participants from Silivri and 230 from Fatih. Participants were selected using a convenience sampling method due to logistical constraints and limited access to a comprehensive sampling frame.

Data were collected through face-to-face interviews conducted at the district health directorates. Health workers who consented to participate and community members aged 18 years or older who visited the health directorates for any reason were invited to take part in the study. The inclusion criteria were: being 18 years of age or older, being able to communicate in Turkish, and providing informed consent. Individuals with cognitive impairments that could interfere with survey comprehension or who declined to participate were excluded.

Data collection was concluded after a three-month period, as it was not feasible to recruit additional participants beyond this point. The study was completed with a total of 309 respondents; 119 from Silivri and 190 from Fatih; corresponding to response rates of 77.3% and 82.6%, respectively, and an overall response rate of 80.5%.

Patient and Public Involvement

Patients or members of the public were not involved in the design, conduct, reporting, or dissemination of this research. The study involved collecting survey data from healthcare workers and members of the public, but they did not participate in shaping the study protocol or interpretation of the results.

Data Collection Tool

The survey consisted of two main sections. The first section collected sociodemographic data from the participants. The second section included 42 items designed to assess knowledge regarding cancer epidemiology (15 items), screening programs (9 items), and environmental risk factors (18 items). Knowledge levels for each section and the overall knowledge were quantified based on participants' responses. Specifically, the section on environmental risks addressed factors associated with common cancers that can potentially be diagnosed at early stages, including breast, cervical, colorectal, prostate, lung, gastrointestinal, skin, thyroid, testicular, and bladder cancers. The internal consistency analysis was conducted solely for the knowledge-related questions. The Cronbach's alpha coefficient for the 42 knowledge items was 0.944, while the reliability coefficients for the sections were 0.850 for epidemiology, 0.835 for screening, and 0.937 for environmental risks, indicating strong consistency across all components. Each correct response was assigned 1 point, enabling the computation of section-specific knowledge totals as well as a combined overall knowledge measure.

Data Analysis Methods

Data were analyzed using SPSS version 26.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics for categorical data were presented as frequencies and percentages, while continuous data were expressed as mean, standard deviation, minimum, and maximum values. The Kolmogorov-Smirnov test was applied to assess the normality of continuous variables. Since the data did not meet the assumptions for parametric testing, the Mann-Whitney U and Kruskal-Wallis test was utilized for between-group comparisons. There were no missing data across variables, and therefore, no imputation or data cleaning procedures related to missingness were required. To account for potential confounding in determinants of cancer knowledge, we performed hierarchical multivariable linear regression with the total knowledge score as the dependent variable (range: 0–42). The main exposure of interest was participant group (healthcare workers vs general public). Covariates were selected a priori based on their established or plausible associations with health knowledge in the literature and their potential to confound the relationship between participant group and knowledge. Accordingly, age and sex were included as core demographic covariates. Education (5 levels) and income (3 levels) were included as key socioeconomic indicators, and health-related behaviors (dietary pattern, physical activity, smoking, and alcohol use) were entered to reflect lifestyle factors that may correlate with both socioeconomic position and health knowledge.

We fitted models in a prespecified sequence to evaluate the robustness of the between-group association after sequential adjustment for potential confounders. Model 1 included participant group, age, and sex. Model 2 additionally adjusted for education and income (entered as ordinal variables, coded from 0 upward). Model 3

further adjusted for health-related behaviors (dietary pattern, physical activity, smoking, and alcohol use; modeled as binary covariates coded 0/1). Covariates were retained based on the prespecified framework rather than univariable significance testing. Regression results were reported as unstandardized coefficients (B) with 95% confidence intervals and p-values. Assumptions of linear regression were assessed using standard diagnostic procedures (residual and fitted-value plots and collinearity diagnostics). A p-value of less than 0.05 was considered statistically significant.

Results

Of the total participants, 68.9% (n = 213) were female, and the mean age was 40.5 ± 13 years (range: 18–74). In terms of educational background, 12% had completed primary education, 8.1% secondary, 17.5% high school, 54.0% university, and 8.4% held a postgraduate degree. Perceived low income, defined as reporting income lower than expenses, was noted by 61.3% of community members and 34.8% of healthcare professionals. Regarding health behaviors, 59.3% of the community and 79.1% of healthcare professionals reported consuming natural foods. Physical activity was practiced by 61.3% and 73.9%, respectively. Smoking rates were 24.2% in the community and 32.2% among healthcare professionals, while alcohol consumption was relatively low in both groups (5.7% and 4.3%, respectively). A personal history of cancer was reported by 6.7% of community members and 6.1% of healthcare professionals, whereas 27.3% and 25.2%, respectively, reported a family history of cancer. (Table 1).

When asked whether environmental factors play an important role in cancer development, 66.5% of the general public and 78.3% of healthcare professionals responded affirmatively.

The item with the highest correct response rate across all domains was "Breast cancer is the most prevalent type of cancer among women," with 86.1% correct among healthcare workers (HCWs) and 81.9% among the general public (GP). The lowest correct rate was observed for the item "Liver cancer is considered a highly lethal cancer type," at 12.2% for HCWs and 4.6% for GP. In the screening domain, regarding the existence of routine screening programs and their role in early detection of certain cancers, but showed limited awareness of lung cancer screening availability (7.7%). Among healthcare workers, breast cancer screening was the most widely recognized (87.0%), while awareness of prostate cancer screening was the lowest (35.7%) (Table 2).

In the environmental knowledge domain, the statement "Excessive exposure to radiation may increase cancer risk" was correctly identified by 73.7% of GP and 88.7% of HCWs. Conversely, the item "Smoking is one of the causes of bladder cancer" had the lowest correct response rate in the general public (34.5%), whereas among healthcare workers, the lowest rate was observed for the item linking smoking to prostate cancer (35.7%). Notably, the bladder cancer item also had the highest "Do Not Know" response rate in the general public (51.0%).

Table 1. Sociodemographic, Behavioral, and Health Status Characteristics of the Participants

	n	%
Participant group		
General Public	194	62.80
Healthcare Worker	115	37.20
Gender		
Female	213	68.90
Male	96	31.10
Education Level		
Primary school	37	12.00
Middle school	25	8.10
High school	54	17.50
University	167	54.00
Postgraduate	26	8.40
Marital status		
Married	203	65.70
Single	106	34.30
Perceived Income Status		
Income Below Expenses	159	51.50
Income Equal to Expenses	125	40.50
Income Above Expenses	25	8.10
Dietary Preference		
Primarily Natural/Unprocessed Foods	206	66.70
Primarily Processed/Packaged Foods	103	33.30
Physical Activity		
Active	204	66.00
Inactive	105	34.00
Smoking status		
Smoker	84	27.20
Non-smoker	225	72.80
Alcohol Consumption		
Alcohol User	16	5.20
Non-user	293	94.80
Cancer diagnosis history		
Yes	20	6.50
No	289	93.50
Family History of cancer		
Yes	82	26.50
No	227	73.50

Among HCWs, the highest “Do Not Know” rate (44.3%) was observed for the item on dietary fat and breast cancer risk. Overall, while HCWs demonstrated higher correct response rates, substantial uncertainty remains among both groups regarding several environmental risk items, particularly those involving indirect or less-publicized associations (Table 2).

A total of 12 participants (8 from the general public and 4 healthcare workers) did not answer any of the knowledge questions correctly. At least half of the questions were answered correctly by 76.5% of healthcare workers and 57.2% of the general public. When examined by domain, this proportion was 53.0% vs. 36.1% for cancer

epidemiology, 53.9% vs. 18.0% for cancer screening, and 79.1% vs. 73.2% for environmental factors, respectively. The study assessed cancer-related knowledge across epidemiology, screening, and environmental risk domains among 309 participants. Statistically significant differences were observed across various sociodemographic and behavioral subgroups.

Healthcare workers demonstrated significantly higher knowledge levels than the general public in all domains: epidemiology (7.7 ± 3.6 vs. 6.4 ± 2.8 , $p < 0.001$), screening (5.2 ± 2.7 vs. 2.6 ± 2.1 , $p < 0.001$), and environmental risk factors (12.5 ± 5.0 vs. 10.7 ± 5.7 , $p = 0.006$). Consequently, their total knowledge level was also notably higher (25.4 ± 9.9 vs. 19.7 ± 8.6 , $p < 0.001$) (Table 3).

Educational attainment was a strong determinant of knowledge. Participants with postgraduate education demonstrated the highest levels of knowledge across all domains, particularly in screening (mean of 5.9 ± 2.3 correct responses) and environmental risk awareness (14.3 ± 4.2), contributing to a combined knowledge level (KL) of 28.3 ± 7.7 ($p < 0.01$ for all domains). Perceived income status was also significantly associated with knowledge. Those who reported having income above expenses displayed greater awareness in both screening (4.4 ± 2.4) and environmental risk domains (12.8 ± 4.4) compared to participants whose income was reported as lower than expenses ($p < 0.01$) (Table 3).

Behavioral factors such as diet and physical activity showed significant associations. Those who primarily consumed natural foods had higher screening (4.0 ± 2.7) and environmental knowledge (11.9 ± 5.2) than those who consumed mostly processed foods ($p < 0.001$, $p = 0.023$ respectively). Similarly, physically active participants demonstrated higher overall knowledge levels, with a mean of 22.7 ± 9.5 correct responses compared to 20.2 ± 9.3 among inactive participants ($p = 0.012$). Smoking status was associated with knowledge in the screening domain, where smokers showed slightly greater awareness (4.0 ± 2.6 vs. 3.4 ± 2.6 ; $p = 0.048$), although no significant differences were found in environmental knowledge or overall knowledge levels. Participants with a family history of cancer demonstrated significantly greater awareness in the epidemiology domain (7.8 ± 2.8 vs. 6.6 ± 3.3 ; $p = 0.004$), though no meaningful differences were observed in overall knowledge.

These findings highlight the multifactorial nature of cancer knowledge and underscore the influence of education, income, and health-related behaviors on awareness. Targeted interventions tailored to sociodemographic and behavioral profiles may help close existing knowledge gaps. (Table 3)

In hierarchical multivariable linear regression, healthcare-worker status was consistently associated with higher total cancer knowledge scores across all models. In the fully adjusted model (Model 3), healthcare workers scored on average 3.55 points higher than the general public ($B=3.551$, 95% CI 1.174 to 5.927; $p=0.004$), independent of age, sex, education, income, diet, physical activity, smoking, and alcohol use. Age was positively associated with knowledge ($B=0.114$ per year, 95% CI 0.034 to 0.195; $p=0.005$). Higher education ($B=1.074$ per

Table 2. Distribution of Knowledge about Cancer Epidemiology, Screening, Environmental Risks among the General Population (GP) and Healthcare Workers (HCW)

Knowledge About Cancer Epidemiology	Healthcare Workers Knowledge Rate (n=115)			General Public Knowledge Rate (n=194)		
	Correct Answer (%)	Incorrect Answer (%)	Do Not Know (%)	Correct Answer (%)	Incorrect Answer (%)	Do Not Know (%)
Breast cancer is the most prevalent type of cancer among women.	86.10%	1.70%	12.20%	82.00%	3.10%	14.90%
Cancer is characterized by the uncontrolled proliferation of cells in the body.	76.50%	21.70%	1.70%	82.00%	18.00%	0.00%
Uterine cancer is relatively common among women.	73.90%	11.30%	14.80%	60.80%	10.30%	28.90%
Among the fastest-spreading cancers are gastrointestinal system (GIS) cancers, such as pancreatic, bile duct, stomach, esophageal, and colorectal cancers.	70.40%	2.60%	27.00%	55.70%	5.20%	39.20%
Smoking is associated with at least 40% of cancers in men.	65.20%	2.60%	32.20%	63.40%	8.20%	28.40%
The incidence of cancer increases significantly in adulthood and older age.	61.70%	15.70%	22.60%	56.20%	26.80%	17.00%
Lung cancer is the most frequently diagnosed cancer in men.	57.40%	9.60%	33.00%	57.20%	8.80%	34.00%
Gastrointestinal cancers are among the most lethal cancer types.	47.00%	16.50%	36.50%	47.90%	9.30%	42.80%
Lung cancer is the leading cause of cancer-related deaths in women.	45.20%	10.40%	44.30%	28.90%	18.60%	52.60%
Bladder cancer is more commonly observed in women.	41.70%	18.30%	40.00%	16.50%	20.60%	62.90%
Thyroid cancer is more prevalent in women than in men.	40.00%	20.00%	40.00%	34.50%	11.90%	53.60%
Testicular cancers tend to metastasize rapidly.	33.90%	20.00%	46.10%	9.80%	22.20%	68.00%
Uterine cancer is the most fatal cancer among women.	30.40%	37.40%	32.20%	27.80%	34.50%	37.60%
Prostate cancer is the leading cause of cancer-related deaths in men.	27.00%	47.80%	25.20%	11.90%	59.30%	28.90%
Liver cancer is considered a highly lethal cancer type.	12.20%	58.30%	29.60%	4.60%	58.20%	37.10%
Knowledge About Cancer Screening	Correct Answer (%)	Incorrect Answer (%)	Do Not Know (%)	Correct Answer (%)	Incorrect Answer (%)	Do Not Know (%)
In Turkey, breast cancer screenings are offered free of charge to women aged 40 and above.	87.00%	0.00%	13.00%	46.40%	4.10%	49.50%
Cancers with established routine screening programs are typically diagnosed at earlier stages, facilitating more effective treatment and potentially extending patient survival.	82.60%	2.60%	14.80%	70.10%	5.20%	24.70%
In Turkey, cervical cancer screenings are offered free of charge to women aged 30 and above.	72.20%	3.50%	24.30%	37.60%	3.10%	59.30%
In Turkey, colorectal cancer screenings are offered free of charge to individuals aged 50 and above.	71.30%	0.90%	27.80%	36.10%	1.00%	62.90%
Stomach cancer screenings are not routinely conducted in Turkey.	45.20%	8.70%	46.10%	8.20%	28.90%	62.90%
Although thyroid cancer screenings may be performed, they are not conducted routinely.	41.70%	9.60%	48.70%	25.80%	6.70%	67.50%
Bladder cancer screenings are not part of the routine screening programs in Turkey.	41.70%	12.20%	46.10%	10.30%	25.80%	63.90%
Lung cancer screenings are not routinely available in Turkey.	39.10%	14.80%	46.10%	7.70%	32.00%	60.30%
Although screening methods for prostate cancer exist, routine screening is not implemented in Turkey.	35.70%	11.30%	53.00%	18.00%	9.30%	72.70%
Knowledge About Environmental Risks Of Cancer	Correct Answer (%)	Incorrect Answer (%)	Do Not Know (%)	Correct Answer (%)	Incorrect Answer (%)	Do Not Know (%)
Excessive exposure to radiation may increase cancer risk.	88.70%	1.70%	9.60%	73.70%	1.50%	24.70%
Smoking is the most significant cause of lung cancer.	82.60%	3.50%	13.90%	71.10%	5.70%	23.20%
Excessive exposure to ultraviolet radiation may cause skin cancer.	82.60%	1.70%	15.70%	68.60%	1.50%	29.90%
Direct exposure to pesticides through inhalation, ingestion, or skin contact may cause cancer.	82.60%	1.70%	15.70%	71.60%	1.50%	26.80%
Occupation or work-related exposures may be a cause of cancer.	79.10%	5.20%	15.70%	54.10%	11.90%	34.00%
Environmental effects are very important in the development of cancer.	78.30%	7.00%	14.80%	66.50%	5.70%	27.80%
Exposure to polluted air may be a cause of cancer.	77.40%	4.30%	18.30%	64.40%	8.20%	27.30%
Walking at a moderate pace for at least 30 minutes on at least 5 days a week reduces the risk of developing cancer.	76.50%	4.30%	19.10%	63.90%	5.20%	30.90%
Alcohol and hot beverages may contribute to certain digestive system cancers.	74.80%	3.50%	21.70%	66.00%	5.20%	28.90%
Consumption of deep-fried foods may increase cancer risk.	73.90%	7.80%	18.30%	65.50%	8.20%	26.30%
Certain sexually transmitted viral infections are a cause of cervical (uterine) cancer.	71.30%	2.60%	26.10%	53.60%	10.80%	35.60%
Consuming at least five servings of fruits and vegetables per day reduces the risk of developing cancer.	71.30%	7.00%	21.70%	67.00%	4.10%	28.90%
Digestive system cancers may be related to dietary factors.	70.40%	3.50%	26.10%	63.90%	8.20%	27.80%
Obesity may be a contributing factor to certain types of cancer.	65.20%	9.60%	25.20%	59.80%	10.30%	29.90%
Some viral infections may lead to the development of cancer in organs at later stages.	62.60%	6.10%	31.30%	49.00%	13.40%	37.60%
Smoking is one of the causes of bladder cancer.	40.90%	15.70%	43.50%	34.50%	14.40%	51.00%
A high-fat diet may increase the risk of breast cancer.	37.40%	18.30%	44.30%	46.40%	13.90%	39.70%
Smoking is one of the causes of prostate cancer.	36.50%	21.70%	41.70%	35.10%	17.00%	47.90%

Table 3. Comparison of the Knowledge Levels (KL) Across Sociodemographic and Behavioral Characteristics

	Epidemiology KL	Screening KL	Environment KL	Total KL
Participant group				
General Public	6.4±2.8 (7 (0–13))	2.6±2.1 (2 (0–8))	10.7±5.7 (11 (0–18))	19.7±8.6 (21 (0–34))
Healthcare Worker	7.7±3.6 (8 (0–14))	5.2±2.7 (5 (0–9))	12.5±5.0 (14 (0–18))	25.4±9.9 (28 (0–40))
p	<0.001	<0.001	0.006	<0.001
Gender				
Female	6.7±3.2 (7 (0–14))	3.6±2.6 (4 (0–9))	11.5±5.5 (13 (0–18))	21.8±9.5 (23 (0–40))
Male	7.2±3.1 (7 (0–14))	3.4±2.7 (3 (0–9))	11.3±5.5 (12 (0–18))	21.9±9.6 (23 (0–39))
p	0.175	0.356	0.713	0.887
Education Level				
Primary school	5.8±3.3 (6 (0–11))	2.8±2.3 (3 (0–7))	11.9±5.9 (14 (0–18))	20.5±9.7 (24 (0–32))
Middle school	6.1±2.9 (6 (0–13))	2.8±2.4 (3 (0–8))	11.2±5.1 (11 (0–18))	20.1±9.0 (22 (0–38))
High school	6.4±3.1 (7 (0–13))	2.9±2.2 (2 (0–9))	9.6±5.8 (11 (0–18))	18.8±9.1 (20 (0–34))
University	7.2±3.2 (7 (0–14))	3.7±2.7 (4 (0–9))	11.5±5.4 (12 (0–18))	22.4±9.4 (23 (0–40))
Postgraduate	8.2±2.9 (9 (0–12))	5.9±2.3 (5 (0–9))	14.3±4.2 (14 (0–18))	28.3±7.7 (31 (0–39))
p	0.006	<0.001	0.003	<0.001
Marital status				
Married	6.9±3.2 (7 (0–14))	3.6±2.6 (4 (0–9))	11.1±5.7 (13 (0–18))	21.6±9.6 (23 (0–40))
Single	6.9±3.1 (7 (0–13))	3.6±2.7 (3 (0–9))	11.9±5.1 (12 (0–18))	22.4±9.2 (23 (0–39))
p	0.872	0.978	0.322	0.719
Perceived Income Status				
Income Below Expenses	6.7±3.1 (7 (0–14))	2.9±2.5 (2 (0–9))	10.3±5.6 (11 (0–18))	19.9±9.1 (21 (0–40))
Income Equal to Expenses	7.1±3.3 (7 (0–14))	4.3±2.7 (4 (0–9))	12.5±5.3 (14 (0–18))	23.8±9.6 (25 (0–39))
Income Above Expenses	7.3±3.3 (8 (2–13))	4.4±2.4 (4 (1–9))	12.8±4.4 (14 (4–18))	24.6±9.1 (28 (9–38))
p	0.362	<0.001	0.001	<0.001
Dietary Preference				
Primarily Natural/Unprocessed Foods	7.0±3.2 (7 (0–14))	4.0±2.7 (4 (0–9))	11.9±5.2 (13 (0–18))	22.9±9.4 (24 (0–40))
Primarily Processed/Packaged Foods	6.6±3.1 (7 (0–12))	2.7±2.4 (2 (0–9))	10.4±5.9 (11 (0–18))	19.7±9.4 (21 (0–39))
p	0.37	<0.001	0.023	0.003
Physical Activity				
Active	7.2±3.1 (7 (0–14))	3.8±2.7 (4 (0–9))	11.8±5.4 (13 (0–18))	22.7±9.5 (24 (0–40))
Inactive	6.3±3.2 (6 (0–14))	3.2±2.5 (3 (0–9))	10.7±5.7 (12 (0–18))	20.2±9.3 (22 (0–39))
p	0.01	0.061	0.113	0.012
Smoking status				
Smoker	7.0±3.3 (7 (0–14))	4.0±2.6 (4 (0–9))	11.4±5.5 (12 (0–18))	22.4±9.7 (24 (0–39))
Non-smoker	6.8±3.1 (7 (0–14))	3.4±2.6 (3 (0–9))	11.4±5.5 (13 (0–18))	21.6±9.4 (23 (0–40))
p	0.672	0.048	0.934	0.347
Alcohol Consumption				
Alcohol User	7.1±3.7 (8 (0–13))	4.6±2.6 (5 (0–8))	12.8±6.9 (16 (0–18))	24.4±12.1(29(0–38))
Non-user	6.9±3.2 (7 (0–14))	3.5±2.6 (3 (0–9))	11.3±5.4 (12 (0–18))	21.7±9.3 (23 (0–40))
p	0.557	0.081	0.072	0.076
Cancer diagnosis history				
Yes	7.6±2.9 (8 (1–13))	3.7±2.8 (3 (0–9))	11.6±5.3 (12 (0–18))	22.9±8.4 (22 (4–40))
No	6.8±3.2 (7 (0–14))	3.6±2.6 (4 (0–9))	11.4±5.5 (13 (0–18))	21.8±9.6 (23 (0–39))
p	0.247	0.892	0.993	0.853
Family History of cancer				
Yes	7.8±2.8 (8 (0–13))	3.7±2.7 (3 (0–9))	12.2±5.1 (14 (0–18))	23.6±8.8 (25 (0–39))
No	6.6±3.3 (7 (0–14))	3.5±2.6 (4 (0–9))	11.1±5.6 (12 (0–18))	21.2±9.7 (23 (0–40))
p	0.004	0.742	0.14	0.061

Table 4. Hierarchical Multivariable Linear Regression Predicting Total Knowledge Score

Predictor	Model 1	Model 2	Model 3
	B (95% CI), p	B (95% CI), p	B (95% CI), p
Group (HCW vs general public)	5.573 (3.472–7.673) p<0.001	3.935 (1.647–6.224) p=0.001	3.551 (1.174–5.927) p=0.004
Age	0.088 (0.010–0.167) p=0.027	0.114 (0.034–0.194), p=0.005	0.114 (0.034–0.195), p=0.005
Gender	-0.243 (-2.437–1.952) p=0.828	-0.496 (-2.671–1.680) p=0.654	-0.586 (-2.894–1.722) p=0.618
Education	—	1.101 (0.123–2.080) p=0.028	1.074 (0.059–2.089) p=0.038
Perceived Income Status	—	2.225 (0.607–3.842) p=0.007	1.988 (0.331–3.645) p=0.019
Dietary Preference	—	—	-1.360 (-3.638–0.918) p=0.241
Physical Activity	—	—	-1.472 (-3.654–0.709) p=0.185
Smoking status	—	—	-0.602 (-3.012–1.808) p=0.623
Alcohol Consumption	—	—	-1.741 (-6.501–3.020) p=0.472
(Constant)	16.261 (12.817–19.704) p<0.001	12.004 (7.507–16.501) p<0.001	15.419 (8.721–22.118) p<0.001

Model 1: group + age + sex; Model 2: Model 1 + education + income; Model 3: Model 2 + diet + physical activity + smoking + alcohol. Education and income were modeled as ordinal variables; behavioral covariates were binary.

category, 95% CI 0.059 to 2.089; $p=0.038$) and higher income ($B=1.988$ per category, 95% CI 0.331 to 3.645; $p=0.019$) were also independently associated with higher knowledge scores. Sex and health-behavior variables were not significantly associated with knowledge in the fully adjusted model. Notably, the group coefficient attenuated after adding education and income (from $B=5.573$ in Model 1 to $\sim B=3.5$ in Models 3) but remained statistically significant, suggesting partial confounding by socioeconomic factors while supporting the robustness of the group difference (Table 4).

Discussion

This study evaluated the knowledge of cancer epidemiology, screening programs, and environmental risk factors among healthcare professionals and the general public. Our findings indicate that while healthcare professionals generally demonstrated higher levels of knowledge across all domains, significant knowledge gaps persist in both groups, particularly regarding less publicized environmental risk factors and certain screening modalities. Importantly, this between-group difference remained robust in the fully adjusted multivariable linear regression model: healthcare-professional status was independently associated with higher total knowledge scores ($B=3.551$; 95% CI: 1.174 to 5.927; $p=0.004$), even after controlling for age, sex, education, income, diet, physical activity, smoking, and alcohol use. This persistence suggests that the observed knowledge gap is

not explained solely by differences in sociodemographic or behavioral profiles and supports the need for targeted, audience-appropriate educational strategies for the general public, alongside continued reinforcement within healthcare settings.

Participants with higher educational attainment and greater perceived income levels exhibited significantly higher knowledge levels, particularly in the domains of cancer screening and environmental risk factors. These findings align with previous studies indicating that educational level and socioeconomic status are strong predictors of cancer awareness and health literacy [11–14]. This pattern was also supported by our fully adjusted multivariable model: both education ($B=1.074$ per category; 95% CI: 0.059 to 2.089; $p=0.038$) and income ($B=1.988$ per category; 95% CI: 0.331 to 3.645; $p=0.019$) remained independently associated with higher total knowledge scores after controlling for age, sex, and health-related behaviors. Consistent with these results, medical professionals and individuals with university-level education demonstrated significantly greater awareness of cancer-related risk factors, including environmental carcinogens. Furthermore, the literature also suggests that cancer awareness tends to increase with income level [11–14].

In addition, participants reporting healthy lifestyle habits, including a diet rich in unprocessed foods and routine physical activity, demonstrated greater awareness across domains. This supports existing evidence that lifestyle factors are positively associated with health

knowledge. However, these patterns should be interpreted in light of confounding: in the fully adjusted multivariable model, behavioral indicators (dietary pattern, physical activity, smoking, and alcohol use) did not remain independent predictors of the overall knowledge score, suggesting that observed behavior–knowledge differences may be partly explained by sociodemographic factors, particularly education and income. Nevertheless, knowledge regarding the cancer-preventive role of nutrition and exercise was only partially adequate. Specifically, 67.0% of the general public and 71.3% of healthcare professionals correctly identified fruit and vegetable consumption as cancer-protective. Similarly, 63.9% of the public and 76.5% of professionals recognized the role of physical activity in cancer prevention. These findings are in line with international data; for example, a study among Saudi women reported that only about 50% were aware of the link between insufficient physical activity and cancer risk [15].

A slight but statistically significant difference was observed in screening awareness, with smokers reporting higher levels than non-smokers ($p = 0.048$). No significant differences were observed in knowledge levels among alcohol users. Taken together, these results indicate that health behaviors may coincide with higher awareness in some unadjusted, domain-specific comparisons, yet they do not necessarily translate into higher overall knowledge after accounting for key sociodemographic determinants. This reinforces the need to complement information-based education with behaviorally informed strategies that facilitate the adoption of cancer-preventive practices.

While a majority correctly identified smoking as a cause of lung cancer (71.1% of the public, 82.6% of professionals), far fewer were aware of its association with bladder and prostate cancers both below 36%. This limited understanding of less publicized associations indicates a need for broader cancer education. Despite high awareness of smoking as a cause of lung cancer, its association with bladder and prostate cancer remained poorly recognized, even among healthcare professionals. Although prior studies have generally addressed the overall link between smoking and cancer without examining specific cancer types, they have similar to our findings consistently highlighted smoking as the most commonly acknowledged environmental risk factor for cancer among the public [11, 15, 16].

The highest correct response rates were observed for widely known facts, such as the high prevalence of breast cancer among women, while lower awareness was reported for more fatal cancers like liver cancer. Notably, knowledge regarding cancers included in Türkiye's national free screening program namely breast, cervical, and colorectal cancers varied significantly between healthcare professionals and the general public. While over 70% of healthcare professionals were aware of these screenings, recognition among the public was substantially lower: 46.4% for breast, 37.0% for cervical, and 36.1% for colorectal cancer screenings. These disparities are consistent with known barriers to screening participation reported in previous research, including limited knowledge, fear, discomfort, and lack of physician

recommendation [6]. For cervical cancer in particular, awareness levels reported in the literature range from 12.2% to 69% [14, 17]. One Turkish study similarly found that awareness of cervical (49.1%) and colorectal (35.3%) cancer screenings was considerably lower than for breast cancer (65.5%) [17]. Our findings further reflect this pattern, particularly in the general public, and underscore the persistent challenges in promoting preventive services despite the existence of national programs.

Environmental risk factors were more widely recognized than screening indicators but still showed critical gaps. The majority of respondents identified air pollution (64.4% of the public, 77.4% of professionals), radiation (73.7% vs. 88.7%), and ultraviolet exposure (68.6% vs. 82.6%) as carcinogenic, in line with IARC reports [8]. However, knowledge of other risk factors—such as dietary fat, infections, and pesticide exposure—was more limited. Although pesticide-related risks were recognized by a large proportion (71.6% public, 82.6% professionals), awareness of infection-related cancers (e.g., HPV, *Helicobacter pylori*) remained low (49% public vs. 62.6% professionals). Previous studies have similarly shown that while smoking, alcohol, and radiation are commonly known risks, infections, dietary risks, and occupational exposures are less frequently recognized [11, 15, 16]. This is concerning given the established role of these factors in the development of cervical, gastric, and liver cancers [5].

Earlier research among Turkish university students revealed alarmingly low levels of cancer knowledge, with some even believing cancer to be contagious [18, 19]. In contrast, our study suggests a modest improvement in public awareness over the past decade, likely influenced by national cancer control initiatives and public health campaigns. Nonetheless, persistent disparities highlight the continued need for targeted interventions.

Given the multifactorial etiology of cancer and the often decades-long latency of environmental exposures, it is rarely possible to attribute cancer to a single cause. Therefore, public health efforts must aim to reduce cumulative exposure to all known carcinogens. To achieve this, environmental health education strategies should be integrated into national cancer control efforts, particularly focusing on smoking, air quality, radiation, and chemical exposures, dietary factors, and infection-related risks. These campaigns must also be tailored to address knowledge gaps among socioeconomically disadvantaged populations and even within healthcare professionals, thereby enhancing the effectiveness of both primary and secondary prevention strategies.

Strengths and Limitations

This study has certain limitations that should be acknowledged. The cross-sectional design does not allow for causal inferences, and the use of convenience sampling within health directorates may limit generalizability beyond the sampled population. Although stratification was planned, logistical constraints during data collection led to some deviation from the intended sample distribution. Additionally, reliance on self-reported data introduces the possibility of recall and social desirability

bias.

Despite these limitations, the study offers several notable strengths. It is among the few investigations in Turkey that assess the knowledge of both the general public and healthcare professionals regarding cancer risk factors particularly environmental and behavioral components within the framework of nationally prioritized screening programs. The inclusion of two urban districts and the participation of both healthcare professionals and individuals from the general population enhance the diversity and practical relevance of the findings. Moreover, the use of a structured and pilot-tested questionnaire strengthens the internal validity of the data collected. Another strength of the study is the absence of missing data, which allowed all analyses to be performed on complete responses without the need for imputation, thereby increasing the reliability and internal validity of the results. Importantly, this study contributes to the limited body of research on environmental cancer risk awareness in middle-income countries and underscores persistent knowledge gaps that may impede the effectiveness of cancer prevention efforts.

In conclusion, a substantial proportion of cancers can be prevented through the avoidance of modifiable environmental risk factors, while others are manageable through early detection and timely treatment. Although individual actions such as avoiding tobacco or limiting UV exposure play a role, many risks in air, water, food, and the broader environment require comprehensive public health responses, including regulation and policy enforcement.

This study identified considerable knowledge gaps in cancer epidemiology, screening, and environmental risk factors, not only among the general public but also among healthcare professionals. Despite 78.3% of healthcare workers and 66.5% of community members acknowledging the role of environmental factors in cancer, overall awareness was inadequate.

Improving knowledge about environmental carcinogens and available screening programs is therefore crucial to promoting preventive behaviors and reducing exposure. Public health strategies should prioritize educational campaigns that emphasize tobacco avoidance, healthy diets, reduced exposure to pollution and infections, and early symptom recognition. In-service training for healthcare providers, along with continuous community education, will be essential to enhancing cancer literacy and supporting sustainable prevention.

The findings of this study can inform evidence-based, population-specific educational strategies to address knowledge deficits and support national cancer control efforts through informed public engagement and risk reduction.

Author Contribution Statement

AEÖ, MMÖÇ, and BPSG contributed to the study conception and design. BPSG, ÖSD, MOA, MMÖÇ, MNA, Hİ, and MH were responsible for data collection and curation. MMÖÇ and BPSG performed the data analysis and interpretation. AEÖ, MH, MMÖÇ, and GNİ contributed to the methodological framework of the

study. AEÖ, MMÖÇ, and GNİ supervised the research process. MNA, Hİ, MMÖÇ, and MEÖ contributed to data visualization. AEÖ, MEÖ, MOA, MH, and MMÖÇ drafted the manuscript. AEÖ, MMÖÇ, and GNİ critically revised the manuscript. All authors reviewed and approved the final version of the manuscript.

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Ethics approval

Ethical approval for the study was obtained from the Istanbul Faculty of Medicine Ethics Committee on February 23, 2024 (Approval No. 367). Additionally, research permits were granted by the Istanbul Provincial Health Directorate.

Scientific Body Approval / Student Thesis Status

This study is not part of any approved student thesis and was not submitted to any scientific body for approval.

Consent to participate

All participants had to provide informed consent before completing the questionnaire.

Availability of data and materials

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

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Study Registration

The study was not registered in any clinical trial, guideline, or systematic review registry, as it was a cross-sectional study.

Competing interests

The authors declare no competing interests.

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