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Original Article

Prevalence, Incidence and Mortality of Thyroid Cancer in Kazakhstan: Data from the Unified National Electronic Health System 2014-2021

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Abstract:
Introduction: Thyroid cancer is one of the most common endocrine malignancies. According to global studies, its prevalence has been increasing worldwide and continues to grow. Although there have been global epidemiological studies on thyroid cancer, there is limited data on its epidemiology in Central Asian countries, including Kazakhstan.
Materials and Methods: A retrospective study utilized data from the Unified National Electronic Health System on thyroid cancer patients in Kazakhstan from 2014 to 2021. A descriptive analysis of patients was performed based on key demographic factors. Survival analysis was conducted using the Kaplan-Meier estimator and Cox proportional hazards regression.
Results: In total, 4,877 cases of thyroid cancer have been included during the period from 2014 to 2021 in Kazakhstan. Most of the diagnosed patients throughout the given period were females. The highest incidence and prevalence rates were found in the age group of 51-70 years old, while the highest mortality rate was among patients older than 70 years. Increasing age and male sex were the major predictors of mortality among thyroid cancer patients.
Conclusion: The obtained data coaligned with global data on thyroid cancer. Increased age, male sex, and living area were associated with poor prognosis. The study was limited by missing information on comorbidities and treatment types that the patients could have received. Therefore, further research is needed to assess the impact of such significant factors on survival.

Keywords: Thyroid Cancer; Kazakhstan; Incidence; Prevalence; Survival Analysis; Retrospective Studies

Introduction

The thyroid gland is an endocrine organ located in the neck that produces the hormones thyroxine (T4) and triiodothyronine (T3), which play a central role in the regulation of metabolic processes [1]. Thyroid cancer is a malignant neoplasm of the thyroid gland and, although relatively uncommon compared with many other malignancies, it represents the most frequent cancer of the endocrine system [2].

Over recent decades, both the incidence and reported prevalence of thyroid cancer have increased worldwide. A comprehensive analysis by Bao et al. (2021), based on population-level data from 204 countries between 1990 and 2019, estimated more than 233,000 new cases of thyroid cancer globally in 2019 [3]. Similarly, Pizzato et al. (2022) reported a continued global rise in incidence rates, while mortality trends remained largely stable, reflecting the generally favorable prognosis of this disease [4]. These observations highlight substantial geographic and demographic variation in thyroid cancer burden and underscore the importance of country-specific epidemiological analyses.

Several studies have investigated the epidemiology of thyroid cancer in Kazakhstan, primarily focusing on incidence trends. In particular, the study by Igissinov et al. (2019) reported 5,559 newly diagnosed cases between 2009 and 2018, with a markedly higher incidence among women and a peak incidence observed in the 50–59-year age group for both sexes [5]. While these findings provided important baseline information, they also indicated the need for further research incorporating a broader range of patient characteristics. Specifically, data on regional distribution, place of residence (urban versus rural), and selected sociodemographic factors remain limited, and survival outcomes have been insufficiently explored at the population level.

To address these gaps, the Unified National Electronic Health System (UNEHS) of Kazakhstan offers a valuable registry-based data source for large-scale epidemiological research. UNEHS was established to collect and store electronic healthcare records from hospital and outpatient settings nationwide, enabling longitudinal follow-up and population-level analyses [6]. Previous studies have demonstrated the utility of UNEHS for descriptive epidemiological research in various disease areas, including glomerular disease [8], congenital heart disease [9], and selected oncological conditions such as breast cancer [10]. At the same time, as with most administrative and registry-based datasets, UNEHS is subject to inherent limitations, including incomplete historical coverage, missing demographic variables, and limited clinical detail regarding tumor characteristics, treatment, and cause-specific mortality. These factors necessitate cautious interpretation of epidemiological measures derived from the registry.

In this context, the present study aims to provide a descriptive epidemiological overview of thyroid cancer in Kazakhstan using UNEHS data from 2014 to 2021. The analysis focuses on registry-based incidence patterns, period prevalence among recorded patients, all-cause mortality, and overall survival, stratified by age, sex, ethnicity, region, area of residence, and selected sociodemographic characteristics. By presenting updated descriptive and survival estimates from a nationwide electronic health registry, this study seeks to contribute to the limited body of evidence on thyroid cancer epidemiology in Central Asia and to serve as a foundation for future studies incorporating more detailed clinical and etiological data.

Methodology

Study design and population

This is a retrospective observational study that utilized data from the Unified National Electronic Health System (UNEHS) of Kazakhstan. The study population consisted of patients with a recorded diagnosis of thyroid cancer identified using the International Classification of Diseases, 10th Revision (ICD-10). Patients with ICD-10 code C73 were considered to have thyroid cancer and were eligible for inclusion.

Initially, 7,521 records corresponding to thyroid cancer diagnoses were identified in the registry. Data management procedures were applied to construct a patient-level cohort. Duplicate records representing multiple healthcare encounters for the same individual were identified using unique population registry numbers (RPN ID) and removed, retaining only one record per patient. Patients with missing information on age or sex were excluded from further analyses. Missing data on these variables affected approximately 36% of the initially identified records.

Formal statistical assessment of missing data mechanisms was not done during the study. Therefore, the assumption that missingness occurred at random could not be formally verified, and the potential for selection bias cannot be excluded. After data cleaning and exclusions, a total of 4,877 unique patients were included in the final analytical cohort.

Population-level denominator data stratified by age and sex were obtained from the national statistical agency of Kazakhstan and were used for rate calculations.

Exposure and covariates

Descriptive analysis of patients with thyroid cancer included age at diagnosis, sex, ethnicity, region, area of residence, social status, hospital admission type, and mortality status, as recorded in UNEHS.

Age at diagnosis was calculated based on recorded dates of birth and diagnosis and categorized into five groups: younger than 18 years, 18–34 years, 35–50 years, 51–70 years, and older than 70 years. Ethnicity was classified as Kazakh, Russian, or Other, in accordance with registry-based categories. Area of residence was categorized as urban or rural. Hospital admission type was recorded as planned, urgent, or unspecified.

Social status was categorized as employed, unemployed, retiree, disabled, or other. Regional distribution was defined according to the administrative divisions in place in 2018.

Statistical analysis

Incidence was defined as the number of newly recorded thyroid cancer cases per calendar year within the UNEHS registry and was expressed per 100,000 population. Prevalence was defined as period prevalence, representing the proportion of individuals registered with a diagnosis of thyroid cancer in UNEHS during the study period from 2014 to 2021, expressed per 100,000 population. Due to the absence of registry data prior to 2014, prevalence estimates are likely to underestimate the true population prevalence, particularly in the early years of the study period.

Mortality was defined as all-cause mortality among patients diagnosed with thyroid cancer, as cause-specific mortality information was not available in the registry. Accordingly, mortality rates reflect deaths from any cause occurring during follow-up and should not be interpreted as thyroid cancer–specific outcomes.

Survival analysis was performed using the Kaplan–Meier estimator to assess overall survival, with differences between groups evaluated using the log-rank test. Time-to-event was calculated from the date of first recorded thyroid cancer diagnosis to the date of death or last available registry entry, whichever occurred first.

Cox proportional hazards regression models were used to estimate hazard ratios (HRs) and 95% confidence intervals (CIs). Two models were fitted: an unadjusted model and a multivariable model adjusted for age group, sex, area of residence, and ethnicity. Formal testing of the proportional hazards assumption was not conducted, and this limitation is further described in the discussion. A two-sided p-value of <0.05 was considered statistically significant.

All analyses were performed using STATA version 15 within a secure JupyterLab environment to ensure data confidentiality.

Results

Demographic characteristics

After data management and cleaning, a total of 4,877 unique patients with a recorded diagnosis of thyroid cancer were included in the analysis for the period 2014–2021. Table 1 summarizes the distribution of cases according to age at diagnosis, sex, ethnicity, area of residence, hospital admission type, and social status.

The mean age at diagnosis was 60.5 years (SD 13.4). Nearly half of the cohort (51.59%) consisted of patients aged 51–70 years, while only one case was recorded among individuals younger than 18 years. The majority of patients were female (86.75%). With regard to ethnicity, most patients were classified as Kazakh (57.47%), followed by Russian (27.89%), while approximately 15% belonged to other ethnic groups.

Most patients (75%) resided in urban areas, whereas 25% were residents of rural regions. Hospital admissions were predominantly planned (69%); 28% were classified as unspecified, and 2% as urgent. Among urgently admitted patients, a higher proportion of deaths was observed; however, given the small number of urgent admissions, this finding should be interpreted with caution.

Regarding social status, the largest proportion of patients were categorized as “other” (41%). Employed and retired individuals each accounted for 21% of the cohort, while 14% were unemployed at the time of diagnosis and 1.25% were classified as disabled.

Table 1. Socio-demographic characteristics of patients with thyroid cancer in the period of 2014-2021.

Demographic characteristics	Total n = 4,877 (100%)	Aliven = 4,473 (91.72%)	Dead n = 404 (8.28%)
Age, mean +-SD	60.5+-13.4	59.5+-13.1	72.4+-10.7
Age groups, n (%)			
<18	1 (0.02%)	1 (0.02%)	0 (0%)
18-34	494 (10.13%)	492 (11%)	2 (0.5%)
35-50	1,409 (28.89%)	1368 (30.58%)	41 (10.15%)
51-70	2,516 (51.59%)	2290 (51.20%)	226 (55.94%)
>70	457 (9.37%)	322 (7.20%)	135 (33.42%)
Gender, n (%)			
Female	4231 (86.75%)	3,951 (88.33%)	280 (69.31%)
Male	646 (13.25%)	522 (11.67%)	124 (30.69%)
Ethnicity, n (%)			
Kazakh	2,803 (57.47%)	2,573 (57.52%)	230 (56.93%)
Russian	1,360 (27.89%)	1,234 (27.59%)	126 (31.19%)
Other	714 (14.64%)	666 (14.89%)	48 (11.88%)
Residence, n (%)			
Rural	1,209 (24.79%)	1,084 (24.23%)	125 (30.94%)
Urban	3,668 (75.21%)	3,389 (75.77%)	279 (69.06%)
Hospital admission, n (%)			
Planned	3,372 (69.14%)	3,019 (67.49%)	353 (87.37%)
Urgent	101 (2.07%)	52 (1.16%)	49 (12.13%)
Unspecified	1,404 (28.79%)	1,402 (31.34%)	2 (0.5%)
Social status, n (%)			
Employed	1,035 (21.22%)	985 (22.02%)	50 (12.38%)
Unemployed	688 (14.11%)	646 (14.44%)	42 (10.40%)
Retiree	1,053 (21.59%)	812 (18.15%)	241 (59.65%)
Disabled	61 (1.25%)	52 (1.16%)	9 (2.23%)
Other	2040 (41.83%)	1978 (44.22%)	62 (15.35%)

Figure 1 illustrates the regional distribution of thyroid cancer cases across Kazakhstan, with the three largest cities presented as separate administrative units. The highest number of registered cases was observed in Almaty city (1,499 cases), followed by Karaganda region (1,031 cases) and East Kazakhstan region (843 cases). The lowest numbers of cases were recorded in Atyrau (58 cases) and Mangystau (148 cases) regions.

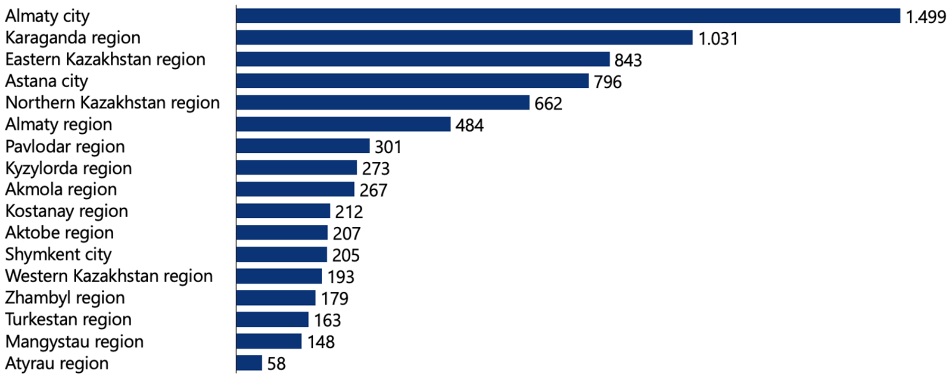

Figure 1. Total number of thyroid cancer cases in Kazakhstan in the period of 2014-2021 distributed by region.

Incidence, prevalence, and mortality

Figure 2 presents registry-based incidence, period prevalence, and all-cause mortality rates among patients diagnosed with thyroid cancer, stratified by sex. Between 2014 and 2021, incidence rates demonstrated a fluctuating but generally increasing pattern, particularly among women. Female incidence peaked at 7.4 per 100,000 population in 2016 and subsequently stabilized between 4.7 and 5.8 per 100,000 in later years. In contrast, incidence among men remained consistently low throughout the study period and did not exceed 1.4 per 100,000.

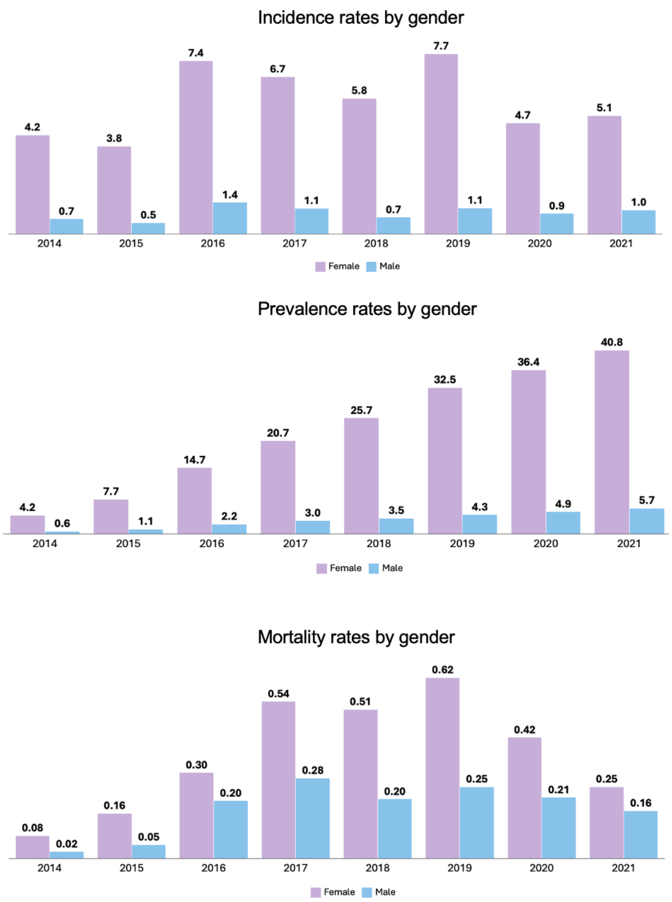

Figure 2. Incidence, prevalence and mortality rates thyroid cancer in Kazakhstan during each year in the period of 2014-2021 by gender, per 100,000.

Period prevalence increased steadily over time in both sexes. Among women, prevalence rose from 4.2 per 100,000 in 2014 to 40.8 per 100,000 in 2021, while a similar upward trend was observed among men. These prevalence estimates reflect the accumulation of registered cases within UNEHS during the study period and are influenced by the absence of registry data prior to 2014.

Age-stratified analyses showed that the highest incidence and prevalence rates were concentrated in the 51–70 and >70-year age groups, with peaks observed in selected calendar years, including 2016 and 2019. All-cause mortality rates among patients with thyroid cancer remained comparatively low across most age groups, with higher values observed among older patients. The highest mortality rate was recorded in women in 2019 (0.62 per 100,000) and in individuals aged over 70 years during the same year (3.82 per 100,000). Mortality rates showed minimal variation in younger age groups.

Survival analysis

Figure 4 presents the Kaplan–Meier curve for overall survival of the entire cohort, with corresponding 95% confidence intervals. Throughout the maximum follow-up period of eight years, the estimated overall survival probability remained above 0.75.

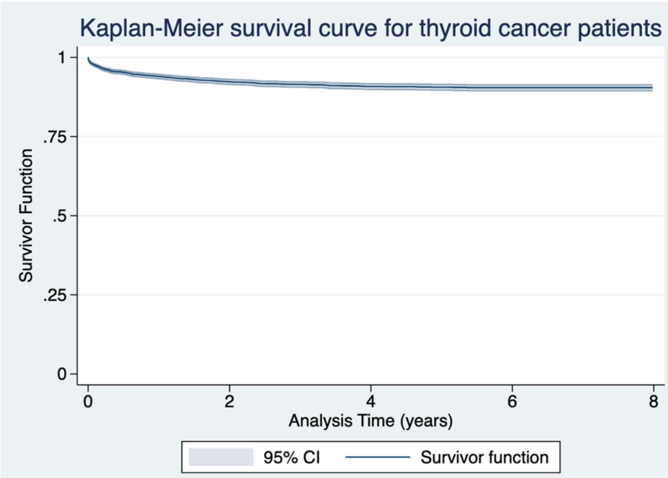

Figure 4. Kaplan-Meier survival curve for the entire cohort with 95% confidence intervals.

Figures 5–8 show Kaplan–Meier survival curves stratified by sex, age group, area of residence, and ethnicity. Statistically significant differences in overall survival were observed between males and females, between urban and rural residents, and across age groups (log-rank test, $p < 0.05$). No statistically significant differences in survival were observed between ethnic groups.

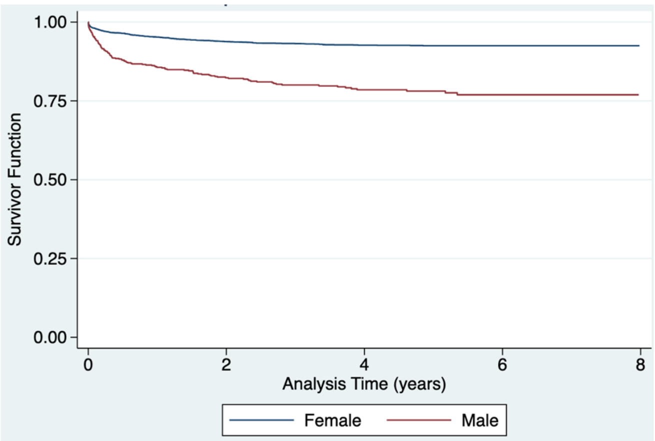

Figure 5. Kaplan-Meier survival curve stratified by gender, log-rank test $p < 0.05$.

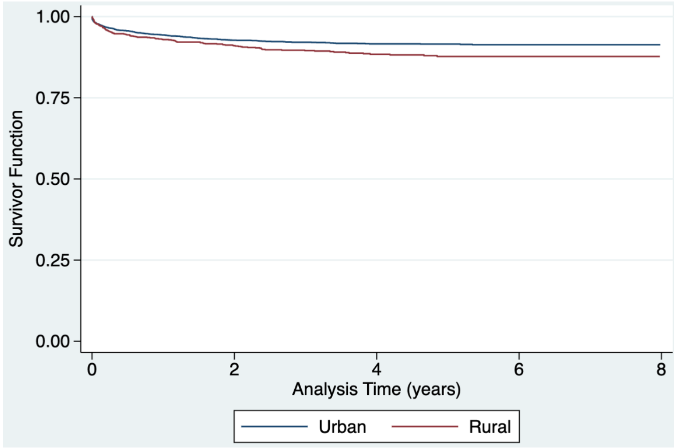

Figure 6. Kaplan-Meier survival curve stratified by residence, log-rank test $p < 0.05$.

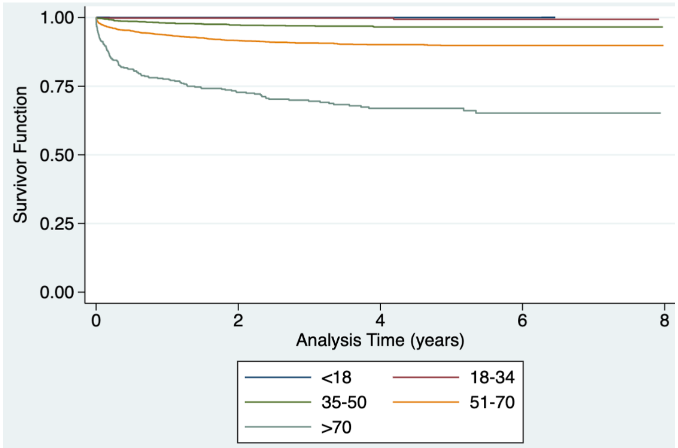

Figure 7. Kaplan-Meier survival curve stratified by age group, log-rank test $p < 0.05$.

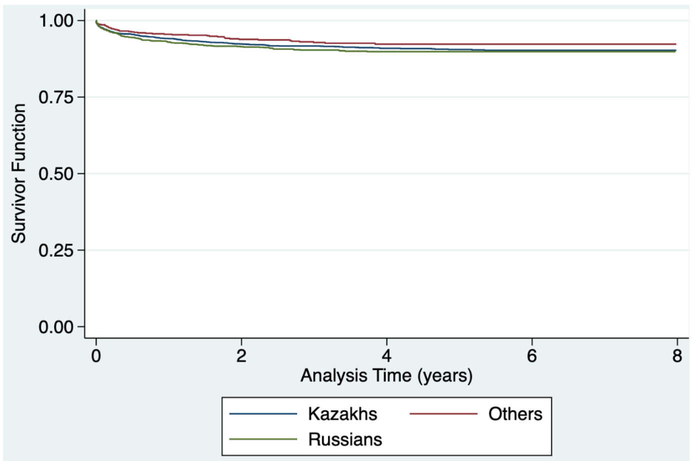

Figure 8. Kaplan-Meier survival curve stratified by ethnicity, log-rank test $p = 0.16$.

Table 2 presents hazard ratios (HRs) with 95% confidence intervals from Cox proportional hazards regression analyses. Model 1 reports unadjusted estimates, while Model 2 presents estimates adjusted for age group, sex, area of residence, and ethnicity. Compared with the reference age group, patients aged 51–70 years and those older than 70 years had approximately threefold and twelvefold higher risks of death, respectively. Younger age groups demonstrated substantially lower hazards of death.

Table 2. Association between age, gender, residence, ethnicity and all-cause mortality rates for thyroid cancer between 2014 and 2021.

Variable	UnadjustedHR (95% CI)	p-value	Adjusted to demographicsHR (95% CI)	p-value
Demographics				
Age groups				
18-34	0.14 [0.03 - 0.57]	<0.05	0.15 [0.04 - 0.60]	<0.05
35-50	ref.		ref.	
51-70	3.15 [2.26 - 4.40]	<0.05	3.10 [2.22 - 4.32]	<0.05
>70	12.11 [8.54 - 17.18]	<0.05	11.77 [8.27 - 16.73]	<0.05
Gender				
Female	ref.		ref.	
Male	3.18 [2.57 - 3.92]	<0.05	2.86 [2.31 - 3.54]	<0.05
Residence				
Urban	ref.		ref.	
Rural	1.37 [1.11 - 1.70]	<0.05	1.39 [1.13 - 1.73]	<0.05
Ethnicity				
Kazakh	ref.		ref.	
Russian	1.10 [0.89 - 1.37]	0.39	0.98 [0.78 - 1.23]	0.863
Other	0.80 [0.58 - 1.09]	0.154	0.76 [0.55 - 1.04]	0.081

Male sex was associated with a higher hazard of death compared with female sex. Patients residing in rural areas exhibited a modestly higher hazard of death compared with urban residents. No statistically significant differences in hazard ratios were observed across ethnicity categories.

All survival and mortality outcomes represent all-cause events and should be interpreted accordingly.

Discussion

Study observations

This study evaluated demographic characteristics of thyroid cancer patients in Kazakhstan using the UNEHS registry, providing an extended descriptive and survival analysis. Overall, the patterns observed are consistent with global trends regarding female predominance and peak incidence in individuals aged 51–70 years [3].

Compared with global data, the incidence of thyroid cancer in Kazakhstan is lower: Bao et al. (2021) reported more than 233,000 new cases globally in 2019, whereas Kazakhstan recorded approximately 5,559 new cases over a comparable multi-year period [3].

The majority of patients resided in urban areas (75%), with 25% in rural regions. While these differences may reflect population distribution and access to healthcare, no causal inference can be made from the available data.

Hospital admission type and social status data were limited due to large proportions of unspecified records (28% and 41%, respectively), restricting detailed comparisons across these variables. Urgent admissions were infrequent (2%), and a higher proportion of deaths occurred among these patients; however, the small sample size precludes strong conclusions.

Regional analyses indicated the highest number of cases in Almaty city, Karaganda, and East Kazakhstan. While Almaty's higher case count likely reflects population density and healthcare infrastructure, the elevated numbers in Karaganda and East Kazakhstan may relate to local environmental exposures, including historical radiation exposure in East Kazakhstan and potential iodine deficiency in some regions, although direct data are not available [13].

Incidence, period prevalence, and all-cause mortality rates were consistently higher among females, aligning with global observations [3]. However, the underlying reasons for this sex difference remain unclear, as current population-level data —including our cohort — do not provide information on hormonal, genetic, or behavioral factors that may contribute. Further research is needed to explore biological and environmental mechanisms that might explain the higher burden of thyroid cancer among women.

Age-specific prevalence was highest among patients aged 51–70 years, and the highest all-cause mortality occurred in patients over 70. Because mortality reflects deaths from any cause, these findings should not be interpreted as thyroid cancer–specific outcomes.

Kaplan–Meier survival analysis showed high overall survival over 8 years. Stratified analyses demonstrated statistically significant differences by age, sex, and residence, but no significant differences by ethnicity. Cox regression confirmed that older age, male sex, and rural residence were associated with higher hazard ratios; these associations are descriptive and should not be interpreted as causal.

Limitations

Several limitations are inherent to registry-based studies but do not diminish the value of the findings. A substantial proportion of records had missing data for age, sex, hospital admission type, and social status, resulting in the exclusion of 36% of initially identified cases. While demographic comparisons of included versus excluded cases did not reveal major differences, selection bias remains possible.

Prevalence estimates for early years (2014–2015) may be underestimated because the registry did not capture patients diagnosed before 2014. This limitation has been explicitly considered when interpreting trends.

Survival analysis is constrained by the 8-year follow-up and lack of detailed treatment or comorbidity data. Comorbidities such as hypertension, cardiovascular disease, diabetes, and other cancers are known to influence thyroid cancer outcomes. Similarly, data on histologic subtypes were unavailable, which may affect observed mortality trends. Despite these limitations, this study provides robust, descriptive, and survival data for a nationally representative cohort, highlighting patterns and disparities that can inform healthcare planning and policy.

Further healthcare implications and recommendations

Older age, male sex, and rural residence were associated with lower survival probabilities. Although causal mechanisms cannot be inferred, these subgroups may benefit from targeted interventions.

Specific interventions could include targeted screening programs for men over 50, particularly in rural regions, to improve early detection. Expansion of regional cancer centers and diagnostic facilities in underserved areas could help reduce disparities in outcomes. Telemedicine programs could be implemented to improve follow-up care and monitoring, especially in rural populations where access to specialists is limited.

These recommendations provide a foundation for future studies that incorporate treatment details, comorbidities, and tumor subtypes to better understand survival determinants.

Finally, it is important to emphasize that all mortality rates reported are all-cause, and therefore, the observed associations do not reflect thyroid cancer-specific prognosis. These findings provide valuable descriptive epidemiology while highlighting the need for future studies with cause-specific survival data.

Conclusion

In conclusion, this study provides a comprehensive descriptive and survival analysis of thyroid cancer patients in Kazakhstan, focusing on key demographic factors related to outcomes. Older age, male gender, and rural residence were associated with slightly lower survival, although causal relationships cannot be established.

It is important to emphasize that the reported mortality reflects all-cause mortality rather than thyroid cancer-specific deaths, and no causal inferences can be drawn from this observational data.

The study was limited by the lack of information on comorbidities, treatment modalities, and tumor subtypes, as well as incomplete data for hospital admission and social status, which may introduce bias and limit generalizability.

Despite these limitations, the findings suggest potential high-risk subgroups—older adults, males, and rural residents—who could benefit from targeted healthcare interventions. Such interventions may include screening programs for men over 50, expansion of regional cancer diagnostic and treatment centers, and the implementation of telemedicine to improve follow-up and monitoring in underserved areas.

Future research incorporating detailed clinical data, comorbidities, treatment information, and cause-specific survival is needed to better understand predictors of thyroid cancer outcomes and to inform evidence-based healthcare policies in Kazakhstan.

Overall, this study adds valuable population-level evidence on thyroid cancer epidemiology in Central Asia and provides a foundation for designing targeted strategies to improve patient survival.

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