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SHORT COMMUNICATION

Impact of residential proximity to hospital on diagnostic inequality: A retrospective analysis from Central Poland

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Abstract

Introduction: Access to oncology care in Poland remains uneven, with rural residents limited to specialist availability. We analyzed geographic factors that may worsen cancer outcomes and deepen health disparities in Poland between rural and urban inhabitants.
Objectives: This study aims to evaluate the impact of geographic and demographic factors on cancer diagnosis in central Poland, focusing on disparities between urban and rural populations.
Methods: A retrospective cohort analysis was conducted on 4,771 patients suspected of having cancer at the Nikolay Pirogov Specialized District Hospital in Łódź between 2020 and 2024. Clinical records and public health datasets were analyzed. Logistic regression was used to assess associations between cancer diagnosis and variables such as distance to the nearest hospital, residence type (urban vs. rural), age, and sex. Models were adjusted for potential confounders.
Results: Of the 4,771 patients evaluated, 2,996 (62.8%) received a cancer diagnosis and 1,775 (37.2%) did not. In multivariable models, living 5–10 km from the hospital (vs. <5 km) was associated with higher odds of confirmed diagnosis, while residence types were not independently associated with diagnosis. We explicitly limited inference to individuals who ultimately accessed hospital care.
Conclusion: Geographic accessibility showed a localized association within the 5–10 km band, whereas residence >10 km and urban/rural status did not demonstrate independent effects after adjustment. These findings are hypothesis-generating and should be interpreted as indicators of potential access pathways among hospital-admitted patients, rather than causal effects. Targeted interventions (e.g., mobile diagnostics, transportation support, and optimized referral pathways) warrant evaluation.

Keywords: Cancer treatment initiation; Cancer diagnosis; Distance to hospital; Urban–rural disparities; Healthcare accessibility

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1. Introduction

Access to healthcare in Poland, particularly for oncology patients, remains unequal. The Patient Rights and Healthcare Ombudsman identifies three primary barriers to accessing medical care.[1] One of the key factors limiting the effectiveness of cancer treatment is geographical exclusion—that is, barriers stemming from a patient's place of residence.

Other significant contributors include disparities in education and financial resources.[1]

Despite relatively broad access to primary care physicians (with approximately 94% of the population covered by primary healthcare services), access to oncological diagnostics remains limited. Over half of Polish patients report difficulties accessing diagnostic tests, such as ultrasound examination, computed tomography, and magnetic resonance imaging, often due to their geographical location. Patients living in regions far from major urban centers frequently face long travel distances, which not only delays treatment initiation but also influences decisions regarding whether to pursue therapy or participate in clinical trials.[2]

According to the *Health at a Glance 2023* report, approximately 3% of patients in Poland experienced serious difficulties accessing healthcare.[3] The primary causes included long waiting times (affecting over 2% of patients), financial constraints, and the distance to medical facilities. Over 84% of patients waited more than 3 months for a specialist appointment, and 85% encountered problems booking appointments by phone.[2]

Although some progress has been made—Poland's OncoIndex has increased from 32 to 42 points in recent years—many modern oncological therapies remain unavailable or are not reimbursed.[4] While oncology drug programs are accessible in many cities, including smaller ones with populations under 100,000, reimbursement is typically limited to advanced stages of cancer and only after standard treatments such as surgery, radiotherapy, and chemotherapy have been exhausted.[5]

Geographical exclusion is not unique to Central and Eastern Europe. In the United States, there are also pronounced disparities in access to oncology care between urban and rural residents. Patients from rural areas often have to travel significant distances to reach the nearest oncology center, which results in delayed cancer diagnoses, reduced utilization of organ-preserving treatments (e.g., in breast cancer), lower participation in clinical trials, and generally higher cancer-related mortality.[6-8]

Demographic factors, such as low income and lack of higher education, further exacerbate these disparities in access and quality of care. Data from Poland, the United States, and across Europe demonstrate that geography continues to disproportionately influence a patient's chance of survival.[9] Implementing effective mobile diagnostic programs, expanding telemedicine, and increasing the number of specialists in smaller towns are among the strategies that could help reduce geographical exclusion. Ensuring equitable access to cancer treatment should be a priority in every modern healthcare system.[10]

As of December 31, 2021, Łódź voivodeship had a total population of 2,416,902. Of these, 1,499,697 individuals resided in urban areas, while 917,205 lived in rural regions. This means that approximately 62.1% of the voivodeship's population lived in cities, with the remaining 37.9% in rural areas. This distribution is relatively consistent with national trends, as reports from the Central Statistical Office (GUS) indicate that approximately 60% of Poland's population resides in urban areas and 40% in rural regions.[11]

We hypothesize that disparities in access to healthcare between urban and rural populations contribute to differences in the stage at which cancer is diagnosed and, consequently, in treatment outcomes. In other words, geographic exclusion and limited healthcare access in rural areas may independently worsen cancer-related outcomes.

This focus is particularly relevant in Poland, where healthcare infrastructure is unevenly distributed: major clinical hospitals and specialist centers are concentrated in large cities, while rural populations often face significant barriers to timely diagnosis and treatment due to long travel distances, limited availability of healthcare professionals, and fewer diagnostic facilities. According to Statistics Poland, as of December 2023, the country's population was approximately 38.3 million, with approximately 60% (23.1 million) residing in cities and 40% (15.3 million) in rural areas.[1] These rural communities often experience delayed diagnoses and limited access to oncological care—factors that may lead to poorer health outcomes.[11]

The urgency of addressing these disparities is underscored by national cancer trends. According to data from the National Cancer Registry, the annual incidence of cancer in Poland increased by 2.4% between 2010 and 2016, with 164,875 new cases reported in 2017.[12] Forecasts estimate this number will rise to approximately 176,000 new cases per year by 2025. Recognizing the social and economic burden of cancer, the Polish Parliament adopted the National Oncological Strategy in April 2019. This strategic plan, which outlines goals for 2020–2030, emphasizes the need to improve cancer care and outcomes, yet the challenge of regional inequalities in access remains inadequately addressed.[11]

The demographic context further complicates this picture. Poland is experiencing significant population aging, with projections suggesting ongoing and deepening demographic decline. This trend disproportionately affects rural and smaller municipalities, where aging populations coincide with a weaker healthcare infrastructure. These overlapping factors, such as aging, geographic isolation, and limited access, may create a compounding effect that contributes to higher cancer mortality in underserved areas.

Our analysis focused on evaluating these geographic disparities in cancer care access by comparing patients residing in urban versus rural areas. We did not model environmental pollution directly; therefore, we treated it as a contextual background and acknowledged potential spatial variability. In this study, we analyzed only the subset of individuals who ultimately reached hospital care; therefore, results should not be generalized to people who never presented to the hospital.

2. Materials and methods

2.1. Datasets

The study utilized routinely collected clinical data from the electronic medical records system at the Nikolay Pirogov Specialized District Hospital, Łódź, Łódź, Poland. Public datasets on healthcare infrastructure were sourced from the National Health Fund (Narodowy Fundusz Zdrowia) and the GUS of Poland, Warsaw, Poland.

2.2. Study design

This retrospective cohort study was based on prospectively collected data from all patients evaluated for suspected cancer at the Nikolay Pirogov Specialized District Hospital in Łódź between 2020 and 2024. Patients were followed to determine whether a cancer diagnosis was confirmed, resulting in two groups: diagnosed and not diagnosed.

The study aimed to assess whether geographical factors—specifically distance to healthcare facilities and place of residence (urban vs. rural)—were associated with the likelihood of receiving a cancer diagnosis. By integrating clinical data with publicly available infrastructure indicators, we evaluated regional disparities in cancer diagnosis within the Łódź voivodeship. To contextualize geographic access, we added a map of the Łódź voivodeship displaying hospital locations and primary care (POZ) sites that refer patients to the hospital (Figure 1). This figure is intended to visualize spatial accessibility rather than to serve as a causal exposure. Provider-level heterogeneity was acknowledged and considered in the interpretation.

We did not model environmental pollution directly; instead, we treated it as a contextual background factor and acknowledged that spatial variability may persist across the region. Consequently, pollution was not included as a covariate and was discussed as a limitation. We did not assume a constant supply of providers across the region.

2.3. Patient selection and data collection

2.3.1. Inclusion and exclusion criteria

All patients evaluated for suspected cancer at the Nikolay Pirogov Specialized District Hospital, Łódź, Łódź, Poland, between January 1, 2020, and December 31, 2024, were eligible for inclusion. Only patients with complete clinical documentation, including demographic characteristics, diagnosis data, and treatment history, were included in the analysis.

Patients were excluded if essential information—such as cancer type and residence data—was missing. Only residents of the Łódź voivodeship or directly adjacent areas were included to ensure comparability in healthcare access and environmental exposures (Figure 2).

2.3.2. Residential classification

Patients' place of residence was categorized as urban or rural based on GUS definitions. Urban areas included cities and towns within their administrative boundaries, while rural areas comprised villages and smaller settlements outside those boundaries.

Residence data were recorded at the time of initial evaluation. While this may not fully represent long-term residence, the approach provides a practical approximation for assessing geographic disparities in access to diagnosis. Ideally, residential status would be confirmed at least 12 months before diagnosis to reduce potential bias from healthcare-seeking migration.

2.4. Statistical analysis

Descriptive statistics were used to summarize the demographic and clinical characteristics of the cohort. Group comparisons for categorical variables were performed using the Chi-square (χ^2) test. To assess associations between healthcare accessibility and confirmed cancer diagnosis, logistic regression models were used to estimate odds ratios (ORs) with 95% confidence intervals (CIs).

Multivariable logistic regression was used to adjust for key confounders, including age, sex, and comorbidity. A significance threshold of $p<0.05$ was applied. For missing data, a complete case analysis approach was employed. Variables with more than 10% missingness were reviewed for potential systematic bias, and sensitivity analyses were performed where applicable. Given a sample size of 4,771 patients—of whom 2,996 (63%) were diagnosed with cancer—the study had >80% statistical power to detect moderate effect sizes (e.g., OR = 0.75) with a two-sided alpha level of 0.05. All analyses were conducted using STATA version 18 (StataCorp, United States).

3. Results

3.1. Study sample characteristics

The study cohort included 4,771 patients evaluated for suspected cancer at the Nikolay Pirogov Specialized

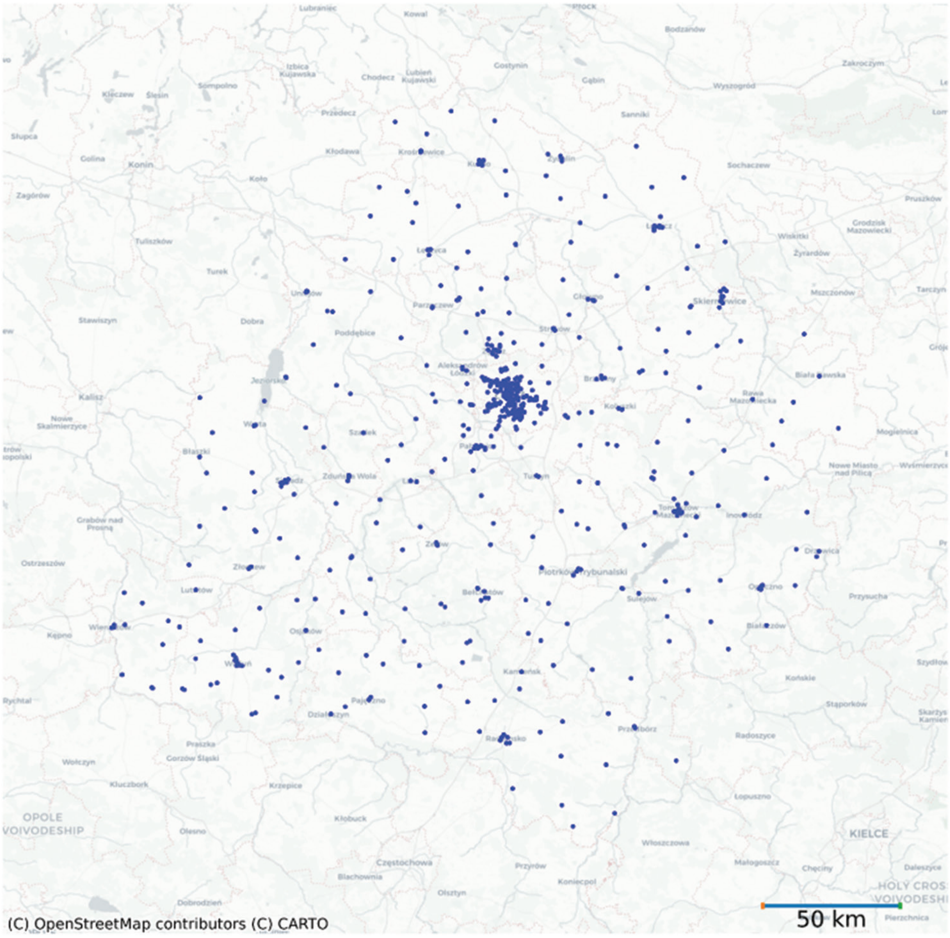

Figure 1. Accessibility map of the Łódź voivodeship, showing hospital locations (study sites) and primary care (POZ) facilities that refer patients to the hospital. Figure created by the authors.

District Hospital in Łódź between 2020 and 2024. Among these, 2,996 patients (62.8%) received a cancer diagnosis, while 1,775 patients (37.2%) did not. This distribution indicates a higher proportion of confirmed cancer cases within the evaluated population.

Among the analyzed population, 3,945 patients (82.7%) were urban residents, while 826 (17.3%) resided in rural areas. This urban predominance contrasts with national data from the GUS (GUS, 2023),[1] which reports that approximately 60% of Poland's population lives in urban areas and 40% in rural regions. The underrepresentation of rural patients suggests potential barriers to healthcare access, such as geographic distance.

Further analysis of urban–rural distribution by diagnosis showed that, among patients without cancer (n = 1,775), 337 (19.0%) were rural residents. In the cancer group (n = 2,996), 489 (16.3%) were rural residents. This difference was statistically significant (p=0.019), suggesting a disparity in diagnosis patterns based on place of residence.

Sex distribution was similar between groups. Among non-cancer patients, 888 (50.0%) were male and 887 (50.0%) were female, while the cancer group included 1,483 (49.5%) males and 1,513 (50.5%) females (p=0.72), indicating no significant sex-based difference.

Regarding age distribution, in the non-cancer group (n = 1,775), 370 (20.8%) were aged <65 years, 606 (34.1%) were aged 65–74, 566 (31.9%) were aged 75–84, and 233 (13.1%) were ≥85 years. In the cancer group (n = 2,996), 639 (21.3%) were <65, 1,086 (36.2%) were 65–74, 906 (30.2%) were 75–84, and 365 (12.2%) were ≥85. The age distribution did not differ significantly between groups (p=0.35), suggesting no significant age-related disparity in cancer diagnosis within the cohort. These proportions reflect only the population that reached hospital care; the study did not quantify individuals who may have experienced barriers and never presented to the hospital.

3.2. Treatment outcomes

A high proportion of both cancer and non-cancer patients completed the diagnostic or therapeutic process (Outcome Category 1): 84.0% of cancer patients and 93.9% of non-cancer patients (p<0.001). Fewer patients were referred for outpatient follow-up (Outcome Category 2) or discharged at their own request (Outcome Category 3).

Stratification by place of residence revealed that urban patients—regardless of diagnosis—were more likely to complete the diagnostic or therapeutic process (Outcome Category 1) than rural patients. Rural cancer patients more frequently experienced adverse outcomes, including discharge upon request (Outcome Category 3) or death (Outcome Category 4): 16.0% versus 12.4% in urban cancer patients. Although not statistically significant across all categories, these trends suggest potential disparities in the continuity of care and access to services. Observed differences in outcomes by residence type should be interpreted cautiously, as they may reflect case-mix, referral patterns, and unmeasured contextual factors rather than residence type *per se*.

3.3. Geographic factors

Analysis of distance to the nearest hospital showed significant differences between patients with and without cancer (p=0.007). Among non-cancer patients (n = 1,775), 1,417 (79.8%) lived within 5 km from a hospital, 36 (2.0%) lived 5–10 km away, and 322 (18.1%) resided over 10 km away. In the cancer group (n = 2,996), 2,439 (81.4%) lived within 5 km, 93 (3.1%) between 5 km and 10 km, and 464 (15.5%) over 10 km from the hospital.

Significant differences were also observed across categories of city population sizes (p<0.001). In the non-cancer group, 1,247 (70.3%) lived in cities of 100,000–500,000 inhabitants, and 297 (16.7%) in towns with <10,000 inhabitants. Among cancer patients, 2,044 (68.2%) lived in mid-sized cities, and only 14 (0.5%) lived in towns with <10,000 people. These data reflect disparities in access and urbanization.

3.4. Cancer type distribution

Patients were categorized into diagnostic groups (Table 1), revealing stark contrasts (p<0.001). A total of 1,775 patients were classified as having no cancer. Among the 2,996 cancer patients, the most frequent diagnoses were cancers of the genitourinary system (56.4%), followed by the digestive system (18.4%), respiratory tract (9.3%), and others (7.8%). Less common were cancers of the lymphatic and hematopoietic systems (5.3%), breast (2.2%), and skin (0.6%).

Table 1. Cohort characteristics relevant to diagnosis

Characteristic	Cancer (n=2,996)	No cancer (n=1,775)	Total (n=4,771)
Sex (female)	1,513 (50.5)	887 (50.0)	2,400 (50.3)
Age			
<65	639 (21.3)	370 (20.8)	1,009 (21.1)
65–74	1,086 (36.2)	606 (34.1)	1,692 (35.5)
75–84	906 (30.2)	566 (31.9)	1,472 (30.8)
≥85	365 (12.2)	233 (13.1)	598 (12.5)
Residence type			
Urban	2,507 (83.7)	1,438 (81.0)	3,945 (82.7)
Rural	489 (16.3)	337 (19.0)	826 (17.3)
Distance to the nearest hospital			
<5 km	2,439 (81.4)	1,417 (79.8)	3,856 (80.8)
5–10 km	93 (3.1)	36 (2.0)	129 (2.7)
>10 km	464 (15.5)	322 (18.1)	786 (16.5)

Note: Data are represented in n (%).

These proportions should be interpreted cautiously, as they reflect the hospital's referral profile and available specialties (e.g., gynecologic oncology). Therefore, this internal distribution is not compared to national incidence statistics.

Descriptive patterns were consistent with the accessibility map (Figure 1), visualizing the POZ distribution relative to the hospital and suggesting heterogeneous referral pathways across urban and rural settings.

3.5. Multivariable analysis

Multivariable logistic regression assessed the association between cancer diagnosis and the following variables: sex, age, distance to the nearest hospital, and place of residence. The model included all 4,771 observations and yielded a likelihood-ratio chi-square of 11.81 (p=0.0375), indicating a statistically significant model fit.

Sex (OR = 1.023, p=0.704) and age (OR = 0.999, p=0.635) were not significantly associated with cancer diagnosis. However, residing 5–10 km from a hospital (versus <5 km) was associated with higher odds of diagnosis (OR = 1.628, p=0.022). Living in an urban area was not significantly associated with cancer diagnosis (OR = 1.292, p=0.223).

These results suggest that distance to healthcare facilities, particularly living 5–10 km away, may be associated with a higher likelihood of receiving a cancer diagnosis—potentially due to increased access or proactive healthcare-seeking behavior. Other factors, including sex, age, and urban/rural status, did not show independent associations.

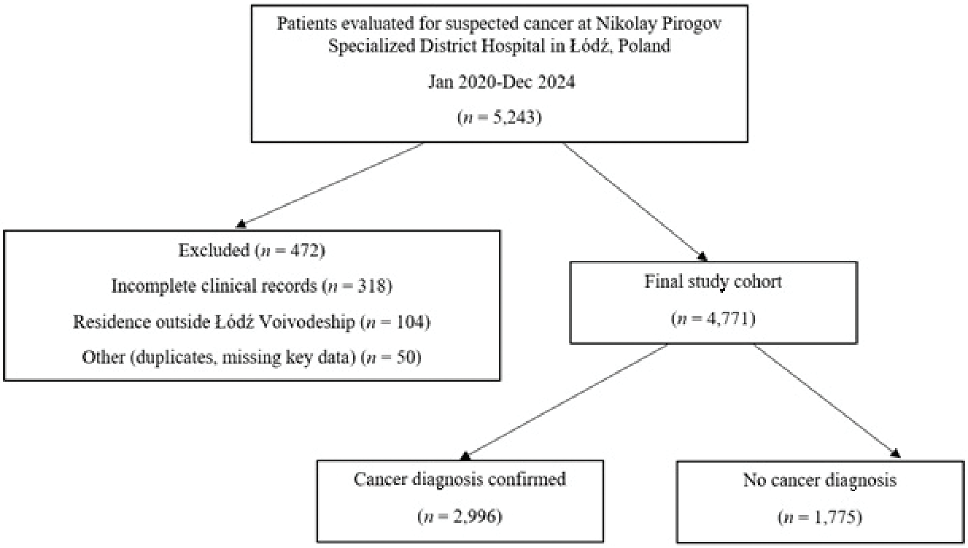

Figure 2. Flow diagram showing the inclusion/exclusion of participants

4. Discussion

Environmental conditions, including air quality, likely vary across central Poland; at the same time, many rural residents commute to urban centers for employment, suggesting comparable socioeconomic circumstances between rural and urban inhabitants. However, a significant disparity exists in healthcare accessibility. Rural areas have fewer than half as many medical facilities as urban regions, resulting in reduced availability of medical consultations, preventive screenings, and vaccinations. This shortage potentially contributes to lower healthcare engagement among rural populations. Enhancing healthcare infrastructure in rural regions could facilitate early diagnosis and treatment initiation, potentially improving health outcomes and increasing life expectancy for rural residents.

Our findings indicate that despite the hospital primarily serving rural areas, urban residents were overrepresented in our cohort, suggesting potential barriers to healthcare access for rural populations. The significantly lower proportion of rural patients, particularly among those diagnosed with cancer, highlights disparities that may be driven by geographical, logistical, or socioeconomic challenges. The significant difference in urban–rural distribution among cancer and non-cancer patients (p=0.019) further supports the need for targeted healthcare accessibility improvements in rural regions.

Interestingly, neither sex nor age was significantly associated with cancer diagnosis in our cohort, suggesting that these factors may not independently influence cancer detection in this population. While previous studies have indicated age-related disparities in cancer detection, our results suggest that these disparities may not be as pronounced in this particular healthcare setting. The relatively balanced age distribution between cancer and non-cancer patients (p=0.35) supports this observation. However, further studies are necessary to explore other contributing factors, such as healthcare-seeking behavior, comorbidities, and genetic predispositions.

As an auxiliary sensitivity check, we also fitted a model using urban versus rural residence as the dependent variable (Table 2). As expected, increasing distance from hospitals was strongly associated with rural residence, confirming the internal geographic consistency of our dataset and supporting the validity of the main model that assesses cancer diagnosis.

Regarding treatment outcomes, a significantly higher proportion of cancer patients were discharged upon request or died (p<0.001). This trend underscores the need for improved patient support systems, particularly for individuals with complex oncological treatment pathways. In addition, the distribution of cancer types in our cohort, with a predominance of genitourinary system cancers, reflects the hospital's specialization rather than national cancer prevalence. This highlights the importance of considering institutional profiles when interpreting disease distribution patterns.

Our findings align with previous research emphasizing the disparities in healthcare access between urban and rural populations in Poland. Rural residents continue to face considerable challenges in obtaining timely medical care, potentially contributing to delayed cancer diagnoses and poorer health outcomes. Addressing these disparities requires targeted policy interventions, including expanding healthcare infrastructure in rural areas, implementing

Table 2. Multivariable logistic regression for confirmed cancer diagnosis

Predictor	Odds ratio	95% confidence interval	*p*-value
Sex (female vs. male)	1.02	0.89–1.17	0.704
Age (per year)	1.00	0.99–1.01	0.635
Distance 5–10 km vs. <5 km	1.63	1.07–2.47	0.022
Distance >10 km vs. <5 km	0.94	0.67–1.32	0.731
Urban vs. rural	1.29	0.86–1.94	0.223

mobile screening programs, and enhancing transportation support for patients living in remote locations.

The high detection rate of genitourinary cancers may be attributed to nationwide and regional initiatives promoting self-examinations, cervical cancer screenings, and other preventive programs. These efforts, including invitations for cytology screenings and breast self-examination campaigns, are conducted not only in urban areas but also in rural regions. In recent years, Łódź voivodeship has implemented cervical cancer screening programs, contributing to a significant reduction in the incidence of cervical malignancies over the past five years. This trend is reflected in national statistics, with the voivodeship now reporting one of the lowest cervical cancer incidence rates in the country. These findings underscore the importance of expanding cancer awareness and education across the voivodeship. They also support the effectiveness of preventive strategies in reducing cancer incidence, highlighting the need for continuous public health initiatives to ensure equal access to early diagnosis and treatment.

This study has several limitations that should be considered when interpreting the findings. First, the observational design precludes the establishment of causality between distance to healthcare facilities, urbanization, and cancer treatment initiation. While associations can be identified, definitive causal relationships cannot be confirmed.

Second, the analysis relies on data from a single center, the Nikolay Pirogov Specialized District Hospital in Łódź. Single-center studies often lack external validity, limiting the generalizability of the results to other settings or populations. In addition, single-center studies may be more prone to publication bias and may have lower methodological quality than multicenter studies.

Third, the study did not account for individual lifestyle factors such as diet, smoking, and alcohol consumption, which can significantly influence cancer risk and treatment outcomes. The absence of these variables may introduce unmeasured confounding, potentially biasing the observed associations.

Fourth, we did not include environmental pollution or provider density as covariates. Both may vary spatially and could confound observed associations. The absence of small-area identifiers precluded multilevel modeling; as a result, unmeasured area-level factors may remain in the model residuals.

Finally, the reliance on existing datasets may not capture all potential confounding variables that influence cancer treatment initiation. Factors such as socioeconomic status, education level, and health literacy were not included, but could play significant roles in healthcare access and decision-making. Addressing these limitations in future research could provide a more comprehensive understanding of the factors influencing cancer treatment initiation and help develop targeted interventions to reduce disparities between urban and rural populations.

5. Conclusion

This study highlights potential disparities in healthcare accessibility among patients who reached hospital care in the Łódź region. While the majority of rural residents in our cohort lived farther from hospitals, most urban residents had access within a 5 km radius, which may facilitate earlier evaluation. In multivariable analysis, a localized effect was observed for patients living 5–10 km from a hospital, whereas living >10 km from a hospital and residence type did not show independent associations after adjustment. These findings should be interpreted as indicators of potential access pathways rather than causal effects. They emphasize the need to further investigate how geographic distance and healthcare infrastructure interact to shape diagnostic timelines.

Targeted interventions—such as establishing satellite clinics, implementing mobile diagnostic units, improving transport support, and providing incentives for healthcare professionals to work in rural areas—could help reduce inequities in access. Future population-based and multilevel studies are warranted to confirm these results and better capture individuals who never reach hospital care.

In conclusion, our study underscores the importance of equitable access to timely cancer diagnostics across geographic settings and provides a starting point for more comprehensive research and health policy planning in Poland.

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Conflict of interest

The authors declare that they have no competing interests.

Author contributions

Conceptualization: All authors
Formal analysis: Anna Skotny
Methodology: Anna Skotny
Writing–original draft: Anna Skotny
Writing–review & editing: Paulina Podlawska-Nowak

Ethics approval and consent to participate

This study was conducted using anonymized clinical data collected from patients evaluated at the Nikolay Pirogov Specialized District Hospital in Łódź, Poland. Approval to use these data for scientific purposes was granted by the hospital administration on October 28, 2024. The approval includes access to medical records containing information on diagnoses, addictions, comorbidities, age at the time of hospitalization, medications used, and patients' medical history over the past five years. All data were fully anonymized before analysis, and no personally identifiable information—such as names, national identification numbers, addresses, or contact details—was included.

Consent for publication

Not applicable.

Availability of data

The anonymized data that support the findings of this study are available from the corresponding author upon reasonable request supported by consent of the local Ethics Committee.

Further disclosure

The authors used large language models to improve language, enhance grammar, and assist in editing the manuscript. All artificial intelligence-generated suggestions and modifications were carefully reviewed and verified by the authors to ensure accuracy, completeness, and originality.

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