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# Investigating the possibility of redesigning Oncology patients' care based on data from Social Security administrative sources

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## ABSTRACT

**OBJECTIVE:** Given the absence of a Greek neoplasm registry, this study aims to develop a logical systematic algorithm for the identification of newly diagnosed cancer patients (incidence) within a specified timeframe. Specifically, it focuses on four distinct cancer types, namely breast, lung, colon, and prostate cancer, for the year 2017. This alternative methodological approach leverages administrative datasets, particularly healthcare service records about cancer patients as documented by Greek Social Security Funds's perspective.

**METHODOLOGY:** A retrospective study was conducted utilizing administrative healthcare data of cancer patients who underwent any type of care (radiotherapy, chemotherapy, surgery, medical interventions, etc.) within facilities affiliated with both public and private healthcare providers contracted with EOPYY (National Organization for the Provision of Health Services), as well as home care settings. Data were sourced from EOPYY and IDIKA (e-Government Center for Social Security Services). The development of a logical algorithm facilitated the identification of newly diagnosed cases of with breast, lung, colon and prostate cancer, by cross-referencing ICD-10 diagnosis codes for each type of cancer with the treatment information derived from EOPYY's administrative dataset. Furthermore, study examined the incidence rates of these four cancer types across different age groups, genders, and geographical regions of patient residence. The estimated incidence and the five-year survival were compared with GLOBOCAN data for each cancer type. Heterogeneity in the geographical distribution consists a limitation of the current study mainly attributed to the methodology of data collection and secondarily interpreted in epidemiological terms

**RESULTS:** In 2017, Greece saw the emergence of 8,305 newly diagnosed breast cancer patients, 6,605 lung cancer patients, 5,886 prostate cancer patients, and 4,838 colon cancer patients, totalling 25,634 incident cases. Incidence rates for the studied cancer types exhibited an upward trajectory with patient age. Notably, lung and colon cancer exhibited a higher incidence rate among males, accounting for 77.3% and 56.3% of cases, respectively, as opposed to females. Moreover, regional disparities in cancer incidence were evident, with the highest rates observed in Attica (breast cancer: 176 per 100,000 person-years), Western Macedonia (lung cancer: 66 per 100,000 person-years), Western Macedonia (colon cancer: 63 per 100,000 person-years), and Attica (prostate cancer: 123 per 100,000 person-years).

**CONCLUSIONS:** This study demonstrates the feasibility of utilizing administrative data from the perspective of Greek Social Security Funds to effectively identify incident cancer cases over a defined timeframe. Such a methodological approach proves indispensable for evaluating the efficiency of healthcare expenditures, addressing epidemiological considerations, and enhancing the provision of healthcare services for individuals afflicted by cancer.

**KEYWORDS:** *Neoplasms, Cancer, Administrative health care databases, Administrative data, Incidence, Social Security, Newly diagnosed patients*

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## INTRODUCTION

Cancer consists a major public health problem [1], worldwide and especially in middle and high income countries, including Greece[2]. Therefore, optimal and accurate estimation of cancer incidence is still a challenge. Based on estimates by the Global Cancer Observatory (GLOBOCAN), the most common types in Europe (2018) are breast cancer (ICD-10:C50), colon cancer (ICD-10:C18), lung cancer (ICD-10:C34) and prostate cancer (ICD-10:C61) with incidence rates 12.1%, 11.8%, 10.9% and 10.8% respectively [3]. In Greece, the four most frequent types of cancer representing approximately 50% of new diagnoses in both genders for all age groups in 2018 were lung cancer (14.8%), breast cancer (11.5%), colon cancer (10 .9%) and prostate cancer (10.6%).

Increasing interest in the use of "real world data" (RWD) is apparent existing, drawing from a diverse array of sources, including patient registries, electronic health records and administrative claims [4]. National Cancer Registries stand as reliable data sources for the long-term study of cancer epidemiological trends [5] drawing from a diverse array of sources[6]. However, Greece remains among a select group of European nations lacking a systematically operational, publicly accessible National Cancer Registry. Consequently, incidence rates are reported through international databases, such as Globocan, relying on calculations and data sourced from neighboring countries like Bulgaria and Italy [7]. Presently, Greece has witnessed fragmented research endeavors in the realm of cancer epidemiology, with data predominantly accessible through regional cancer registries [8, 9, 10].

Healthcare administrative databases encompass a comprehensive array of information such as hospital admissions, medical and diagnostic procedures, drug prescriptions, and laboratory data. Accurate identification of patient diagnoses in real-world data sources, such as administrative healthcare databases, is pivotal for comprehending the disease trajectory experienced by patients. To obtain reliable information, the utilization of administrative claims data, devoid of linkage to a cancer registry, presupposes the meticulous delineation of the selection process for each group of cancer patients. This process should aim for the most efficient possible identification of patients based on cancer type. Failure to do so entails the risk of the selected patient group (cohort) deviating from an accurate representation of the target population, potentially leading to either underestimation (poor sensitivity) or overestimation of the population with the disease (poor specificity) [11]. In addition, the implementation of validated algorithms serves as fundamental research tools for identifying patients within administrative databases [12] and mitigating the risk of misclassification [13].

In Greece, the absence of a systematically operational national neoplasm registry, coupled with escalating budgetary constraints [14] has led to the exploration of alternative approaches. Administrative data, designed primarily for accounting and managerial purposes, now presents an opportunity to assess the efficiency of health expenditures [15]. Furthermore, it can serve as a secondary means to construct the epidemiological profile and quality indicators for cancer patients within the country[16].

In Greece, EOPYY as the sole purchaser of publicly funded health and pharmaceutical care services for approximately 95% of the country's permanent population stands as a critical source of administrative data as it collects individual-level data on the utilization of public health services, based on a standardized benefits package[17]. It's essential to highlight that EOPYY has been extending coverage to patients through contracted public and private sector health providers since 2012.

The aim of the study is to delineate an alternative methodological approach for investigating newly diagnosed patients with the four most prevalent types of cancer (breast, lung, colon, and prostate) in Greece. This involves leveraging anonymized administrative data from EOPYY and Social Security Electronic Governance (IDIKA) through the development of logical algorithms. Specifically, the present study aims to develop an algorithm for the precise identification of these four cancer types using administrative healthcare data spanning a one-year period from the initial diagnosis.

## MATERIAL AND METHODS

### Study design

A retrospective observational study was conducted using administrative healthcare data of EOPYY patients (both outpatients and inpatients) diagnosed with breast, lung, colon and prostate cancer in the year 2017. This data was obtained through EOPYY's reimbursement system, governed by EOPYY Legislation (Integrated Regulation for Health Services - EKPY). The administrative healthcare data included courses of Radiotherapies (R), Hospitalizations (H) as well as Medication (M), Medical Interventions/diagnostic tests (MI) carried out in public and private healthcare providers contracted with EOPYY (hospitals, clinics, diagnostic centers, and pharmacies). A logical algorithm was applied, utilizing eligibility/exclusion criteria on the administrative data, resulting in the identification of newly diagnosed cancer patients by cancer type within the EOPYY system in 2017.

### Study population and follow-up

The study population comprised beneficiaries of EOPYY, accounting for 95% of Greece's total population, (including insured individuals, family members, pensioners, and uninsured persons) based on the 2017 census [18].

The aforementioned population comprised 25,634 newly diagnosed patients in 2017 (suffered from breast, lung colon and prostate cancer) irrespective of age, gender, or disease stage, across all regions of Greece.

Data sources

Data were retrieved from the following administrative databases (Table 1).

- EOPYY database: This database contained incidental data on the utilization of health services, along with associated public expenditures on services such as radiotherapy, hospitalizations, medications, and medical interventions.
- IDIKA database: The IDIKA database stored pharmaceutical prescriptions and electronic medical intervention referrals.

*Table 1: Data sources for health services utilization*

| HEALTH SERVICE | Database | Health services |
|---|---|---|
| EOPYY | eDAPY (Health Vouchers Reports of Providrers) | Outpatient care data (radiotherapy, medical interventions) and inpatient care (hospitalisations) |
| | KMES (Central Processing Unit of Prescriptions) | Data of pharmaceuticals prescriptions |
| IDIKA | e-Prescription - Electronic Prescription | Pharmaceuticals prescription and laboratory and imaging tests referral data |

### Data collection

Anonymized administrative data pertaining to service utilization per patient and category of care (radiotherapy, medications, hospitalisations, medical interventions) were collected for the years 2016-2017.

**Specifically, data encompassed:**

**a)** Demographic patient characteristics such as age, gender, geographical area (region) of residence.

**b)** Cancer-related clinical characteristics, including ICD-10 coding at the time of diagnosis, documented across all provided medical and pharmaceutical services [19].

**c)** Health care resource utilization data for each type of care, including the date of service, care type (radiotherapy, medications, hospitalisations, medical interventions), provider identification, provider type (public or private).

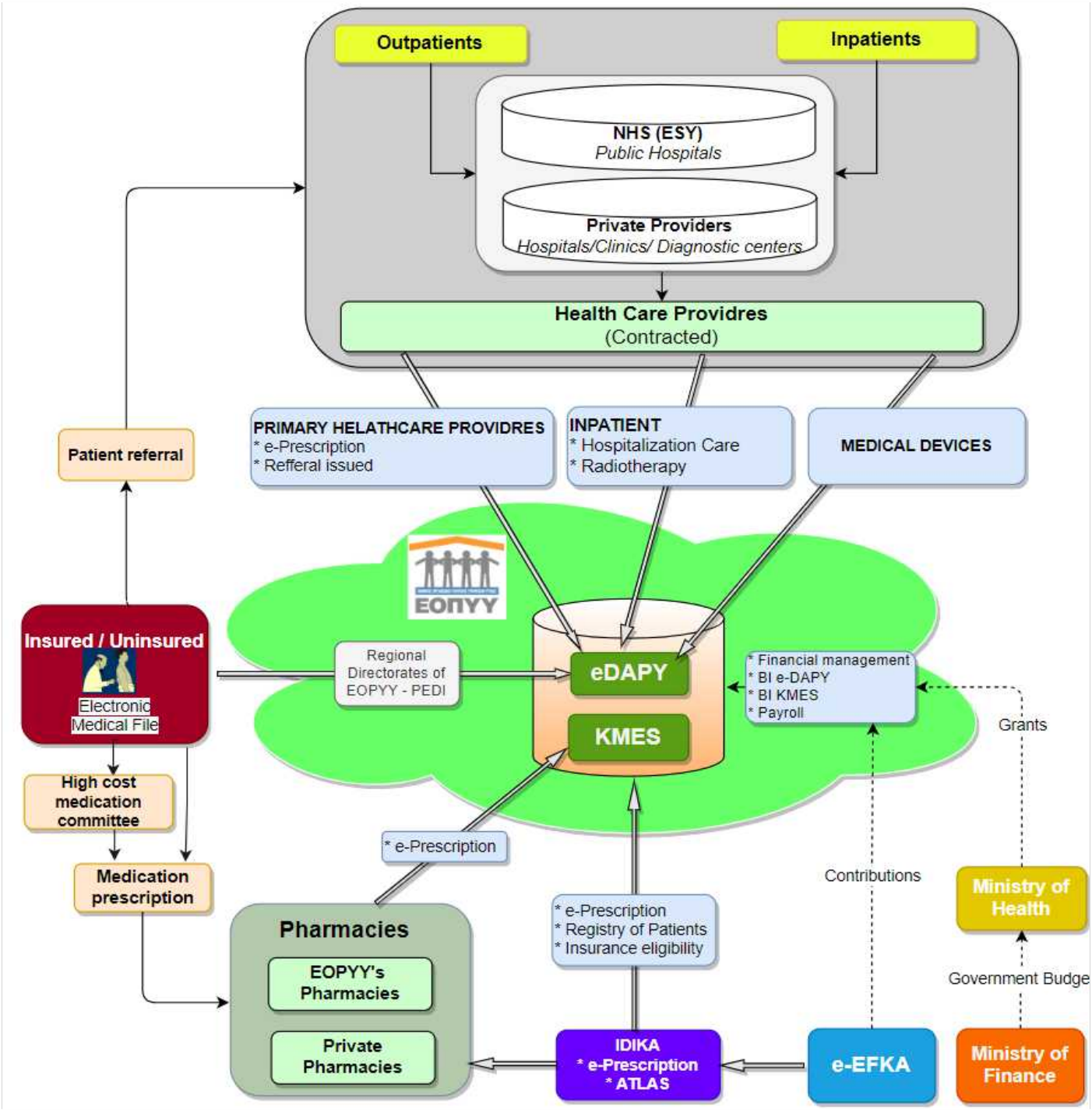
Medications included chemotherapy, targeted therapy, or immunotherapy, categorised under the Anatomical Therapeutic Chemical Classification (ATC) system, specifically under the category L: Antineoplastic and immunomodulating agents [20].

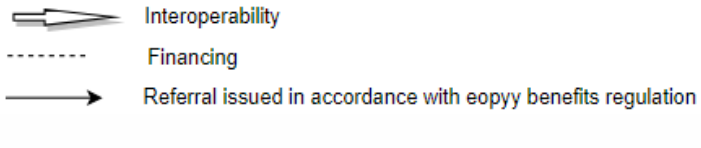
Hospitalizations were classified according to the Greek Diagnostic-Related Groups (DRGs) system [21] including surgical procedures (surgical DRGs), antineoplastic medication administration, and other hospitalization types. Medical interventions encompassed laboratory and imaging tests.

In order to ensure anonymization, each patient was assigned a unique anonymous patient identification code (ID).

**Interoperability of computer systems**

Figure 1 illustrates the interoperability of Information systems (administrative health databases) within EOPYY (eDAPY and KMES) and IDIKA (e Prescription) with various health providers (e.g., private physicians, public hospitals, private pharmacies, and EOPYY pharmacies) all within the general operational environment of EOPYY.






eDAPY: Health Vouchers Reports of Providers
KMES: Central Processing Unit of Prescriptions
IDIKA: Social Security Electronic Governance
e-EFKA: Electronic National Social Security Fund
**Figure 1**. EOPYY operational system environment

**Time period of data analysis**

Although the electronic systems of EOPYY (e-DAPY and KMES) had been operational since 2012, it was only in 2016 that public healthcare providers (Public Hospitals) were mandated to submit their claims electronically through EOPYY's systems. Consequently, beginning in 2016 and gradually over subsequent years, the EOPYY databases became more comprehensive.

As such, 2017 was defined as the study period for identifying newly diagnosed cancer patients, Specifically, newly diagnosed patients (diagnosed with breast, lung, colon or prostate cancer) were defined as those who had: a) claims submitted to EOPYY in 2017 and b) no claims related to any type of cancer submitted in 2016 (Figure 2).

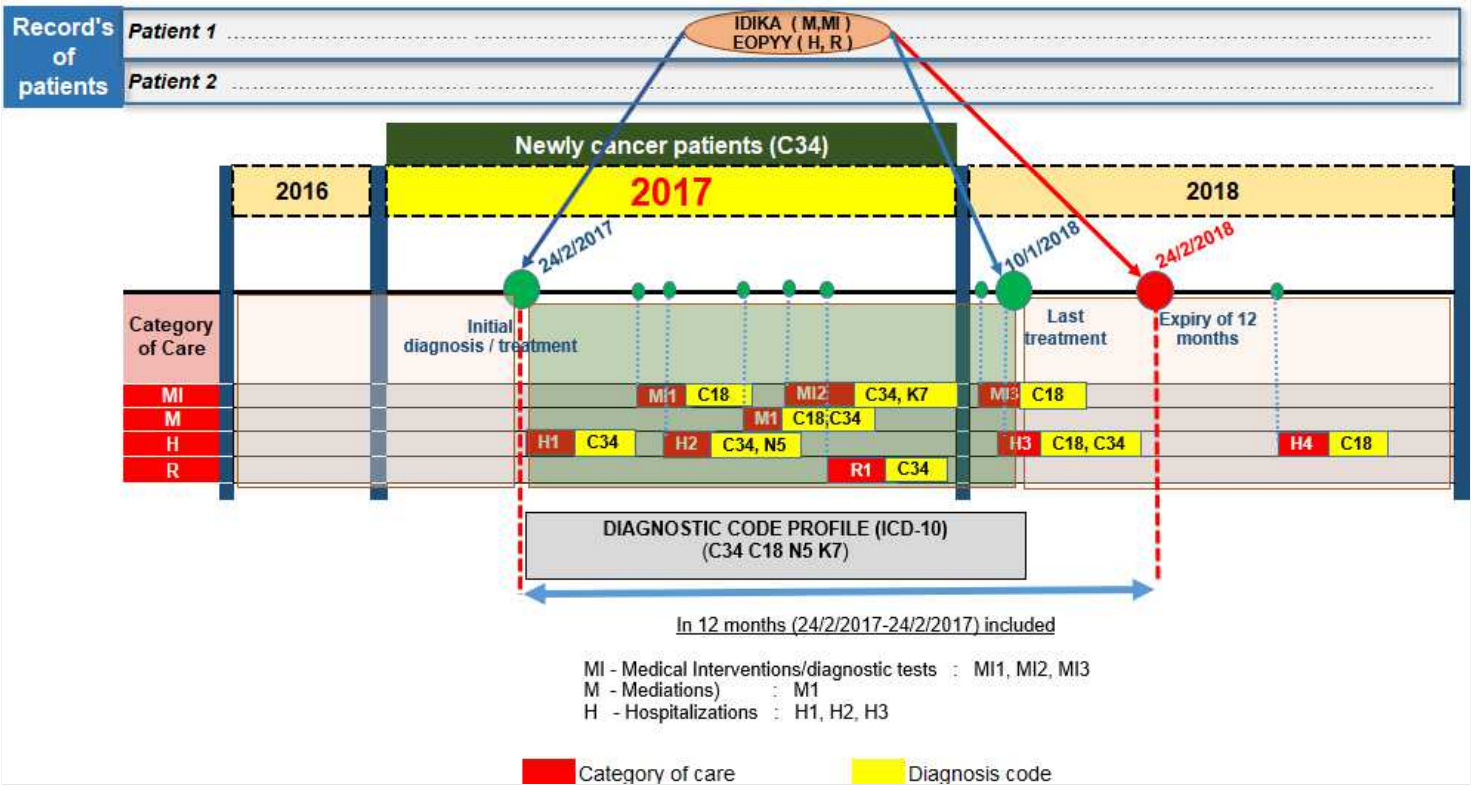



*Figure 2. Time period for cancer patients' data analysis*

**Eligibility and exclusion criteria of the study population**

The eligibility and exclusion criteria for the study population are depicted in Table 2.

*Table 2. Patient eligibility and exclusion criteria.*

| a/a | Eligibility Criteria |
|---|---|
| 1 | Each pharmaceutical prescription or medical intervention referral or hospitalization admission or radiotherapy session should be related to at least one of the under-study types of cancer (C50, C34, C61, C18) |

| a/a | Exclusion Criteria |
|---|---|
| 1 | Patients performing only diagnostic tests related to at least one of the under-study types of cancer (C50, C34, C18, C61) |
| 2 | Patients undertaken Only Antineoplastic Drug (ATC:L) |
| 3 | Combination of the above two cases |

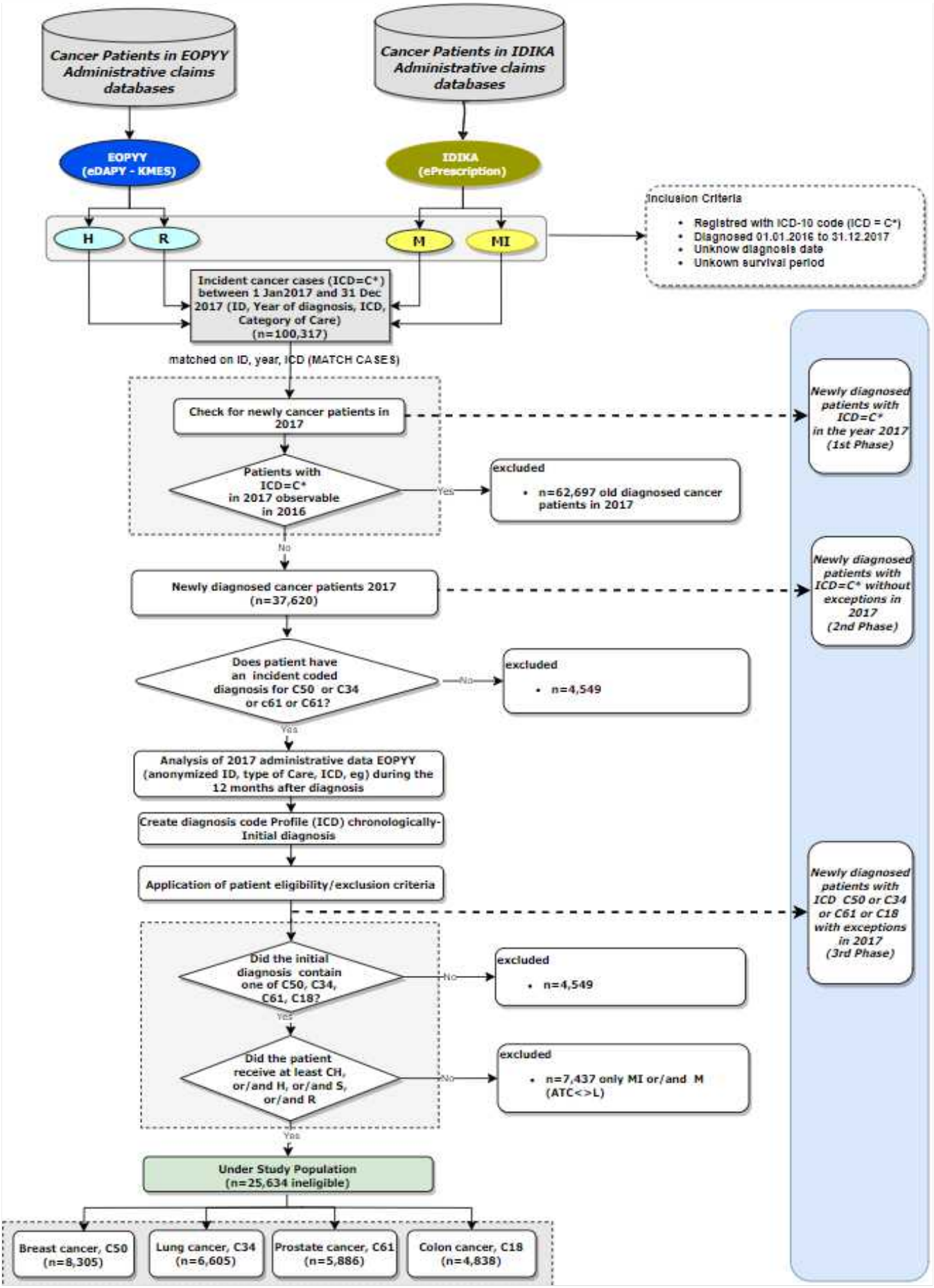
**Identification of newly diagnosed cancer patients**

Figure 3 illustrates the new algorithm (in three phases), outlining information flows as well as the corresponding procedures for the identification and stratification of the newly diagnosed cancer patients for the four studied cancer types in 2017 in Greece.

- In the 1st phase, newly diagnosed cancer patients in 2017 who received health services (Radiotherapy, Hospitalizations, Medications, Medical interventions/Diagnostic tests) for any type of cancer (ICD -10: C) were identified through the computerized systems of EOPYY and IDIKA.

- In the 2nd phase, newly diagnosed cancer patients with an ICD-10 diagnosis code corresponding to at least one of the four studied cancer types (breast, lung, colon, prostate, colon), without applying any exclusion criteria, were extracted from the pool of cancer patients identified in the 1st phase.

- In the 3rd phase, eligibility /exclusion criteria (Table 2) were applied to the newly diagnosed cancer patients identified in the 2nd phase.




N: Hospitalizations, R: Radiotherapy, M: Medications, MI: Medical Interventions/diagnostic tests
S: Surgeries, CH: Chemotherapies

**Figure 3**. Information flow diagram for the identification of eligible newly diagnosed patients with a diagnosis of breast, lung, colon and prostate cancer through the computerized systems of the EOPYY and IDIKA.

### Ethical Issues

The research protocol of the study received approval from the Ethics Committee of the Nursing Department of the National and Kapodistrian University of Athens (EKPA). Furthermore, permission to use and utilize anonymized data was granted by the EOPYY Administration. The protection of individuals data was maintained in accordance with the General Data Protection Regulation (GDPR) of European Union (EU) (2016/679).

### Statistical analysis

Descriptive statistical analysis was performed on the quantitative variables under study using the SPSS v22 statistical package. Quantitative variables were summarized using measures of central tendency (mean value), while categorical variables were presented as absolute counts (n) and relative frequencies (%).

## RESULTS

### Patient allocation by cancer type

The study population included a total of 25,634 newly diagnosed cancer patients for the year 2017, suffering from any of the four specified cancer types (Figure 4).

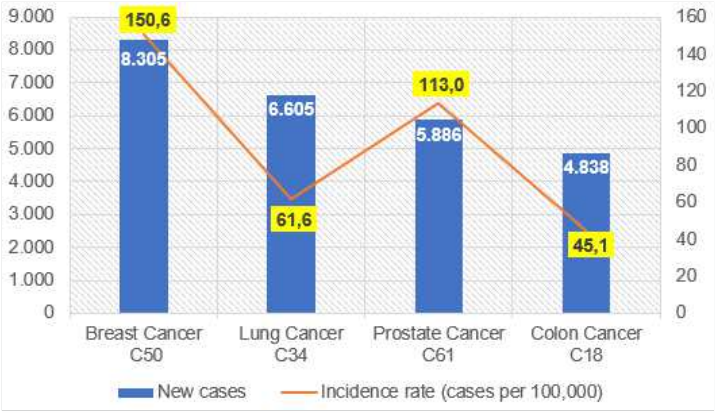



*Figure 4. Allocation of the studied patients by type of cancer (N=25,634).*

For breast cancer, the data are presented as the number of new patients per 100,000 women, whereas data for prostate cancer, it refers to the number of new patients per 100,000 men.

### Patient allocation by gender and age group

Figure 5 illustrates the incidence of patients by type of cancer (lung and colon) and gender, for the year 2017 (per 100,000 inhabitants).

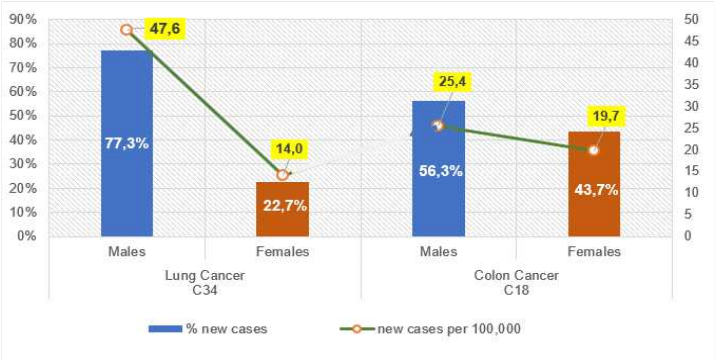



*Figure 5. Number of patients by gender and type of cancer per 100,000 inhabitants.*

Among the studied population, males predominated for all types of cancer except breast cancer.

In the case of breast cancer, only 2% of male patients were recorded out of the total of patient population. For lung and colon cancer, males comprised the majority with proportions of 77.3% and 56.3%, respectively.

Figure 6 presents the incidence of patients by type of cancer and age group (<=30, 31-60, >60), in 2017 (per 100,000 inhabitants).

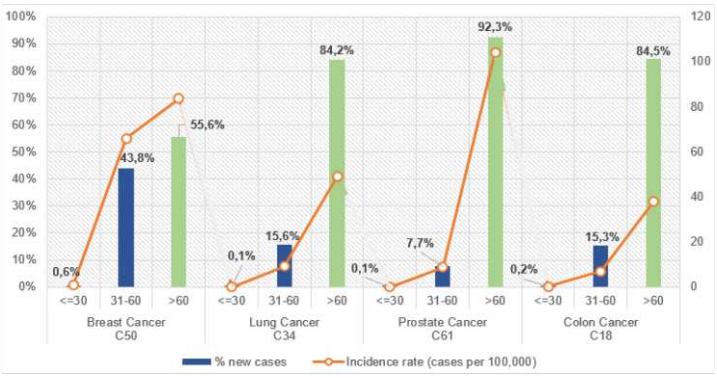



*Figure 6. Number of patients by age group and type of cancer per 100,000 inhabitants.*

It is notable that approximately 80% of patients suffering from lung, colon, and prostate cancer, were individuals over the age of 60, while for breast cancer, more than 40% of women fell within the age range of 31 to 60 years.

### Patient allocation by region of residence

Figure 7 displays the incidence of patients by type of cancer and geographical region (per 100,000 inhabitants).

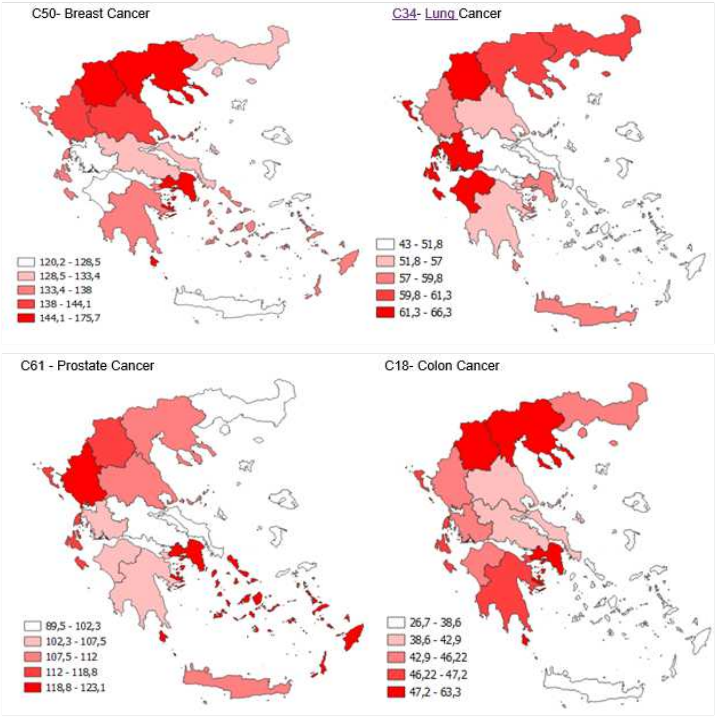



*Figure 7. Allocation of cancer patients by region of residence per 100,000 inhabitants.*

The highest incidence of breast cancer was reported in the Attica region, whereas lung and colon cancer have higher incidences in Western Macedonia. Prostate cancer incidence was notable in both Attica and Epirus regions.

### Comparison with other cancer databases

Table 3 provides a comparison between the incidence data obtained in this study and the corresponding data from the Globocan database.

As already mentioned, data for Greece reported in the Globocan database are not obtained from primary or secondary sources but from neighboring countries, due to the absence of national or regional registries available or mortality data, in order to develop a national cancer registry. [7]

***Table 3. Comparison of the current study epidemiological data with data derived from the Globocan database***

| EOPYY - Current Study - Cancer Types (2017) | New cases | Globocan Cancer Types (2018) | New cases |
|---|---|---|---|
| Malignant neoplasm of breast **(C50)** | 8.305 | Malignant neoplasm of breast **(C50)** | 7.734 |
| Malignant neoplasm of bronchus and lung **(C34)** | 6.605 | Malignant neoplasm of trachea, bronchus and lung **(C33-C34)** | 9.964 |
| Malignant neoplasm of prostate **(C61)** | 5.886 | Malignant neoplasm of prostate **(C61)** | 6.457 |
| Malignant neoplasm of colon **(C18)** | 4.838 | Malignant neoplasm of colon **(C18)** | 4.391 (*) |
| ** This category was given by Globocan as malignant neoplasms of the colon, rectosigmoid junction, rectum anus and anal canal (C18-C21)* | | | |
| *Literature base [27] approximately 60% of cases with C18-C21 diagnosis correspond to C18* | | | |

It should be mentioned that the 5-year survival rate is considered a valuable measure of progress in the battle against cancer [22]. Table 4 below presents the correlation of the 5-year survival rate with cancer incidence in Greece. Survival data for this study 5- were obtained from the database in Greece (IDIKA), while data for England (NHS) were sourced from Cancer Research UK [23].

***Table 4: Correlation of 5-year survival rate with cancer incidence in Greece sourced from IDIKA database***

| EOPYY Present Study - Cancer Types (2017) | Five-year survival rate | Public Health of England (2014-2018) | Five-year survival rate |
|---|---|---|---|
| Malignant neoplasm of breast (C50) | 81,3% | Malignant neoplasm of breast (C50) | 86,3% |
| Malignant neoplasm of bronchus and lung (C34) | 20,2% | Malignant neoplasm of trachea, bronchus and lung (C33-C34) | 17,6% |
| Malignant neoplasm of prostate (C61) | 74,2% | Malignant neoplasm of prostate (C61) | 88% |
| Malignant neoplasm of colon (C18) | 55,3% | Malignant neoplasm of colon (C18) | 57,7% |

## DISCUSSION

This retrospective study represents an endeavor to utilize administrative data to identify newly diagnosed cancer patients within a defined time frame from the perspective of the Greek Social Security. A review of Greek and European literature underscores the significance of administrative and financial data in estimating cancer incidence [24]. Most of these studies have primarily relied on inpatient care data to validate cancer case identification [25, 26].

The estimated incidence data in this study exhibit a noteworthy resemblance to the corresponding data in the Globocan database (2018) concerning breast, colon, and prostate cancer. This is despite variations in the severity of the disease, differences in healthcare systems among countries, as well as the study's design and limitations [27]. Notably, discrepancies of approximately 10% were observed for these cancer types.

It is important to note that for colon cancer, this study employed ICD-10 code C18 (colon cancer), while the Globocan database encompasses all data related to the codes C18 to C21 (Colorectum). Research indicates that colon cancer (C18) accounts for 60.9% of all bowel cancers (C18 to C21) [27]. Therefore, a corresponding correction was applied to address this.

Substantial differences in incidence estimates were observed for lung cancer. In this study, the ICD-10 diagnosis code C34 was used for lung cancer [28], whereas the Globocan database incorporates the codes ICD-10 C33-C34. However, ICD-10 diagnosis code C34 represents 99% of respiratory system cancers, thus negating any significant impact on our study results.

In addition, due to the non-timely submission of oncological patients claims from Public Hospitals to EOPYY, an approximate "correction" was applied to account for the observed "reduction" in newly diagnosed lung cancer patients related to the non-submitted patient costs.

The deviation observed in incidence estimates for lung cancer (6,605 vs. 9,964) might be attributed to the fact that a high percentage of patients with Non-Small Cell Lung Cancer NSCLC and stage IV lung disease aged over 65 years appeared to have not received treatment, according to Ganti et al [29]. Age serves as a critical risk factor for lung cancer, with an increased prevalence of the disease among the elderly [30]. Moreover, according to the literature, lung cancer patients are diagnosed with metastatic disease in 40-50% of cases [31], resulting in a median survival of less than nine months [32]. These factors may contribute to underestimating the incidence of lung cancer in Greece compared to the Globocan database, as many cases of patients with lung cancer may be left untreated.

This retrospective study relies on the collection from administrative sources, which may contain undetected coding errors/deficiencies in diagnostic and therapeutic procedures. Consequently, the analysis could underestimate the total number of cancer patients currently undergoing treatment, providing a conservative or baseline scenario for future analyses.

In general, the observed differences can also attributed to the inherent dissimilarities between the two methodologies being compared. This study utilizes administrative data, while the Globocan data are derived from estimates of morbidity (incidence) and mortality obtained from neighbouring countries with established national cancer registries. This might not be representative of Greece [7].

Furthermore, in this study, the discrepancies in incidence estimates could be explained considering that, the identification of patients is affected by the quality of the data and the criteria/hypotheses applied to the algorithm, which in our case is based on medico-pharmaceutical claims.

Specifically, the initial diagnosis of the patient's disease (ICD-10) is not recorded in the EOPYY database and thus the initial diagnosis code is indirectly extracted from the first chronologically registered health service out of the total of services provided per patient. However, this does not

necessarily mean that this is actually the initial diagnosis as there could be cases of "loss" in the private sector funded by households' budgets.

Another limitation of the study is that there could be some cases with incorrect classifications of initial diagnosis code, particularly in cases of disease metastases or final stages of cancer where only palliative care medication is administered [33]. These erroneous ICD-10 codes cannot be identified and corrected in the system, potentially leading to inaccuracies in incidence estimation. Furthermore, under-diagnosis, under-reporting, or under-registration of patient cases, especially in remote areas of Greece, may result in an underestimation of cancer incidences.

Finally, the "non-timely" submission of cancer patients' claims from Public Hospitals to EOPYY an additional challenge to accurately recording the total cases of oncological patients.

In line with findings from other studies, our study demonstrates that the largest number of patients per cancer type occurs in men, with the exception of breast cancer [34]. Worldwide, colon and lung cancers are the most frequently diagnosed types of cancer among adults aged 65 years and older [35].

A high incidence of prostate cancer patients is recorded in Epirus region which is justifiable given its relatively high proportion of aging population [36]. Notably, an increase in lung cancer cases has been documented in the region of Western Macedonia, likely attributable to the environmental contamination within these areas [37]. Furthermore, differences were also identified across geographic regions concerning patients residences. Specifically, low cancer incidence rates were observed in remote areas (Central Greece, North and South Aegean). This phenomenon could be elucidated by two factors: a) potential under-diagnosis in these remote regions in contrast to more urbanized areas such as Attica and Central Macedonia, and b) the practice of some patients declaring their place of treatment as their permanent residence, even when their actual region of residence differs. It is crucial to highlight that in the current study the identification/mapping of patients was feasible to a significant extent due to security's (EOPYY's) comprehensive coverage of 100% of the cost of antineoplastic health services (which encompasses at least medications and radiotherapy in both the public and private sectors) and the vast majority of patients utilizing this healthcare benefit. In contrast to other studies that sample a specific population, such as cancer patients admitted to a particular hospital, hospital, and extrapolate their findings to the entire cancer patient population, this study derives its data (for the four cancer types) from the total population, thereby producing more reliable results. The methodological approach employed followed in this study holds added value particularly for Greece, where a National Registry of Neoplasms operates non-systematically [8]. Given the absence of a Greek Registry of Neoplasms, further studies are warranted to validate/ensure the consistency of the analysed data.

## CONCLUSION

Our findings demonstrate the feasibility of employing administrative data to identify newly diagnosed cancer patients over a specific time frame from the standpoint of the Greek Social Security Funds. This methodological approach is deemed imperative for epidemiological purposes, enhancing healthcare services for cancer patients, and evaluating the efficiency of health expenditures. The establishment of a national cancer registry, seamlessly integrated with the EOPYY database, emerges as a pivotal imperative to enhance the effectiveness and efficiency in the management of cancer diseases.

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