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Assessing the magnitude of surveillance bias in prostate cancer, melanoma and lung cancer

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ABSTRACT

Background: Changes in cancer incidence can result from changes in screening and diagnostic practices rather than changes in the true occurrence of cancer, leading to surveillance bias. Quantitative approaches to estimate this bias are lacking.
Objectives: To develop an approach to estimate surveillance bias in prostate cancer, melanoma, and lung cancer.
Methods: We used population-based data from Swiss cancer registries on incidence and mortality from 1989 to 2021. Age-standardized incidence was analyzed using Joinpoint regression to identify periods with distinct trends. The same periods were used to segment mortality trends. The magnitude of surveillance bias was assessed for each period by computing the absolute normalized difference between the mean annual changes in age-standardized incidence and mortality rates, since mortality is less affected by screening and diagnostic practices than incidence. Larger differences indicated greater bias. We defined three cut-offs to categorize the bias into low, moderate and high. Analyses were also conducted by cancer stage.
Results: Our estimator of surveillance bias for prostate cancer points to a high bias in 1989–2004 (absolute normalized difference= 5%), low in 2004–2011 (absolute normalized difference = 0.3%), and high in 2011–2014 and 2014–2021 (absolute normalized difference = 6% and 5%). For melanoma, the bias was high from 1989 and 2003 and moderate between 2003 and 2021 (absolute normalized difference = 5.5% and 1.6%). For lung cancer, it was low over the entire study period (absolute normalized difference = 0.5%). In stage-specific analyses, surveillance bias was greater for early-stage than advanced-stage cancers.
Conclusions: We estimated surveillance bias using a simple approach that can be used in daily monitoring activities. Further studies are needed to refine these estimates.

1. Background

Cancer incidence trends, expressed as age-standardized rates, are used to describe and monitor changes in the background risk of cancer in populations over time. Age-standardization adjust for differences in age distribution and enables comparisons of risk across populations and periods [1]. However, for scrutiny-dependent cancers like prostate cancer or melanoma [2], even after adjusting for age, incidence trends do not reflect changes in cancer risk because they are influenced by changes in screening and detection practices [2]. Such changes can indeed substantially increase or decrease incidence, without any actual change in the risk of developing cancer. Failing to consider the effect of changes in cancer screening and diagnostic practices leads to surveillance bias [3].

Surveillance bias is defined as a bias that occurs when changes across time, settings, or populations in the detection of cancers lead to changes in incidence, which can be wrongly attributed to changes in the actual risk of these cancers [4,5]. It is suspected if there is a marked discrepancy between incidence and mortality trends, or between trends in early and advanced cancer stages, since mortality and incidence of

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advanced-stage cancers are less affected by changes in detection practices [4,6]. These descriptive patterns, also called epidemiological signatures [6], are used to visually suggest the presence of surveillance bias, but there are currently no established methods to quantitatively estimate the magnitude of the bias. Quantitative rather than visual assessment would reduce subjectivity, allow comparisons, improve transparency and reproducibility, and support clearer communication and interpretation of incidence trends by epidemiologists, decision-makers, and the public.

We therefore attempted to develop a method to estimate the magnitude of surveillance bias of prostate cancer, melanoma, and lung cancer. We selected prostate cancer and melanoma because they are considered as scrutiny-dependent cancers for which screening and diagnostic practices have changed considerably over time [2,6–10]. Lung cancer was chosen as a comparator because it is considered to be less scrutiny-dependent [6].

2. Methods

We conducted a population-based study using aggregated data from cancer registries in Switzerland on the incidence and mortality of prostate cancer, melanoma, and lung cancer.

In Switzerland, all new cancer cases, including information on stage at diagnosis, are systematically collected by population-based regional cancer registries and then aggregated by the National Institute for Cancer Epidemiology and Registration (NICER) [11]. Cancer registration coverage has steadily increased over time, reaching approximately 97% of the Swiss population in 2021. A recent report showed high data quality for Swiss cancer registries [12]. For years in which coverage was not nationwide, NICER extrapolated data to provide national estimates [11]. Primary tumors are defined according to the rules of the International Association of Cancer Registries (IACR) and the European Network of Cancer Registries (ENCR). For our analyses, we included all cases of prostate cancer (International Classification of Diseases for Oncology, 3rd edition [ICD-O−3]: C61), melanoma (C43) and cancers of the lung, bronchus, and trachea (C33–34) recorded in the Swiss cancer registries between 1989 and 2021 [13]. Cancer mortality data included deaths attributed to prostate cancer, melanoma or cancers of the lung, bronchus, and trachea, according to the Federal Statistical Office coding of causes of death (coded according to the ICD, Eighth Revision, prior to 1995, and ICD, Tenth Revision, 1995 and later). Before 1995, the Eighth Revision of the ICD was used, and cancer was listed as the cause of death whenever the word “tumor” appeared, either as the primary or associated cause, except when conditions such as accidents, poisoning, trauma, or influenza were also reported on the certificate. Cancer mortality rates before 1995 may therefore be overestimated and should be interpreted with caution [14].

We described trends in age-standardized incidence and mortality rates over time, as well as incidence trends by stage. Age-standardized rates were calculated using the direct method, using the 1976 European standard population [14].

To estimate surveillance bias, we computed the absolute normalized difference between the mean annual changes in age-standardized incidence and mortality rates, under the assumption that mortality is less affected by changes in detection intensity than incidence. The estimation consisted of three steps. First, we used Joinpoint regression assuming constant variance (Joinpoint Regression Statistical Software version 5.3.0.0; Surveillance Research Program, National Cancer Institute, Bethesda, MD) to analyze variations in incidence trends and to identify inflection points that segment the time series into periods with distinct trends. For each period, we calculated the difference between the mean annual change in age-standardized incidence and the mean annual change in age-standardized mortality over the same period. Figure S1 illustrates all possible incidence/mortality patterns and their corresponding difference. Second, because the magnitude of the difference depends on the baseline incidence of each cancer and cannot be directly compared across cancer types, we normalized this difference by dividing it by the age-standardized incidence at the beginning of each period. The normalized difference represents the difference between the mean annual change in incidence and the mean annual change in mortality, expressed as a percentage of the incidence at the beginning of each period. Third, we used the absolute value of the normalized difference because our objective was to quantify the magnitude of the difference in slopes, irrespective of the direction of the trends. The absolute normalized difference represented our quantitative estimate of surveillance bias and was computed using the following formula:

$$\text{Absolute normalized difference} : \frac{|\Delta I - \Delta M|}{I_{Baseline}} \times 100$$

where ΔI is the mean annual change in age-standardized incidence during the period considered, ΔM is the mean annual change in age-standardized mortality during the same period, and $I_{Baseline}$is the age-standardized incidence at the beginning of the period.

Surveillance bias increases as the parallelism between incidence trends and mortality trends decreases, i.e., the larger the absolute normalized difference the greater the bias. To ease the interpretation of our surveillance bias estimator, we arbitrarily defined three cut-offs to categorize it into low, moderate and high bias. An absolute normalized difference of less than 1% corresponded to low bias. An absolute normalized difference from 1% to 5% corresponded to moderate bias. An absolute normalized difference equal or greater than 5% corresponded to high bias. Different thresholds could have been used, but any categorization necessarily involves an a priori choice and requires agreement on what is considered a low or high level of bias. Since changes in incidence may affect mortality after a time lag of several years, we also conducted a sensitivity analysis assuming a 5-year lag for mortality, using prostate cancer as an example. The 5-year lag was chosen for illustration only, to demonstrate how the method can account for a delay between changes in incidence and mortality.

The same analyses were conducted by cancer stage at diagnosis, categorized according to the Union for International Cancer Control (UICC; Stage I, II, III and IV) [15]. Analyses by stage were performed only from 2010 onward, as data on stage at diagnosis was available starting that year. For this analysis, we computed the absolute normalized difference of the mean annual change in age-standardized stage I, II and III incidence and the corresponding mean annual change in age-standardized stage IV incidence, under the assumption that incidence of stage IV cancers is less influenced by the intensity of detection than incidence of stage I, II and III cancers. The absolute normalized difference was computed for each stage using the following formula:

$$\text{Absolutenormalizeddifference} : \frac{\left|\Delta I^{Stage\ I} - \Delta I^{Stage\ IV}\right|}{I^{Stage\ I}_{Baseline}} \times 100$$

where ΔI^{StageI} is the mean annual change in age-standardized Stage I incidence during the period considered, $\Delta I^{StageIV}$ is the mean annual change in age-standardized Stage IV incidence during the same period, and $I^{Stage\ I}_{Baseline}$ is the age-standardized Stage I incidence at the beginning of the period. The same formula was used for Stage II and III, by replacing Stage I with the corresponding stage.

3. Results

3.1. Main analysis

For prostate cancer, three inflection points in the age-standardized incidence trend were identified, segmenting it into four periods: 1989–2004, 2004–2011, 2011–2014, and 2014–2021 (Fig. 1 and Supplementary Table S1). Age-standardized incidence and comparison with age-standardized mortality (difference, normalized difference, and absolute normalized difference) for each period are presented in Table 1.

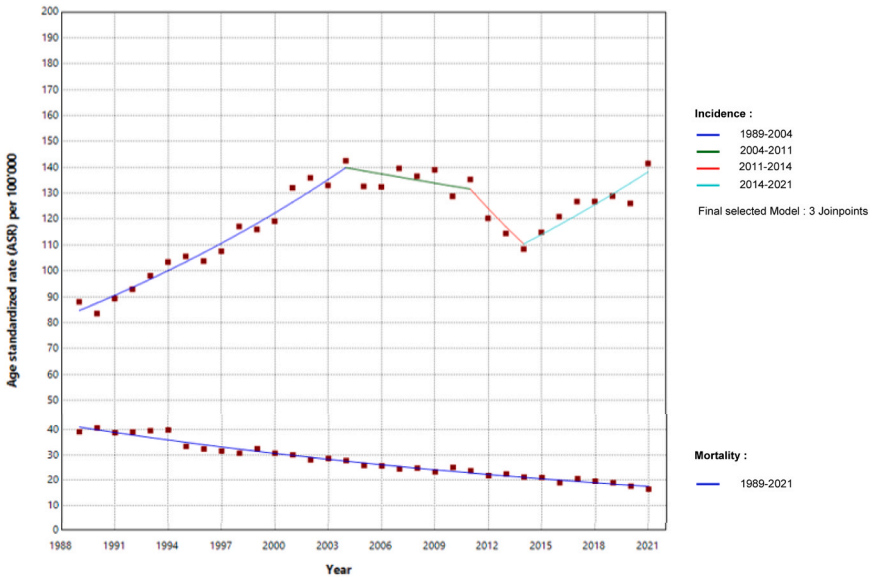

Fig. 1. Prostate cancer age-standardized incidence and mortality rates, all ages, 1989–2021, Switzerland.

Table 1
Age-standardized incidence of prostate cancer, melanoma and lung cancer and comparison with age-standardized mortality (difference, normalized difference, absolute normalized difference) by period, 1989–2021.

Absolute normalized difference	Degree of surveillance bias
< 1%	Low surveillance bias
≥1% to < 5%	Moderate surveillance bias
≥ 5%	High surveillance bias

Period [a]	Change in age-standardized incidence (per 100'000)	Change in age-standardized mortality (per 100'000)	Mean annual change in age-standardized incidence (per 100'000)	Mean annual change in age-standardized mortality (per 100'000)	Difference between mean annual change in age-standardized incidence and mortality	Normalized difference	Absolute normalized difference
Prostate cancer							
1989-2004	54.4	-11.5	3.6	-0.8	4.4	5.0%	5.0%
2004-2011	-7.2	-4.1	-1.0	-0.6	-0.5	-0.3%	0.3%
2011-2014	-26.9	-2.5	-9.0	-0.8	-8.1	-6.0%	6.0%
2014-2021	33.1	-4.9	4.7	-0.7	5.4	5.0%	5.0%
Melanoma							
1989-2003	9.4	-0.5	0.7	-0.04	0.7	5.5%	5.5%
2003-2021	6.2	-0.4	0.3	-0.02	0.4	1.6%	1.6%
Lung cancer							
1989-2021	-3.9	-11.2	-0.1	-0.4	0.2	0.5%	0.5%

Periods were defined analyzing incidence trends using Joinpoint regression; the same periods were used for mortality Note: minor discrepancies between displayed and calculated values are due to rounding, as all calculations were performed using unrounded values .

Age-standardized incidence of prostate cancer increased from 1989 to 2004, declined between 2004 and 2011, and dropped more sharply from 2011 to 2014. From 2014–2021, the incidence rose again. Mortality consistently decreased over the entire period. Our surveillance bias estimator points to a high bias between 1989 and 2004 (absolute normalized difference: 5.0%), low between 2004 and 2011 (absolute normalized difference: 0.3%) and high from 2011 onwards (absolute normalized difference: 6.0% between 2011–2014 and 5.0% between 2014 and 2021).

For melanoma, one inflection point was identified, segmenting the age-standardized incidence trend into two periods: 1989–2003 and 2003–2021 (Fig. 2 and Supplementary Table S1). Age-standardized incidence and comparison with age-standardized mortality (difference, normalized difference, and absolute normalized difference) are presented in Table 1. Age-standardized incidence of melanoma increased from 1989 to 2003. Between 2003 and 2021, the growth in incidence slowed but continued. Mortality remained relatively stable over both periods. Our surveillance bias estimator points to a high bias from 1989 to 2003 (absolute normalized difference: 5.5%) and moderate between 2003 and 2021 (absolute normalized difference: 1.6%).

For lung cancer, no inflection points in the age-standardized incidence trend were identified, indicating a continuous trend from 1989 to 2021 (Fig. 3 and summarized in Supplementary Table S1). Age-standardized incidence and comparison with age-standardized mortality (difference, normalized difference, and absolute normalized difference) are presented in Table 1. Age-standardized incidence showed a

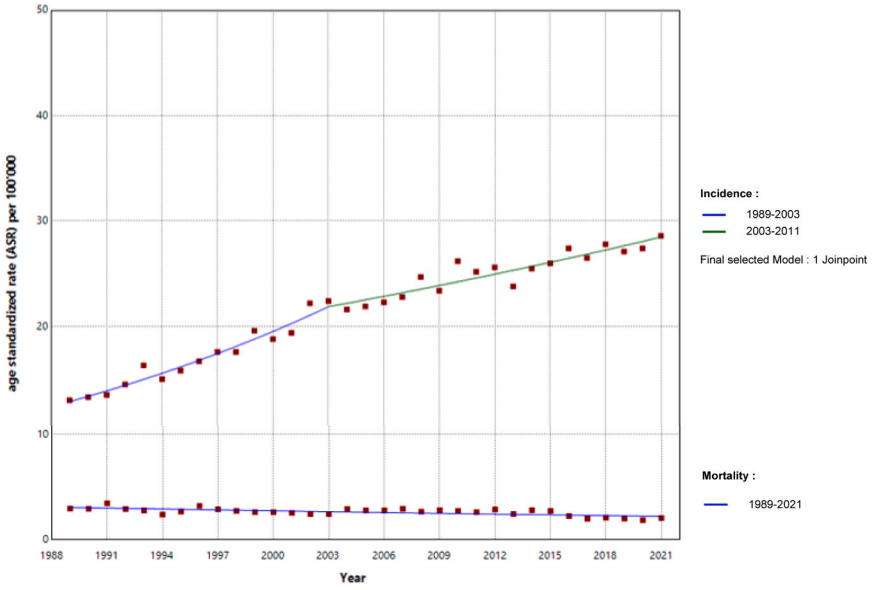

Fig. 2. Melanoma age-standardized incidence and mortality rates, both sexes, all ages, 1989–2021, Switzerland.

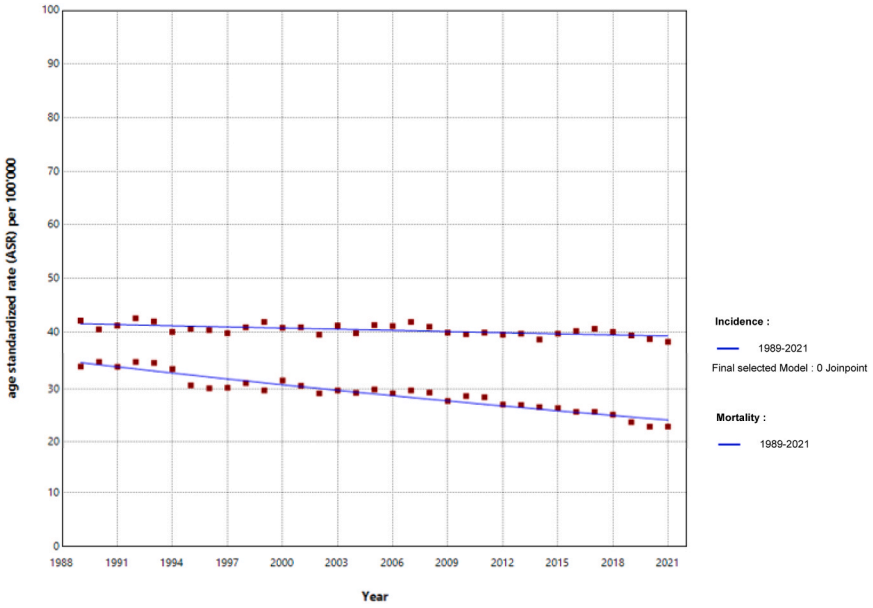

Fig. 3. Lung cancer age-standardized incidence and mortality rates, both sexes, all ages, 1989–2021, Switzerland.

slight decline between 1989 and 2021, and mortality also decreased. Our surveillance bias estimator points to a low bias (absolute normalized difference: 0.5%) throughout the entire period.

The sensitivity analyses using a 5-year lag for prostate cancer mortality yielded similar results to the main analyses and are shown in **Table S2**.

3.2. Stage specific analyses

The results of the Joinpoint regression stratified by stage are shown in supplemental Figures S2-S13. Overall, our estimator of surveillance bias tended to be greater for cancers diagnosed at earlier stages (Stage I and II) than for Stage III cancers, across the three cancer types.

For prostate cancer (Table 2), Stage I incidence declined from 2010 to 2015 and then increased from 2015 to 2021. Stage II incidence showed a decrease between 2010 and 2014, followed by an increase from 2014 to 2017 and a smaller increase between 2017 and 2021. For Stage III, incidence decreased from 2010 to 2014 before slightly increasing from 2014 to 2021. Stage IV incidence slightly increased from 2010 to 2014 and increased from 2014 to 2021. Surveillance bias for Stage I was high between 2010 and 2015 and moderate from 2015 to 2021. Stage II had high surveillance bias between 2010 and 2014 and between 2014 and 2017 and low between 2017 and 2021. For Stage III, surveillance bias was high between 2010 and 2014 and low from 2014 to 2021.

For melanoma (Table 3), Stage I incidence increased between 2010 and 2021. Stage II incidence remained relatively stable between 2010 and 2021. For Stage III, incidence showed a modest increase between 2010 and 2021, and, for stage IV, incidence remained stable from 2010 to 2019 and increased modestly from 2019 to 2021. Surveillance bias was high for stage I, moderate for stage II and high for stage III over the 2010–2021 period.

For lung cancer (Table 4) Stage I incidence increased between 2010 and 2021. For Stage II, incidence increased slightly between 2010 and

Table 2
Age-standardized prostate cancer incidence by stage and comparison with stage IV incidence (difference, normalized difference, absolute normalized difference) by period, 2010–2021.

Absolute normalized difference	Degree of surveillance bias
< 1%	Low surveillance bias
>1% to < 5%	Moderate surveillance bias
≥ 5%	High surveillance bias

Period [a]	Change in age-standardized incidence (per 100'000)	Change in age-standardized stage IV incidence (per 100'000)	Mean annual change in age-standardized incidence (per 100'000)	Mean annual change in age-standardized stage IV incidence (per 100'000)	Difference between mean annual change in age-standardized incidence and stage IV incidence	Normalized difference	Absolute normalized difference
Stage I							
2010-2015	-11.8	2.2	-2.4	0.4	-2.8	-5.3%	5.3%
2015-2021	14.1	6.2	2.4	1.0	1.3	3.2%	3.2%
Stage II							
2010-2014	-8.5	1.0	-2.1	0.3	-2.4	-7.9%	7.9%
2014-2017	13.6	1.6	4.5	0.5	4.0	18.6%	18.6%
2017-2021	5.7	5.8	1.4	1.5	-0.03	-0.1%	0.1%
Stage III							
2010-2014	-4.6	1.0	-1.2	0.3	-1.4	-7.6%	7.6%
2014-2021	6.5	7.4	0.9	1.1	-0.1	-0.9%	0.9%
Stage IV							
2010-2019	4.0	4.0	0.4	0.4	NA	NA	Ref
2019-2021	4.4	4.4	2.2	2.2	NA	NA	Ref

Periods were defined analyzing incidence trends for each stage using Joinpoint regression; the same periods were used for Stage IV incidence Note: minor discrepancies between displayed and calculated values are due to rounding, as all calculations were performed using unrounded values.

Table 3
Age-standardized melanoma incidence by stage and comparison with stage IV incidence (difference, normalized difference, absolute normalized difference) by period, 2010–202.

Absolute normalized difference	Degree of surveillance bias
< 1%	Low surveillance bias
>1% to < 5%	Moderate surveillance bias
≥ 5%	High surveillance bias

Period [a]	Change in age-standardized incidence (per 100'000)	Change in age-standardized stage IV incidence (per 100'000)	Mean annual change in age-standardized incidence (per 100'000)	Mean annual change in age-standardized stage IV incidence (per 100'000)	Difference between mean annual change in age-standardized incidence and stage IV incidence	Normalized difference	Absolute normalized difference
Stage I							
2010-2021	12.4	0.3	1.1	0.003	1.1	10.0%	10.0%
Stage II							
2010-2021	0.7	0.3	0.1	0.003	0.1	3.0%	3.0%
Stage III							
2010-2021	0.9	0.3	0.1	0.003	0.1	7.4%	7.4%
Stage IV							
2010-2019	0.03	0.03	0.003	0.003	NA	NA	Ref
2019-2021	0.3	0.3	0.1	0.1	NA	NA	Ref

Periods were defined analyzing incidence trends for each stage using Joinpoint regression; the same periods were used for Stage IV incidence Note: minor discrepancies between displayed and calculated values are due to rounding, as all calculations were performed using unrounded values.

2013, then declined between 2013 and 2019, with a further decrease from 2019 to 2021. For Stage III and Stage IV, incidence remained stable between 2010 and 2021. Surveillance bias for Stage I was high over the 2010–2021 period. For Stage II, surveillance bias was moderate between 2010 and 2013, low between 2013 and 2019, and high from 2019 to 2021. For Stage III, surveillance bias was low between 2010 and 2021.

4. Discussion

To our knowledge, this is the first attempt to quantitatively assess surveillance bias of various cancers. Using nationwide population-based data, we found that surveillance bias of prostate cancer changed substantially since 1989, being high between 1989 and 2004, low between

Table 4
Age-standardized lung cancer incidence by stage and comparison with stage IV incidence (difference, normalized difference, absolute normalized difference) by period, 2010–2021.

Absolute normalized difference	Degree of surveillance bias
< 1%	Low surveillance bias
>1% to < 5%	Moderate surveillance bias
≥ 5%	High surveillance bias

Period [a]	Change in age-standardized incidence (per 100'000)	Change in age-standardized stage IV incidence (per 100'000)	Mean annual change in age-standardized incidence (per 100'000)	Mean annual change in age-standardized stage IV incidence (per 100'000)	Difference between mean annual change in age-standardized incidence and stage IV incidence	Normalized difference	Absolute normalized difference
Stage I							
2010-2021	3.9	-0.2	0.4	-0.02	0.4	7.8%	7.8%
Stage II							
2010-2013	0.7	0.8	0.2	0.3	-0.04	-1.6%	1.6%
2013-2019	-0.4	-0.3	-0.1	-0.04	-0.02	-0.6%	0.6%
2019-2021	-0.5	-1.5	-0.3	-0.8	0.5	17.5%	17.5%
Stage III							
2010-2021	-0.2	-0.2	-0.02	-0.02	-0.01	-0.1%	0.1%
Stage IV							
2010-2021	-0.2	-0.2	-0.02	-0.02	NA	NA	Ref

Periods were defined analyzing incidence trends for each stage using Joinpoint regression; the same periods were used for Stage IV incidence Note: minor discrepancies between displayed and calculated values are due to rounding, as all calculations were performed using unrounded values.

2004 and 2011, and high between 2011 and 2021 in Switzerland. The bias was high for melanoma between 1989 and 2003 and moderate between 2003 and 2021. For lung cancer, surveillance bias was low. In stage-specific analyses, surveillance bias tended to be greater for cancers diagnosed at earlier stages than for those diagnosed at advanced stages.

The observed patterns of surveillance bias are consistent with changes in incidence due to changes in screening and scrutiny intensity in Switzerland. For prostate cancer, the initial increase in the incidence in the 1990s coincided with the introduction of PSA testing [16]. After 2003, a decline occurred, coinciding with the retrenchment of PSA testing, and incidence trends aligned with mortality trends, resulting in a low degree of surveillance bias. A more pronounced decrease was observed after 2011, following updated guidelines that discouraged PSA use, notably guidelines from the Swiss Medical Board [17]. More recently, incidence has started to rise again, likely due to a combination of increased intensity of PSA testing, enhanced diagnostic sensitivity, or the long-lasting effects of periods with high rates of PSA testing [16]. For melanoma, despite no changes in screening recommendations, early diagnosis has probably increased over time in Switzerland, influencing incidence and resulting in consistently relatively high surveillance bias [18,19]. For lung cancer, surveillance bias was lower than for the other two cancers because incidence trends largely reflect smoking patterns rather than changes in scrutiny intensity [4]. These smoking-related patterns are clear when stratifying by sex, with both incidence and mortality declining among men and increasing among women [4].

Several factors beyond screening influence both incidence and mortality trends and have effects on our estimates of the degree of surveillance bias. First, changes in diagnostic practices can induce surveillance bias by increasing the detection of cancers without necessarily reflecting changes in the underlying disease occurrence. Second, improvements in treatment, which do not generate surveillance bias, but reduce mortality independently of incidence and therefore may influence our surveillance bias estimator. In prostate cancer, for instance, diagnostic and therapeutic practices have evolved significantly, with increasing use of magnetic resonance imaging, active surveillance for low-risk cases, and, more recently, imaging modalities such as prostate-specific membrane antigen positron emission tomography and genetic testing [7,20,21]. Similarly, the diagnostic landscape for melanoma is changing, with advances in non-invasive imaging and molecular techniques such as fluorescence in situ hybridization, comparative genomic hybridization, sequencing, mass spectrometry, and immunohistochemistry being increasingly used to refine diagnosis and classification [22,23]. Moreover, new technologies such as artificial intelligence tools are likely to further change strategies for the detection and management of cancer in the near future, highlighting the need for new estimates [24,25]. Moreover, it has to be considered that screening strategies are also continuing to change. For instance, lung cancer detection may evolve in the coming years: although no national lung cancer screening program currently exists in Switzerland, from 2024 a pilot project is underway in the Canton of Vaud, and its expansion may impact future incidence rates [26–28].

This study has several limitations. First, our approach relies on the assumption that incidence and mortality should move in parallel, meaning that an increase or decrease in true cancer occurrence should result in a proportional change in mortality, unless biased by changes in detection intensity. The same assumption holds for surveillance bias estimates based on the discrepancy between early- and advanced-stages. However, a major limitation of our method is that this assumption does not hold in all cases, as mortality trends are influenced by factors such as improvements in treatment. For instance, if incidence remains stable while mortality declines due to better therapies, the two trends will diverge, but this does not indicate surveillance bias. However, when incidence changes rapidly and substantially, the discrepancy with mortality, whatever its trends, suggests surveillance bias. The same is true when early-stage incidence changes rapidly and substantially without substantial changes in advanced-stage incidence [4]. Second, we calculated surveillance bias by comparing incidence and mortality changes over the same periods, even though changes in incidence may affect mortality after a time-lag of years. In sensitivity analysis we applied a 5-year time lag, showing how the method can account for this delay, but it's difficult to estimate an exact time lag for different types of cancer. Third, NICER extrapolated data to provide national estimates for years in which the registry coverage was not nationwide [11]. Some degree of inaccuracy in these estimates, especially in earlier years,

cannot be excluded.

One strength of this study is that it is based on population-level data spanning a long observation period, during which substantial changes in screening and diagnostic practices occurred. It also includes multiple cancer types, allowing for comparisons across different contexts. Another strength is that it provides a simple quantitative approach that can be used in daily monitoring activities and that goes beyond the graphical and descriptive analyses typically used to illustrate the presence of surveillance bias. Nonetheless, we do not believe that these quantitative estimates should be used in isolation. Rather, they are intended to complement graphical analyses, prompting a more critical interpretation of observed trends of cancer and highlighting the effect of changing scrutiny intensity. For example, if an incidence trend is accompanied by a label indicating high surveillance bias, this may encourage consideration of whether changes in detection intensity or screening practices could have contributed to the observed pattern. Moreover, it is worth noting that some approaches have already been developed to adjust incidence trends for changes in screening and detection practices, or to distinguish temporal patterns that may reflect the impact of screening/diagnostic practices from those potentially related to underlying risk factors on cancer incidence [29,30]. For example, some models use secular trends that reflect incidence in the absence of screening [31], others use changes in the distribution of cancer stages over time, assuming that without changes in detection practices the stage distribution remains approximately constant [32], and age–period–cohort analyses can be used to assess the effects of changes in screening and diagnostic practices on incidence [30]. However, these methods do not provide direct estimates of the magnitude of surveillance bias. Although not precise and hindered by several limitations, our method could be a starting point for estimating potential surveillance bias and offers a practical framework that can be adapted and expanded using more sophisticated data and modeling strategies.

5. Conclusion

This study provided quantitative estimates of surveillance bias for cancers with different degrees of scrutiny dependency. Although the method used to assess the magnitude of the bias has limitations, it represents an initial and exploratory step toward more precise methods for quantifying surveillance bias. Finding a way to quantitatively assess surveillance bias and integrating this information into the interpretation of incidence trends is important for correctly understanding cancer incidence and for guiding public health decisions.

Ethical approval

This study was based on anonymized cancer registration data and did not require formal ethical approval as it did not fall under the Swiss Human Research Act.

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The authors conducted this study within their regular working contracts; no additional funding was obtained for the study.

CRediT authorship contribution statement

Axelle Braggion: Writing – review & editing. **Stéphane Cullati:** Writing – review & editing. **Bernadette W.A. van der Linden:** Writing – review & editing. **Stefano Tancredi:** Writing – original draft, Visualization, Methodology, Formal analysis, Data curation, Conceptualization. **Arnaud Chiolero:** Writing – review & editing, Supervision, Methodology, Formal analysis, Conceptualization.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT to check the English grammar and readability. After using this tool/service, the authors reviewed and edited the content as necessary and take full responsibility for the content of the publication.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ejca.2026.116942.

Data availability

All data used in this work are held by the Swiss National Institute for Cancer Epidemiology and Registration (NICER) and the Swiss Federal Statistical Office (SFSO). The contracts with these entities preclude the direct sharing of the original data by the authors. Data can be obtained through direct request to NICER for cancer registration data and the SFSO for mortality data, respectively.

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