Original Article

Interest in mammography across European countries: a retrospective "Google Trends" comparative study

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Background: Breast cancer is currently the most prevalent and impacting cancer among women and mammography has been recommended for screening by The European Commission Initiative on Breast Cancer since 2003. The objective of this study is to estimate the interest in breast cancer screening breast cancer in European countries by analyzing data from online searches for the term "mammography" obtained via Google Trends.

Methods: The relative search volumes (RSVs) of the term "mammography" translated into various languages and relating to the January 2010–December 2022 period were downloaded from Google Trends. The between-countries differences growth of interest was estimated by a regression model in which the country-time interaction term was introduced.

Results: France [coefficient (coeff): 0.23; 95% confidence interval (CI): 0.18–0.28], United Kingdom (coeff: 0.22; 95% CI: 0.18–0.27) and Germany (coeff: 0.21; 95% CI: 0.16–0.25) showed the higher growth in mammography interest when compared to the average growth. The lowest growths were observed in Eastern European countries: Croatia (coeff: –0.13; 95% CI: –0.18 to –0.09), Serbia (coeff: –0.14; 95% CI: –0.18 to –0.09), Greece (coeff: –0.14; 95% CI: –0.18 to –0.09), Slovenia (coeff: –0.15; 95% CI: –0.2 to –0.11) and Bosnia-Herzegovina (coeff: –0.15; 95% CI: –0.2 to –0.11).

Conclusions: These exploratory findings suggest that online interest in mammography is lower in countries with lower screening coverage and higher breast cancer mortality. These countries could adopt strategies to raise awareness of breast cancer prevention.

Keywords: Mammogram; mammography; breast cancer; Google Trends; infodemiology

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Introduction

Breast cancer is currently the most widespread and impacting tumor among women, with an incidence rate of more than 500,000 cases/year in Europe (1). In Western Europe the incidence and mortality of breast cancer decreased in recent decades. However, in many Eastern European countries such as Romania, Poland, Bulgaria, Latvia, and Slovakia the mortality trend increased (2).

Mammography is the most common diagnostic tool to rule out breast cancer. This technique requires exposure to low ionizing radiation dose and it is highly effective in detecting of early stages of breast cancers, also thanks to the excellent sensitivity in demonstrating breast calcifications (3,4).

Nowadays, undergoing mammography is suggested by structured screening programs integrated into the routine healthcare or following specific clinical requests (5,6).

The European Commission Initiative on Breast Cancer (ECIBC) released the first recommendations in 2003 regarding an organized mammography screening program for early detection of breast cancer in asymptomatic 50–69 years old women (7). Despite recommendations, in the last decades the adherence to breast cancer screening has been highly uneven across European countries (8).

In the last decade, the number of Google searches for certain keywords has been used as an indicator of interest in topics related to public health, like diseases or prevention tools, allowing to explain people's behavior and predict future choices accordingly (9-13). In this regard, Google Trends (https://trends.google.com/) is a publicly available website used to compare the volume of Web search queries in different periods being one of the most used tools in digital epidemiologic studies. More precisely, Google Trends detects the number of searches made in a certain unit of time (e.g., daily, weekly or monthly) over a certain period of interest, and reports the values of the time series as relative search volume (RSV), which is the percentage of the highest value in the series (14).

For instance, several studies have applied Google Trends to gauge interest in breast cancer in a particular country, or in October (World Breast Cancer Awareness Month) or during the coronavirus disease 2019 (COVID-19) pandemics (9,15-18).

However, to our knowledge, there is no study in the literature that compares the trend of online interest in mammography across European populations. Therefore, the main objective of this study was to compare the trajectories of interest in mammography over the last decade in different European countries, and to understand whether they can at least partially mirror the differences in screening coverage and mortality. We present this article in accordance with the RECORD reporting checklist (19) (available at https://qims.amegroups.com/article/view/10.21037/qims-23-196/rc).

Methods

Google Trends data were collected on December 15th. The standardized number of monthly searches (RSV) for the term "mammography" was searched for each European country in the local dominant language selecting the time span since January 2010 to December 2022. States where an official or dominant language could not be identified, and where the number of searches was too low, were not included in the study. The translation of the term "mammography" was carried out using the "Google Translate" tool (https://translate.google.com/). Each translation was validated by verifying its face validity by interviewing women of an adequate cultural level and inhabitants of each country included in the study.

Data analysis

The trajectory of the data of interest towards mammography was estimated by simple linear regression for each country included in the study and the presence of a monotonic time trend was assessed by Mann-Kendall test. To visually compare differences in time trends, each country's intercept was subtracted from the data and regression curves with the same source were graphed. To investigate differences of temporal trends a linear regression model was used in which the number of monthly visits was the dependent variable, while country, time and the country-time interaction were the independent variables. The average trend of the 21 countries included in the study was used as the reference category in the regression model. A first-order autoregressive correlation was assumed to account for within-country clustering.

Results

The following 21 countries and related search terms were introduced in the study: Austria ("Mammographie"), Belgium ("Mammographie"), Bosnia-Herzegovina ("Mamografija"), Croatia ("Mamografija"), Denmark ("Mammografi"), Finland ("Mammography"), France

("Mammographie"), Germany ("Mammographie"), Greece ("Μαστογραφία"), Hungary ("Mammográfia"), Ireland ("Mammogram"), Italy ("Mammografia"), Netherlands ("Mammografie"), Russia ("Маммография"), Serbia ("Mamografija"), Slovakia ("Mamografia"), Slovenia ("Mamografija"), Spain ("Mamografia"), Sweden ("Mammografi"), Turkey ("Mamografi"), United Kingdom ("Mammogram"). Country-specific time-series graphs are reported in Figure S1. All countries showed a significant increasing monotonic trend (Mann-Kendall test: $P<0.05$; *Figure 1*). The main effects of time and country and the time-country interaction coefficients (coeff) of the regression model are reported in *Table 1*.

France (coeff: 0.23; 95% CI: 0.18–0.28), United Kingdom (coeff: 0.22; 95% CI: 0.18–0.27) and Germany (coeff: 0.21; 95% CI: 0.16–0.25) showed the higher growth in mammography interest when compared to the average growth. Interest in mammography has grown significantly more than average also in Sweden (coeff: 0.14; 95% CI: 0.09–0.18), Spain (coeff: 0.13; 95% CI: 0.08–0.17), Italy (coeff: 0.12; 95% CI: 0.07–0.17), Hungary (coeff: 0.10; 95% CI: 0.05–0.14) and Finland (coeff: 0.08; 95% CI: 0.03–0.12). Conversely, Belgium (coeff: −0.02; 95% CI: −0.07 to 0.02), Ireland (coeff: −0.02; 95% CI: −0.07 to 0.02), Netherlands (coeff: −0.04; 95% CI: −0.09 to 0.00) and Denmark (coeff: −0.04; 95% CI: −0.09 to 0.00) had a slope that was not significantly different from the mean slope. Finally, a lower than average increase in Google Searches for mammography was found in 9 countries, most of which in Eastern Europe: Turkey (coeff: −0.08; 95% CI: −0.12 to −0.03), Austria (coeff: −0.09; 95% CI: −0.14 to −0.05), Russia (coeff: −0.1; 95% CI: −0.15 to −0.05) , Slovakia (coeff: −0.11; 95% CI: −0.16 to −0.06), Croatia (coeff: −0.13; 95% CI: −0.18 to −0.09), Serbia (coeff: −0.14; 95% CI: −0.18 to −0.09), Greece (coeff: −0.14; 95% CI: −0.18 to −0.09), Slovenia (coeff: −0.15; 95% CI: −0.2 to −0.11) and Bosnia-Herzegovina (coeff: −0.15; 95% CI: −0.2 to −0.11).

Discussion

While breast cancer is universally recognized as the most widespread and impacting tumor for Western women, interest in mammography screening showed an inhomogeneous growth rate across Europe. More precisely, here we demonstrated that the online interest has increased more among English, German, and French women over the last ten years, while in Eastern European countries, the Google search trajectory was almost horizontal. It is important to note that these differences, at least in part, mirror a trend observed in mammography screening adherence.

According to a recent study by Zielonke *et al.*, in the recommended age group (50–69 years old), a total (organized and opportunistic) screening coverage of 49% in Eastern Europe, 62% in Western Europe, 64% in Northern Europe to 69% in Southern Europe have been reported (8).

Russian Federation, Bulgaria, Greece, Czech Republic and Slovak Republic were reported to be the only countries where population-based breast cancer screening programs were lacking (20). This issue might explain our results since that these countries showed the lowest slopes of interest as reported in the present study.

Breast cancer mortality is perhaps even more complex to predict than screening coverage, with several confounding socioeconomic factors involved (21-23). The results of the present study might be linked to the trend of mortality rates. A recent study identified four clusters of breast cancer mortality. Cyprus, Greece, Luxembourg, Poland, Romania, Serbia, Slovakia, and Slovenia were included in the cluster of countries with increased mortality (21). Conversely, the countries with the greatest increase in online interest in mammography, such as France, Germany, United Kingdom, Sweden, Spain, were classified into the cluster with a high mortality decline. However, in the latter cluster, there were also countries (Netherlands, Belgium, Denmark, Ireland) showing lower growth of online interest (21).

The main contribution of this study was the identification of European countries where women had lower interest in breast cancer prevention over the period 2010–2022. We have also demonstrated that detected trajectories can potentially contribute to predict mortality. However, as other studies have shown, using Google Trends data can be an interesting, promising, and fast indicator but should not replace traditional cancer surveillance systems or mortality rates. The Google Trends data actually refer to searches that are launched by subjects whose motivations and socio-demographic characteristics are unknown (24). However, it is also true that the observable trends and the future predictions that we can derive from these data can provide useful information to support the development of public health strategies and interventions. These results of the present study, for instance, suggest that countries showing less interest in mammography should implement and/or better communicate public breast cancer screening programs as soon as possible. Indeed, increasing awareness about the recommended screening programs, such as

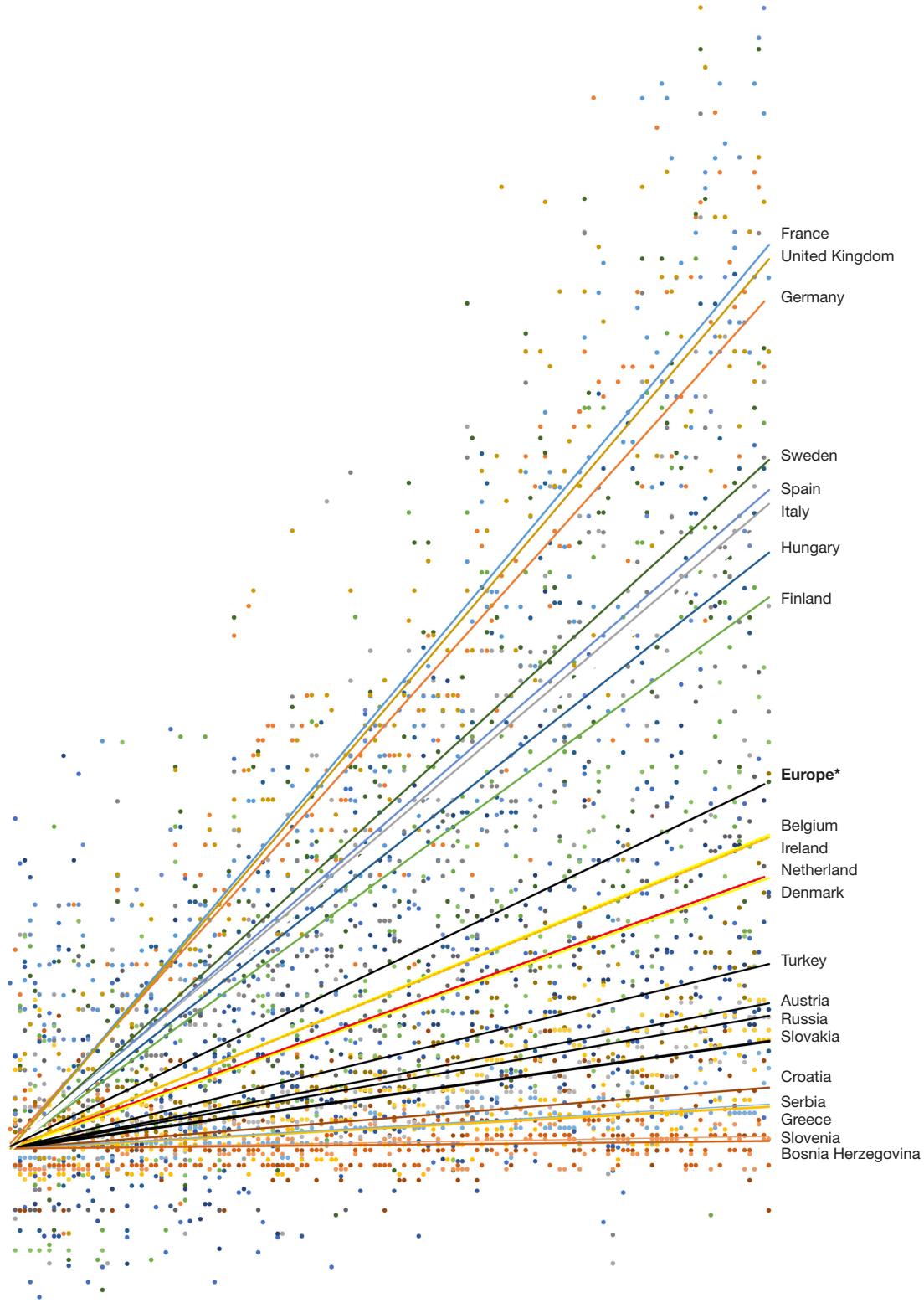

Figure 1 Country-specific regression curves of mammography Google Trend searches in the January 2010–December 2022 period. The slopes were centered by subtracting country-specific intercepts to facilitate between-countries comparison. *, average slope of the included countries.

Table 1 Linear regression model results for differences in growth of online interest in mammography across European countries

	Coefficient	95% CI	P
Country			
Austria	1.72	−2.45 to 5.88	0.42
Belgium	−7.06	−11.23 to −2.90	0.00
Bosnia-Herzegovina	−10.06	−14.22 to −5.89	0.00
Croatia	−6.97	−11.13 to −2.80	0.00
Denmark	8.62	4.45 to 12.78	0.00
Finland	10.46	6.30 to 14.62	0.00
France	−3.35	−7.51 to 0.82	0.12
Germany	18.57	14.40 to 22.73	0.00
Greece	−9.39	−13.55 to −5.23	0.00
Hungary	6.52	2.36 to 10.68	0.00
Ireland	−4.45	−8.62 to −0.29	0.04
Italy	14.52	10.36 to 18.69	0.00
Netherlands	17.97	13.81 to 22.13	0.00
Russia	−9.05	−13.22 to −4.89	0.00
Serbia	−10.52	−14.68 to −6.35	0.00
Slovakia	−9.96	−14.12 to −5.79	0.00
Slovenia	−9.76	−13.93 to −5.60	0.00
Spain	−13.50	−17.66 to −9.34	0.00
Sweden	15.43	11.27 to 19.60	0.00
Turkey	−8.31	−12.48 to −4.15	0.00
United Kingdom	8.57	4.41 to 12.74	0.00
Time (months)	0.16	0.12 to 0.19	0.00
Country * time			
Austria	−0.09	−0.14 to −0.05	<0.001
Belgium	−0.02	−0.07 to 0.02	0.355
Bosnia-Herzegovina	−0.15	−0.2 to −0.11	<0.001
Croatia	−0.13	−0.18 to −0.09	<0.001
Denmark	−0.04	−0.09 to 0.00	0.078
Finland	0.08	0.03 to 0.12	0.001
France	0.23	0.18 to 0.28	<0.001
Germany	0.21	0.16 to 0.25	<0.001
Greece	−0.14	−0.18 to −0.09	<0.001
Hungary	0.1	0.05 to 0.14	<0.001
Ireland	−0.02	−0.07 to 0.02	0.359
Italy	0.12	0.07 to 0.17	<0.001
Netherlands	−0.04	−0.09 to 0.00	0.070
Russia	−0.1	−0.15 to −0.05	<0.001
Serbia	−0.14	−0.18 to −0.09	<0.001
Slovakia	−0.11	−0.16 to −0.06	<0.001
Slovenia	−0.15	−0.2 to −0.11	<0.001
Spain	0.13	0.08 to 0.17	<0.001
Sweden	0.14	0.09 to 0.18	<0.001
Turkey	−0.08	−0.12 to −0.03	0.001
United Kingdom	0.22	0.18 to 0.27	<0.001

Within-country data correlation was accounted by first-order autoregressive structure. Reference category: Europe (between-country average). CI, confidence interval.

mammography screening, is a very important factor to promote adherence among people and possibly reducing the risk of mortality

Our practical recommendation, in healthcare settings such as those pertaining to prevention, where individuals' awareness, knowledge, and interest are crucial, is to utilize Google Trends data in conjunction with health databases to develop increasingly accurate predictive models of patient behavior. For instance, even basic ARIMA/SARIMA models can provide insights into patients' short to medium-term patterns of activity or trends (25,26).

This study represents, to the best of our knowledge, the first attempt to compare women's interest in mammography across Europe. Future studies will investigate other possible Google queries such as "cancer screening" or "breast cancer" in order to describe the different shades of these disparities.

This study has substantial limitations that require a cautious interpretation of the results. First, we did not include all European countries for the reasons previously described (lack of a dominant language, lack of data from Google Trends). Second, only one language was considered for each country. Due to the high percentage of migrants, it is likely that the term mammography is searched in Google with terms other than those considered

for a specific country. Third, we did not consider possible determinants, such as the diffusion rate of web access, especially in less economically developed countries. Fourthly, merging the extracted Google Trends data to determine the mean European slope may have potentially led to an underestimation of reported P values. This is because the data from each country were included in the reference category of the regression model. As a result, the overall variance was reduced. Nevertheless, it is crucial to emphasize that this effect was minimal, and, most importantly, the study's conclusions remained unchanged. Lastly, these results should be considered exploratory and further and deeper time-series analyses should be conducted abandoning the linearity assumption.

Conclusions

From 2010 onwards, in some countries such as France, the United Kingdom and Germany, there has been an increase of online interest (Google Searches) for mammography. On the other hand, most Eastern European countries have not shown a growth of online interest and had lower screening coverage together with higher breast cancer mortality rate. These latter countries could therefore adopt strategies aimed to increase awareness among women about breast cancer prevention, and implement or improve public health policies targeted to decrease cancer mortality.

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Footnote

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