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Lung cancer and breast cancer mortality trends among European women in the age of 45-74 years old

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Introduction. We aimed to analyze and compare the most up-to-date breast and lung cancer mortality trends in European women aged 45-74.

Material and methods. The data on breast and lung cancer mortality in 1960-2017 were obtained from the World Health Organization Mortality DataBase and Eurostat. To determine mortality trends and generate annual percent change, with 95% confidence intervals, joinpoint regression was applied.

Results. In most European Union (EU) member states (15 out of 28), lung cancer mortality was higher than breast cancer mortality, with either increasing or stable lung cancer mortality trends. In four other EU countries, breast and lung cancer mortality trends in the last reported year were almost equal or equal.

Conclusions. Lung cancer is becoming the leading cause of cancer deaths among European women. There is a need for ensuring women-targeted smoking cessation services to decrease tobacco-attributable lung cancer mortality.

Key words: lung cancer; breast cancer; women; mortality; tobacco; cancer prevention; Europe

Introduction
Breast cancer is the most prevalent female neoplasm worldwide. According to the International Agency for Research on Cancer (IARC), in 2018, globally, 2,261,419 women were diagnosed with breast cancer. Moreover, breast cancer is a leading cause of cancer deaths among women (684,996 deceases in 2018). According to the same global cancer statistics, lung cancer is the third-most-common female neoplasm and the second-most-common cause of female cancer deaths globally, with the number of incident cases at 770,828 and the number of deaths at 607,465 in 2018 [1]. In European Union (EU; state of 2018 with 28 EU member states), breast cancer is still the most prevalent female neoplasm, however, lung cancer is the leading cause of female cancer deaths [2].

While a systematic understanding of breast cancer risk factors is still unsatisfactory, it is already known that about 70-80% of female lung cancer cases are associated exclusively to tobacco smoking [3, 4]. Hence, cancer mortality trends are affected by changes in European tobacco consumption patterns. At the end of the 20th century, tobacco-related mortality decreased among men, and was stable or increased among women [5]. This phenomenon is evident in lung cancer, considered a good proxy for smoking prevalence estimations.

Although mechanisms underpinning cancer prevalence and mortality trends are not fully understood, their changes can be a valuable indicator for policymakers and stakeholders, enabling more tailored and efficient actions aimed at decreasing tobacco consumption in EU and its suitable member states. This study aimed to analyze and compare the most recent female breast and lung cancer mortality trends in 31 European countries.

Material and methods
The presented analysis is an update of the data published in the article by Sulkowska et al. in Nowotwory. Journal of Oncology 2015;65(5):395-403, entitled Lung cancer, the leading cause of cancer
We followed previously applied methodology (including the same age group – 45-74 years old) to enable comparability of the data.

**Source of the data**

The analyzed data were obtained in a hybrid manner. First, we obtained data from the World Health Organization (WHO) Mortality Database (MDB) (data available as of 15th December 2019). The MDB contains the number of deaths by country, year, sex, age group, and cause of death. The cause of death is coded according to the International Classification of Diseases (ICD). We identified all female deaths due to breast and lung cancer registered in the MDB since 1960 in twenty-eight EU member states and three non-member states, namely Norway, Russia, and Switzerland. The included diagnosis codes encompassed lung cancer (162-163 – ICD 7th revision; 162 – ICD 8th and 9th revisions; and C33 and C34 – ICD 10th revision) and breast cancer (170 – 7th revision; 174 – 8th and 9th revisions; and C50 – 10th revision). In case the data for additional (following) years were available in Eurostat, these were also included in our analysis (detailed data sources, by country, by year in table SI). The mid-year population estimates were obtained from WHO MDB and Eurostat.

**Statistical analysis**

Crude annual mortality rates were defined as the number of new deaths per 100,000 person-years. In the denominator, we applied the mid-year population, defined as the population's size on the 31st of June. In all calculations, both the numerator and denominator came from the same data source, viz WHO MDB or Eurostat. To enable comparison with other populations, we performed direct age-standardization for the Segi’s World Standard Population [6]. For Luxembourg and Malta, the mortality rates were calculated as three-year moving averages (deploying preceding and the following year).

To determine mortality trends and to generate annual percent change (APC), with 95% confidence intervals (CI), joinpoint regression was applied [7]. The best-fitting model was selected with permutations tests, with an overall significance level at 0.05 and the number of randomly permuted data sets for permutation set at 4499. Rates were considered to decrease if APC<0 and 95% CI does not contain zero, and to increase if APC > 0 and 95% CI do not contain zero; otherwise, rates were considered stable.

Joinpoint analysis was performed using the Joinpoint Regression Program (version 4.3.1.0, National Cancer Institute, Bethesda, MD, USA).

**Compliance with ethical standards**

According to WHO and Eurostat policies, the analyzed data can be freely used for scientific purposes. This study was conducted according to the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) guidelines [8].

**Results**

Breast and lung cancer mortality trends in 1960-2017, analyzed by EU member states, manifested four different patterns: Group 1 – higher mortality from lung cancer than from breast cancer with increasing mortality trends of lung cancer; Group 2 – higher mortality from lung cancer than from breast cancer with stable or decreasing lung cancer mortality trends; Group 3 – almost equal or equal breast and lung cancer mortality trends in the last reported year; Group 4 – other EU countries (tab. I). Non-EU countries were analyzed separately, as Group 5.

In the vast majority of countries of Group 1, lung and breast cancer mortality trends intersected around 2010. In Poland the intersection occurred in 2004, and in Spain in 2016 (fig. 1A). In Austria, Croatia, Germany, and Slovenia, the increase in lung cancer mortality was constant. In Poland, a very short period of trend stabilization was observed between 1968-1972, and in Luxembourg, lung
cancer mortality decreased between 1971-1974. In Czechia, the trend started stabilizing in 2000. In Spain, in 1990, after years of a plateau, lung cancer mortality started increasing.

In Group 2, time of the lung and breast mortality trends intersection varied widely, e.g., in Denmark it took place in 1991, in Sweden in 2001, and in Ireland in 2012 (fig. 1B). Lung cancer mortality trends were sharply decreasing in Belgium, Denmark, Sweden, and the United Kingdom. In Hungary, Ireland, and the Netherlands the decrease was milder. The onset of decreasing trend for lung cancer mortality ranged from 1980 in Ireland to 2015 in Belgium.

In Group 3, breast and lung cancer mortality trends were almost equal or equal (fig. 1C). In all countries of the group lung cancer mortality increased; however, only in Italy the increase was constant. The trend plateaued in Finland and France in 1962-1974 and in 1960-1977, respectively.

In all countries of Group 4, lung cancer mortality has always been lower than breast cancer mortality (fig. 1D). However, in some countries (Bulgaria, Cyprus, Estonia, Lithuania, Malta, Portugal, and Romania), breast cancer mortality decreases substantially and/or lung cancer mortality sharply increases, which might anticipate future intersection of their trends.

Group 5 represents three non-EU countries (fig. 1E). In Norway and Switzerland the trends intersected in 1998 and 2012, respectively. In Russia, such a phenomenon never occurred.

**Discussion**

The presented analysis depicts a substantial increase in female lung cancer mortality in the vast majority of European countries. In comparison with our previous analysis on female lung and breast cancer mortality in the EU [5] (last reported year was 2010), we noticed progressive cancer mortality changes. Previously we forecasted a further increase in lung cancer mortality and the intersection of both analyzed trends for 12 EU countries. This forecast proved to be true for Belgium, Croatia, Spain, Ireland, Germany, and Slovenia, in our current analysis. However, in Finland, France, Greece, and Italy, the trends have not intersected yet. Contrary to our earlier predictions, the current analysis showed that in Estonia and Slovakia breast cancer mortality is still higher than lung cancer mortality.

Considering the most up-to-date data on tobacco use, we know that at present in the EU about 47 million of women are current smokers. Moreover, advanced stage of tobacco epidemic was observed in 12 UE member states, where smoking prevalence among women is higher than 15% [9]. According to the Institute for Health Metrics and Evaluation (IHME), an exceptionally high smoking-attributable disease burden is observed in Bulgaria, Croatia, Greece, Hungary, and Poland, with Disability Adjusted Life Years index ranging between 17.5% and 20% [10]. Trends reported in our analysis are following the IHME data. Noteworthy, in Poland and Croatia, the increase is very sharp, and Hungary is characterized by the highest lung cancer mortality rate among all 31 analyzed countries (>100 per 100,000).

The presented analysis implies that greater efforts are needed to ensure a decline in lung cancer mortality rates. Several possible courses of action are related mainly to more restrictive anti-tobacco policies. Rising excise tax for tobacco products is one of the most impactful available tools to achieve this goal [11], particularly among women who are more responsive to such measures than men [12]. Another solution is banning menthol and slim cigarettes, perceived as more feminine tobacco products, addressed primarily to this group of users [13, 14]. Some of these solutions have already been introduced under the Tobacco Products Directive (2014/40/EU) [15]. However, the declines in lung cancer mortality observed in our analysis should not yet be connected with the enforcement of this particular law since it is in force too short to impact the mortality statistics. Notwithstanding, effective implementation of the Directive should be a priority for European policymakers since it may further reduce lung cancer mortality among EU women.

This analysis’s strength is the completeness of the analyzed cause-of-death data, which was close to 100%, except Cyprus, where it was 68% [16]. The most important limitation results from the possible cross-national differences in coding practices, particularly in codes for ill-defined and unknown causes. It should be taken into account when comparing mortality rates for specific causes across countries. However, since we assessed time trends of mortality rates within the countries in this study, the presented results’ generalizability should not be limited.
Conclusions
In many European countries during the last decades, lung cancer became the leading cause of cancer deaths among women. Ensuring gender-tailored evidence-based smoking cessation services and primary smoking prevention actions should be a priority for European healthcare policymakers to decrease tobacco-attributable lung cancer mortality.

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Conflict of interests: none declared

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References
1. Ferlay J, Ervik M, Lam F, Colombet M, Mery L, Piñeros M, et al. Global Cancer Observatory: Cancer Today. Lyon, France: International Agency for Research on Cancer. 2020 [Available from: https://gco.iarc.fr/today. Accessed on 2021-01-11].
2. Ferlay J, Colombet M, Soerjomataram I, Dyba T, Randi G, Bettio M, et al. Cancer incidence and mortality patterns in Europe: Estimates for 40 countries and 25 major cancers in 2018. European journal of cancer (Oxford, England : 1990). 2018;103:356-87.
3. Ozlü T, Bülbül Y. Smoking and lung cancer. Tuberk Toraks. 2005;53(2):200-9.
4. Walser T, Cui X, Yanagawa J, Lee JM, Heinrich E, Lee G, et al. Smoking and lung cancer: the role of inflammation. Proc Am Thorac Soc. 2008;5(8):811-5.
5. Sulkowska U, Mańczuk M, Łobasiewski J, Zatoński W. Lung cancer, the leading cause of cancer deaths among women in Europe. Nowotwory Journal of Oncology. 2015;65(5):395-403.
6. Segi M. Cancer Mortality for Selected Sites in 24 Countries (1950–57). Department of Public Health, Tohoku University of Medicine, Sendai, Japan. 1960.
7. Kim HJ, Fay MP, Feuer EJ, Midthune DN. Permutation tests for joinpoint regression with applications to cancer rates. Stat Med. 2000;19(3):335-51.
8. Vandenbroucke JP, von Elm E, Altman DG, Gotzsche PC, Mulrow CD, Pocock SJ, et al. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration. PLoS medicine. 2007;4(10):e297.
9. Gallus S, Lugo A, Liu X, Behrakis P, Boffi R, Bosetti C, et al. Who smokes in Europe? Data from 12 European countries in the TackSHS survey (2017-2018). J Epidemiol. 2020.
10. Collaborators GRF. Global burden of 87 risk factors in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet. 2020;396(10258):1223-49.
11. Sharbaugh MS, Althouse AD, Thoma FW, Lee JS, Figueredo VM, Mulukutla SR. Impact of cigarette taxes on smoking prevalence from 2001-2015: A report using the Behavioral and Risk Factor Surveillance Survey (BRFSS). PloS one. 2018;13(9):e0204416.

12. Ngo A, Fong GT, Craig LV, Shang C. Analysis of Gender Differences in the Impact of Taxation and Taxation Structure on Cigarette Consumption in 17 ITC Countries. Int J Environ Res Public Health. 2019;16(7).

13. Anderson SJ. Marketing of menthol cigarettes and consumer perceptions: a review of tobacco industry documents. Tob Control. 2011;20 Suppl 2(Suppl_2):ii20-8.

14. Ford A, Moodie C, Purves R, MacKintosh AM. Adolescent girls and young adult women’s perceptions of superslims cigarette packaging: a qualitative study. BMJ Open. 2016;6(1):e010102.

15. Directive 2014/40/EU of the European Parliament and of the Council of 3 April 2014 on the approximation of the laws, regulations and administrative provisions of the Member States concerning the manufacture, presentation and sale of tobacco and related products and repealing Directive 2001/37/EC Text with EEA relevance. [Available from: https://ec.europa.eu/health/sites/health/files/tobacco/docs/dir_201440_en.pdf. Accessed on 2021-01-11].

16. World Health Organization. The Global Health Observatory. Completeness of cause-of-death data [Available from: https://www.who.int/data/gho/data/indicators/indicator-details/GHO/completeness-of-cause-of-death-data-]. Accessed 2021-01-11].
| Country | Location | ASR 2010 | ASR 2018 | Segment 1 | Segment 2 | Segment 3 | Segment 4 |
|---------|----------|----------|----------|-----------|-----------|-----------|-----------|
|         |          |          |          | Period | APC | 95% CI | Period | APC | 95% CI | Period | APC | 95% CI | Period | APC | 95% CI |
| Austria | Breast   | 41.9     | 37.2     | 1960-1965 | 3.9* | 1.6; 6.1 | 1965-1991 | 0.9* | 0.7; 1.1 | 1991-2018 | -2.4* | -2.5; -2.2 |
|         | Lung     | 45.8     | 51.4     | 1960-1978 | 1.2* | 0.7; 1.7 | 1978-2018 | 2.3* | 2.1; 2.4 |
| Croatia | Breast   | 53.8     | 42.2     | 1985-1999 | 2.4* | 2.1; 2.7 | 1999-2003 | -5.7* | -8.7; -2.5 | 2003-2015 | -0.2 | -0.7; 0.2 | 2015-2018 | -5.5* | -8.5; -2.3 |
|         | Lung     | 43.4     | 60.3     | 1985-2018 | 2.7* | 2.5; 3.0 | 1997-2013 | -1.0* | -1.2; 0.2 | 2015-2018 | -0.2 | -0.8; 0.2 |
| Czechia | Breast   | 40.7     | 34.1     | 1986-1994 | 0.1  | -0.9; 1.2 | 1994-2005 | -2.1* | -2.8; -1.4 | 2005-2008 | -7.7 | -15.9; 1.3 | 2008-2018 | -1.9* | -2.6; -1.2 |
|         | Lung     | 44.1     | 44.4     | 1986-2000 | 2.9* | 2.3; 3.4 | 2000-2018 | 0.5* | 0.1; 0.8 |
| Germany | Breast   | 49.2     | 44.6     | 1973-1992 | 1.0* | 0.8; 1.1 | 1992-2017 | -1.8* | -1.9; 1.7 |
|         | Lung     | 45.8     | 52.4     | 1973-1980 | 2.0* | 1.4; 2.5 | 1980-1991 | 3.8* | 3.4; 4.1 | 1991-2013 | 3.0* | 2.9; 3.1 | 2013-2017 | 1.1 | -0.2; 2.5 |
| Luxembourg | Breast | 49.0    | 45.1     | 1968-1986 | 1.7* | 0.9; 2.5 | 1986-2004 | -3.2* | -4.0; -2.3 | 2004-2016 | -0.5 | -2.0; 0.9 |
|         | Lung     | 41.2     | 46.4     | 1968-1971 | 20.3* | 0.1; 4.4 | 1971-1994 | -14.1 | -40.5; 24.0 | 1974-1985 | 8.5* | 5.5; 11.7 | 1985-2016 | 1.6* | 1.0; 2.1 |
| Poland  | Breast   | 43.5     | 45.4     | 1960-1964 | 14.9* | 12.3; 17.4 | 1964-1981 | 2.2* | 1.9; 2.4 | 1981-1992 | 0.4  | -0.1; 1.0 | 1992-2018 | -0.4* | -0.6; 0.3 |
|         | Lung     | 58.4     | 64.4     | 1960-1968 | 4.6* | 3.4; 5.9 | 1968-1972 | -0.1 | -5.3; 5.3 | 1972-1988 | 4.0* | 3.5; 4.5 | 1988-2018 | 2.7* | 2.6; 2.9 |
| Slovenia | Breast   | 46.4     | 39.9     | 1971-1993 | 1.5* | 1.0; 2.0 | 1993-2018 | -2.5* | -2.9; 2.1 |
|         | Lung     | 42.4     | 61.3     | 1971-2018 | 2.6* | 2.4; 2.8 |
| Spain   | Breast   | 35.1     | 31.9     | 1960-1991 | 2.6* | 2.4; 2.7 | 1991-2018 | -2.2* | -2.4; 0.0 |
|         | Lung     | 25.2     | 32.9     | 1960-1973 | 0.9* | 0.3; 1.5 | 1973-1989 | -1.6* | -2.1; 1.2 | 1989-1996 | 2.0* | 0.1; 3.9 | 1996-2018 | 5.4* | 5.2; 5.7 |
|         |          |          |          |          |      |      |          |      |      |          |      |      |          |      |      |
| Belgium | Breast   | 56.6     | 44.7     | 1960-1986 | 1.1* | 1.0; 1.3 | 1986-1997 | -0.7 | -1.4; 0.1 | 1997-2017 | -2.7* | -2.9; 2.4 |
|         | Lung     | 51.5     | 48.2     | 1960-1966 | -0.1 | -2.6; 2.5 | 1966-2015 | 3.1* | 3.0; 3.2 | 2015-2017 | -7.6 | -20.5; 7.4 |
| Denmark | Breast   | 58.1     | 39.8     | 1960-1997 | 0.5* | 0.4; 0.7 | 1997-2017 | -3.8* | -4.1; 3.4 |
|         | Lung     | 89.6     | 73.8     | 1960-1973 | 5.0* | 4.0; 6.0 | 1973-1984 | 7.6* | 6.2; 9.1 | 1984-1997 | 2.9* | 1.9; 4.0 | 1997-2017 | -1.4* | -1.9; 0.9 |
| Hungary | Breast   | 53.3     | 49.6     | 1960-1976 | 2.9* | 2.4; 3.3 | 1976-1995 | 1.1* | 0.8; 1.5 | 1995-2018 | -1.6* | -1.9; 1.4 |
|         | Lung     | 96.7     | 100.7    | 1960-1975 | 1.1* | 0.6; 1.6 | 1975-1996 | 4.3* | 4.0; 4.7 | 1996-2013 | 3.2* | 2.7; 3.7 | 2013-2018 | -0.4 | -3.1; 2.5 |
| Ireland | Breast   | 55.0     | 46.9     | 1960-1975 | 1.9* | 1.2; 2.6 | 1975-1994 | 0.3  | -0.3; 0.8 | 1994-2017 | -2.4* | -2.8; 2.1 |

Table 1. Age-standardized mortality rates (ASR) of breast and lung cancer, and annual percentage change (APC) with 95% confidence interval (95% CI), by jointpoint analysis segment.
| Country       | Disease   | Year Range | Year | Rate  | 95% CI      | Year | Rate  | 95% CI      | Year | Rate  | 95% CI      | Year | Rate  | 95% CI |
|--------------|-----------|------------|------|-------|-------------|------|-------|-------------|------|-------|-------------|------|-------|--------|
| Netherlands  | Breast    | 1960-1967  | 1974 | 73.4  | 67.6, 79.2  | 1982 | 6.7  | 4.2, 9.2   | 1989 | 4.0  | 2.8, 5.4   | 1994 | 2.6  | 1.9, 3.4 |
|              | Lung      | 1960-1973  | 1967-1994 | 0.0  | -0.1, 0.2 | 1994-2018 | -2.4 | -2.6, -2.3 |
| Sweden       | Breast    | 1960-1968  | 1988-2005 | -1.1 | -1.5, -0.7 | 2005-2017 | -2.9 | -3.4, -2.3 |
|              | Lung      | 1960-1964  | 1964-1991 | 4.3  | 4.0, 4.6 | 1991-2005 | 2.8 | 2.0, 3.5 |
| United Kingdom | Breast   | 1960-1976  | 1976-1989 | 0.4  | 0.1, 0.6 | 1989-2001 | -3.0 | -3.3, -2.7 |
|              | Lung      | 1960-1975  | 1975-1988 | 2.4  | 2.0, 2.8 | 1988-2001 | -1.2 | -1.5, -0.8 |
|              |           |            |      |       |             |      |       |             |      |       |             |      |       |         |
| Group 3      |           |            |      |       |             |      |       |             |      |       |             |      |       |         |
| Finland      | Breast    | 1960-1995  | 1995-2018 | -1.6 | -1.9, -1.2 | 1977-1991 | 1.0 | -10.0, 36.2 |
|              | Lung      | 1960-1962  | 1962-1974 | -0.0 | 1.4, 1.4 | 1974-1977 | 10.7 | -10.0, 36.2 |
| France       | Breast    | 1960-1974  | 1974-1997 | 0.3  | 0.2, 0.5 | 1997-2016 | -1.9 | -2.1, -1.8 |
|              | Lung      | 1960-1977  | 1977-1996 | 3.2  | 2.8, 3.5 | 1996-2008 | 5.3 | 4.5, 6.1 |
| Greece       | Breast    | 1961-1963  | 1963-1980 | 4.4  | 3.9, 5.0 | 1980-1993 | 0.4 | -0.5, 1.2 |
|              | Lung      | 1961-1965  | 1965-2005 | 0.4  | 0.2, 0.6 | 2005-2017 | 4.4 | 3.3, 5.5 |
| Italy        | Breast    | 1960-1970  | 1970-1990 | 0.9  | 0.8, 1.1 | 1990-2017 | -1.7 | -1.8, -1.6 |
|              | Lung      | 1960-1972  | 1972-1988 | 2.4  | 2.1, 2.7 | 1988-1999 | 0.6  | 0.0, 1.2 |
|              |           |            |      |       |             |      |       |             |      |       |             |      |       |         |
| Group 4      |           |            |      |       |             |      |       |             |      |       |             |      |       |         |
| Bulgaria     | Breast    | 1964-1986  | 1986-2018 | -0.2 | -0.4, 0.0 | 2001-2018 | 2.7  | 1.9, 3.5 |
|              | Lung      | 1964-2001  | 2001-2018 | -0.1 | -0.3, 0.2 | 2001-2018 | 2.7  | 1.9, 3.5 |
| Cyprus       | Breast    | 2004-2018  | -1.2 | -2.4, 0.0 |
|              | Lung      | 2004-2018  | 1.6  | -1.1, 4.4 |
| Estonia      | Breast    | 1981-1999  | 1.9  | 1.1, 2.6 | 1999-2017 | -2.4 | -3.0, -1.7 |
|              | Lung      | 1981-1983  | -14.4 | -33.4, 9.9 | 1983-1989 | 6.2 | 0.5, 12.3 | 1989-2000 | -1.5 | -3.4, 0.4 | 2000-2017 | 1.3 | 0.4, 2.2 |
| Latvia       | Breast    | 1980-1994  | 2.2  | 1.4, 3.1 | 1994-2017 | -0.5 | -0.9, -0.1 |
|              | Lung      | 1980-2017  | -0.1 | -0.3, 0.2 |
| Lithuania    | Breast    | 1981-1994  | 2.8  | 1.9, 3.7 | 1994-2011 | -0.8 | -1.5, -0.2 | 2011-2018 | -3.8 | -5.9, -1.6 |
|              | Lung      | 1981-2002  | -0.9 | -1.7, -0.1 | 2002-2018 | 1.5 | 0.3, 2.8 |
| Malta        | Breast    | 1968-1975  | 5.0  | 2.0, 8.2 | 1975-1994 | 0.1  | -0.6, 0.8 |
|              | Lung      | 1968-1973  | -23.0 | -31.7, 13.3 | 1973-1976 | 56.9 | -7.8, 166.9 | 1976-1992 | -0.1 | -2.3, 2.2 | 1992-2016 | 2.8 | 1.7, 3.9 |
| Country  | Region | Year Range | Cases 1960-1991 | Cases 1991-2017 | APC 1960-1997 | APC 1991-2017 | APC 1997-2017 | APC 2000-2018 |
|---------|--------|------------|-----------------|-----------------|----------------|----------------|----------------|----------------|
| Portugal | Breast | 1960-1991 | 40.2            | 38.3            | 1.5*           | 1.3;1.7        | -1.6*          | -1.9;1.4       |
|         | Lung   | 1960-1982 | 17.3            | 21.8            | 2.4*           | 1.8;2.9        | 0.6            | -0.4;1.7       |
|         |        |           |                 |                 |                |                |                | 2.7*           |
|         |        |           |                 |                 |                |                |                | 2.1;3.4        |
| Romania | Breast | 1969-1988 | 47.5            | 47.8            | 2.2*           | 1.9;2.4        | 1.1*           | 0.5;1.7        |
|         | Lung   | 1969-1989 | 29.6            | 37.1            | 0.8*           | 0.5;1.1        | 1.8*           | 1.7;2.0        |
|         |        |           |                 |                 |                |                |                |                |
| Slovakia | Breast | 1992-2001 | 45.6            | 49.6            | 1.0            | -0.1;2.2       | -3.9*          | -7.6;-0.1      |
|         | Lung   | 1992-1995 | 32.9            | 31.4            | -5.0           | -13.6;4.5      | 2.5*           | 2.1;3.0        |
| Norway  | Breast | 1960-1996 | 39.6            | 32.1            | 0.1            | -0.0;0.3       | -2.9*          | -3.2;-2.5      |
|         | Lung   | 1960-1965 | 59.4            | 50.4            | 0.2            | -4.2;4.9       | 6.0*           | 5.7;6.3        |
|         |        |           |                 |                 |                |                |                | 1997-2017 0.2  |
|         |        |           |                 |                 |                |                |                | -0.3;0.8       |
| Switzerland | Breast | 1960-1988 | 45.5            | 37.6            | 0.4*           | 0.2;0.5        | -2.4*          | -2.6;-2.2      |
|         | Lung   | 1960-2006 | 43.1            | 42.7            | 3.7*           | 3.5;3.9        | 0.0*           | 0.9;3.1        |
|         |        |           |                 |                 |                |                |                | 1999-2009 -0.3*|
|         |        |           |                 |                 |                |                |                | 2009-2015 -2.4*|
|         |        |           |                 |                 |                |                |                | -3.0;-1.9      |
| Russia  | Breast | 1980-1994 | 54.6            | 48.4            | 3.1*           | 2.9;3.3        | 2.0*           | 0.9;3.1        |
|         | Lung   | 1980-1988 | 17.3            | 17.8            | 1.6*           | 1.0;2.3        | 1.0*           | 0.9;3.1        |
|         |        |           |                 |                 |                |                |                | 1993-2003 -3.0*|
|         |        |           |                 |                 |                |                |                | -3.5;-2.5      |
|         |        |           |                 |                 |                |                |                | 2003-2015 0.1  |
|         |        |           |                 |                 |                |                |                | -0.2;0.5       |

* New cases diagnosed per 100,000 person-years, age-adjusted to the Segi’s World Standard Population
† For Luxembourg and Malta, the mortality rates were calculated as three-year moving averages (deploying preceding and the following year).
‡ APC statistically significant
Table S1. Completeness\(^1\) of cause-of-death data and their source by years included

| Country     | WHO MDB Years included | Completeness | Eurostat Years included |
|-------------|------------------------|--------------|-------------------------|
| Austria     | 1960-2017              | 100%         | 2018                    |
| Belgium     | 1960-2016              | 100%         | 2017                    |
| Bulgaria    | 1964-2015              | 100%         | 2016-2018               |
| Croatia     | 1985-2016              | 100%         | 2017-2018               |
| Cyprus      | 2004-2016              | 68%          | 2017-2018               |
| Czechia     | 1986-2017              | 100%         | 2018                    |
| Denmark     | 1960-2015              | 100%         | 2016-2017               |
| Estonia     | 1981-2016              | 100%         | 2017                    |
| Finland     | 1960-2016              | 100%         | 2017-2018               |
| France      | 1960-2015              | 100%         | 2016                    |
| Germany     | 1973-2016              | 100%         | 2017                    |
| Greece      | 1961-2016              | 100%         | 2017                    |
| Hungary     | 1960-2017              | 100%         | 2018                    |
| Ireland     | 1960-2015              | 100%         | 2016-2017               |
| Italy       | 1960-2015              | 100%         | 2016-2017               |
| Latvia      | 1980-2015              | 100%         | 2016-2017               |
| Lithuania   | 1981-2017              | 99%          | 2018                    |
| Luxembourg  | 1968-2016              | 100%         | 2017                    |
| Malta       | 1968-2015              | 100%         | 2016-2017               |
| Netherlands | 1960-2016              | 100%         | 2017-2018               |
| Norway      | 1960-2016              | 100%         | 2017                    |
| Poland      | 1960-2016              | 100%         | 2017-2018               |
| Portugal    | 1960-2016              | 100%         | 2017                    |
| Romania     | 1969-2017              | 100%         | 2018                    |
| Russia      | 1980-2015              | 100%         |                         |
| Slovakia    | 1992-2014              | 100%         | 2015-2018               |
| Slovenia    | 1971-2015              | 100%         | 2016-2018               |
| Spain       | 1960-2016              | 100%         | 2017-2018               |
| Sweden      | 1960-2016              | 100%         | 2017                    |
| Switzerland | 1960-2016              | 100%         | 2017                    |
| United Kingdom | 1960-2016          | 100%         | 2017                    |

\(^1\) available for WHO MDB only; WHO MDB – World Health Organization Mortality DataBase.
Figure 1
Breast and lung cancer mortality trends among women aged 45-74 years old
A. Group 1 – EU countries with higher mortality from lung cancer than from breast cancer with increasing lung cancer mortality trends
B. Group 2 – EU countries with higher mortality from lung cancer than from breast cancer with stable or decreasing lung cancer mortality trends
C. Group 3 – EU countries with almost equal or equal breast and lung cancer mortality trends in the last reported year
D. Group 4 - other EU countries
E. Group 5 - non-EU countries
