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ORIGINAL RESEARCH

Incidence and mortality rates in breast, corpus uteri, and ovarian cancers in Poland (1980–2013): an analysis of population-based data in relation to socioeconomic changes

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Objectives: This study aimed to analyze incidence and mortality trends in breast cancer (BC), corpus uteri cancer (CUC), and ovarian cancer (OC) in Poland in the context of sociodemographic changes.

Materials and methods: Incidence and mortality data (1980–2013) were retrieved from the Polish National Cancer Registry, while socioeconomic data (1960–2013) were obtained from the World Bank. Age-standardized incidence and mortality rates were calculated by direct standardization, and join-point regression was performed to describe trends using the average annual percentage change (AAPC).

Results: A significant decrease in birth and fertility rates and a large increase in gross domestic product were observed together with a decrease in the total mortality rate among women, as well as an increase in life expectancy for women. A large, significant increase in BC incidence was observed ($AAPC_{1980–1990}$ 2.14, $AAPC_{1990–1996}$ 4.71, $AAPC_{1996–2013}$ 2.21), with a small but significant decrease in mortality after a slight increase ($AAPC_{1980–1994}$ 0.52, $AAPC_{1994–2013}$ –0.66). During the period 1980–2013, a significant increase in CUC incidence ($AAPC_{1980–1994}$ 3.7, $AAPC_{1994–2013}$ 1.93) was observed, with an initial mortality-rate reduction followed by a significant increase ($AAPC_{1980–2006}$ –1.12, $AAPC_{2006–2013}$ 3.74). After the initial increase of both OC incidence and mortality from 1994, the incidence rate decreased significantly ($AAPC_{1980–1994}$ 2.98, $AAPC_{1994–2013}$ –0.49), as did the mortality rate ($AAPC_{1980–1994}$ 0.52, $AAPC_{1994–2013}$ –0.66).

Conclusion: After 1994, a decrease in OC incidence was found, while the incidence of BC and CUC continued to increase. A reduction in mortality rate was observed for BC and OC predominantly at the end of the study period, while for CUC, after a long decreasing mortality trend, a significant increase was observed.

Keywords: average annual percentage change, breast cancer, corpus uteri cancer, epidemiology, incidence, mortality, ovarian cancer

Introduction

Breast cancer (BC), corpus uteri cancer (CUC), and ovarian cancer (OC) are the top three malignancies related to female genital organs that predominate in high-income countries.[1,2] Political and economic changes in Poland that occurred after political regime transformation in the year 1989 resulted in increasing gross domestic income and redefinition of national health care strategy, with increasing access to medications (including hormonal contraception), diagnostic procedures, and treatment facilities.[3] However life style changes, that occurred after political transformation,

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led unfortunately to growing incidence of cardiovascular diseases, diabetes, overweight, and decreased parity, which are observed in welfare populations.[4–6] Political and economic changes significantly affected socioeconomically dependent behaviors and lifestyle, which influenced significantly risk factors of malignancies, including BC, CUC, and OC.

BC is the most common female malignancy, with peak incidence after 40 years of age. Fortunately, in the developed world a steady decline in BC deaths has been observed since 1990 at a rate of 3.3% in patients under 51 years and 2% per year in elderly women.[2] Factors associated with increased estrogen exposure, such as early menarche, late menopause, delayed first pregnancy, or nulliparity, have been reported to increase the risk of BC.[7] Short-term breast-feeding or lack of breast-feeding as a result of nulliparity were also associated with increased risk of BC.[8] Obesity and postmenopausal weight gain were the two important modifiable risk factors for BC identified in prospective observational studies.[9] Prior radiation exposure, high breast density, history of biopsies for benign breast conditions, and genetic mutations, including *BRCA1* and *BRCA2*, have also proved to be nonmodifiable risks of BC independently of lifestyle and socioeconomic background.[10,11]

In the developed world, CUC is the most commonly diagnosed malignancy of reproductive tract and the fourth-most frequently diagnosed cancer among American females.[2] Over 90% of CUCs are epithelial tumors. Based on clinical, histological, and molecular features, two types of endometrial cancers are distinguished. Estrogen-dependent type I tumors account for 85% of cases and include endometrioid endometrial cancer, which tends to occur in younger women suffering from obesity, diabetes often nulliparous but have favorable prognosis, while estrogen-independent type II endometrial cancers, such as serous, clear-cell, and high-grade endometrioid adenocarcinoma, occur predominantly around the age of 70 years and are characterized by poorer survival.[2] Up to 8% of CUCs are mesenchymal tumours.[12]

OC is the sixth-most common malignancy in women and the leading cause of death in well-developed countries.[2] Ovarian epithelial neoplasms, including borderline ovarian tumors, constitute up to 90% of ovarian malignancies, with established risk factors including increasing age with peak incidence at 70 years, family history of ovarian and/or BC, nulliparity, and tobacco smoking, while use of hormonal contraception, long breast-feeding, multiparity, fallopian tube ligation or excision, and hysterectomy are proven protective factors against this cancer.[13–16] Generally, ovarian epithelial malignancies (excluding borderline tumors) represent an unfavorable prognosis, with an average 5-year survival rate of 45%.[17] Ovarian germ-cell tumors account for 2%–3% of OCs, and occur usually at a young age, with peak incidence in the early 20s.[18] No significant risk factors for germ-cell ovarian tumors have been identified, as 95% of them occur in normal gonads.[18] Approximately 7% of ovarian malignancies are sex cord-stromal tumors, with a significant proportion diagnosed before 40 years of age and the ability to produce a broad variety of steroids and hormones with unidentified predisposing factors.[19]

From well-identified risk factors for BC, CUC, and OC we can distinguish these depending on lifestyle. As there is evidence of increasing lifestyle-related diseases, such as obesity, hypertension, and diabetes, in the Polish population, we asked a question concerning the incidence and mortality of the three most common female genital organ malignancies with proven lifestyle-dependent risk factors during the period 1980–2013 that included rapid economic growth.[4–6] As high-income populations are at risk of different gynecological cancers compared to lower-income countries, using data from a population-based registry, we aimed to provide information regarding incidence and mortality trends for BC, CUC, and OC in Poland from 1980 to 2013 in the context of socioeconomic changes in 1989.[1]

Materials and methods

Data sources

Gross domestic product (GDP) per capita was used as an indicator of economic growth, while crude birth rate (per 1,000 persons) and fertility rate (average number of births during a woman's life span) were used to evaluate economic and reproductive trends. Given that exposure to risk factors can precede the occurrence of cancer by decades, data from 1960–2013 were used to analyze macroeconomic and reproductive trends. The data were retrieved from the World Bank database, which is compiled from officially recognized international sources (http://data.worldbank.org/data-catalog/world-development-indicators).

Data on the incidence of cancer and mortality rates for 1980–2013 were retrieved from the Polish National Cancer Registry (PNCR). Diagnoses made between 1980–1996 were coded using the International Statistical Classification of Diseases and Related Health Problems (ICD), ninth revision: ICD 174 for female BC, ICD 182 for CUC, and ICD 183 for OC. Data after 1996 were coded according to the ICD, tenth revision: C50 for female BC, C54 for CUC, and

C56 for OC. Unfortunately, data for 1981 and 1986–1987 were unavailable for research and data from 1997–1998 were missing, due to strikes by medical staff during that period. The study was approved by the Jagiellonian University Review Board.

Statistical analyses

The world standard population was used to calculate the age-standardized rates for cancer incidence and mortality.[20] A join-point regression analysis using the Joinpoint Regression program, version 4.0.1 (Information Management Services Inc, Rockville, MD, USA) was performed to determine the incidence and mortality trends. The analysis included a logarithmic transformation of the rates, standard errors, and a maximum number of five join points with a minimum of 4 years between two join points.[21,22] This method allowed for the identification of join points based on regression models with 0–5 join points and for the selection of the final best-fitting model, with the estimated annual percentage change (EAPC) based on the trend within each segment. The APC was subsequently calculated to quantify the trend over a fixed number of years as a geometric weighted average of the EAPC-trend analysis, with the weights equal to the lengths of each segment during the prespecified fixed interval. When the slope of the whole trend was statistically significant ($P<0.05$), the trend was described as "significantly increasing" or "significantly decreasing". In other cases, the terms "stable" (for an APC between –0.5 and 0.5 inclusive), "non-statistically significant increase" (for an AAPC of >0.5; $P\geq0.05$), and "non-statistically significant decrease" (for an APC of <-0.05, $P\geq0.05$) were used. Trend-line slopes were arbitrarily considered low if $0.5<$ average APC (AAPC) ≤1, moderate if $1<$ APC ≤3, and high if AAPC >3. All statistical tests were two-sided. The trend data were showed as APC values with 95% confidence intervals.

Results

Macroeconomic data and reproductive trends

The GDP increased from 1960 (US$3,000 purchasing power parity) to 2013 ($12,000 purchasing power parity). Between 1975 and 1989, the GDP per capita was stable at around $6,000, and after a slight decrease in the early 1990s, the GDP began steadily increasing year to year, and doubled in the next 20 years (until 2013).

During that period, we also observed an increase in average life expectancy of women (70.4–82.1 years), while the crude mortality rate for women decreased from 121.8 to 76.1 per 1,000 (Figure 1). The crude birth rate fluctuated, but an increase was observed between 1970 and 1984 (Figure 2). On the other hand, a significant drop in fertility rate was observed from 1960 to 2013, except for 1968–1984 and 2003–2009, when a significant increase was noted (Figure 2).

Female breast cancer

A significant increase in the incidence of female BC was observed during the analyzed period. Between 1980 and 1990, the AAPC for incidence was 2.14 ($P<0.05$), and a two-fold increase in AAPC was observed (reaching 4.71, $P<0.05$) between 1990 and 1996, with a subsequent decrease from 1996 to 2013 to (2.21, $P<0.05$). From 1980 to 1994, a slight but significant increase in BC mortality rate was observed (AAPC 0.52, $P<0.05$). However, the mortality rate started to decrease after 1994 (AAPC –0.66, $P<0.05$) (Table 1, Figure 3). On the other hand, analysis of the incidence of female BC by age-group showed an increase in almost all groups, except women aged 20–24 years and women aged 45–49 years in 1980–1983. In the remaining age-groups, the AAPC varied from 0.27 to 11.37 depending on age and time period, with the highest significant value observed among women aged 55–59 years in 1992–2001 (6.66, $P<0.05$,

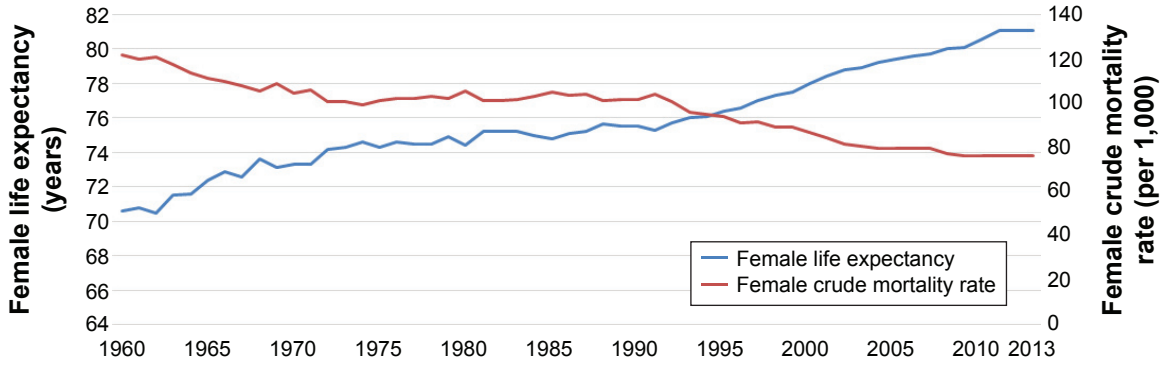

Figure 1 Trends in female mortality rates (crude values) and life expectancy, 1960–2013.

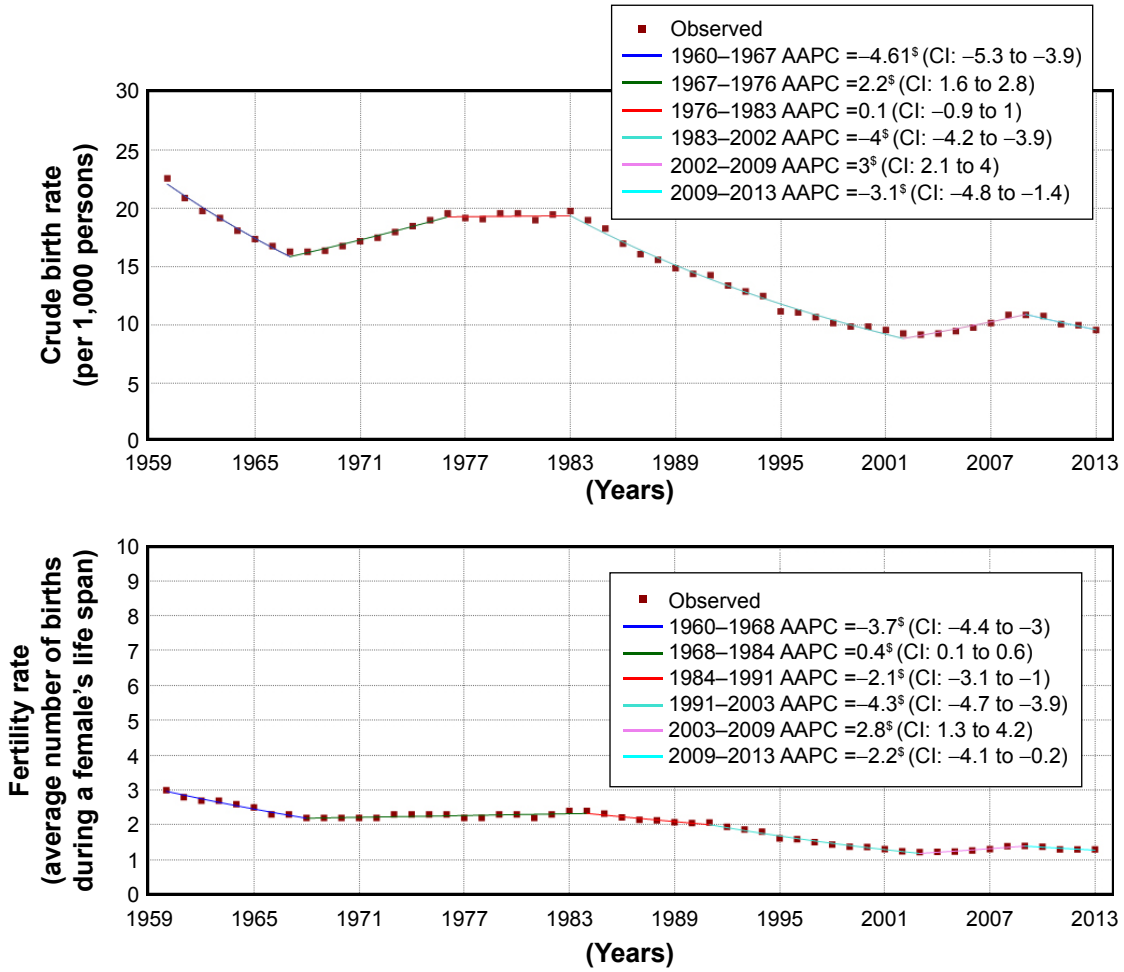

Figure 2 Trends in the crude birth rate (per 1,000 persons) and fertility rate (average number of births during a woman's life span), 1960–2013.
Note: $P<0.05.
Abbreviations: AAPC, average annual percentage change; CI, confidence interval.

Table 2). We also observed a significant decrease in mortality trends in women aged 25–39 years, with significant AAPC values between –3.12 and –1.82 (Table 2). Interestingly, among women aged 40–59 years, increasing trends in BC mortality were observed until the mid- to late 1990s, after which a significant decrease was seen (Table 2). For women aged 60–69 years, the BC mortality rate was stable throughout the study period (Table 2). In patients aged 70–84 years, a bimodal trend was shown for BC mortality, with a significantly increasing AAPC at the beginning of the study period followed by an insignificant decrease (Table 2).

Corpus uteri cancer

CUC incidence varied from 6.6 to 13.7 while the mortality rate ranged from 2 to 2.8. A significantly high increase in CUC incidence was observed from 1980 to 1994 (AAPC 3.70, $P<0.01$) and continued at a lower level until 2013 (AAPC 1.93, $P<0.01$) (Table 1, Figure 3). The mortality rate increased significantly from 1980 to 1989 (AAPC 1.13, $P<0.05$), then stabilized until 2009 (AAPC 0.19, $P\geq0.05$) and decreased (insignificantly) until the end of the study (AAPC –1.6, $P\geq0.05$) (Table 1, Figure 3). Analysis of CUC incidence by age-group confirmed an increase for all age-groups, except women aged 60–64 and 80–84 years, who showed a large decrease in CUC incidence from 1980 to 1983 (Table 2).

Age-specific trend lines for mortality related to CUC across age-groups reflected a significant decline among those aged 40–44, 45–49, and 50–54 years. A continuous increase in mortality rate during the study period was observed only in women aged 85+ years. In women aged 55–59, 70–74, 75–79, and 80–84 years, the mortality rate remained insignificant and moderately decreased until the early 2000s, then increased in the last years of the observation period. For women aged 60–64 and 65–69 years, after an initial increase in mortality due to CUC, we observed a gradual decrease in mortality in

Table 1 Incidence and mortality of breast, corpus uteri, and ovarian cancers in Poland, 1980–2013

Years	Breast cancer (174§/C50§§)						Corpus uteri cancer (182§/C54§§)						Ovarian cancer (183§/C56§§)					
	Incidence			Mortality			Incidence			Mortality			Incidence			Mortality		
	n	CR	ASR	n	CR	ASR	n	CR	ASR	n	CR	ASR	n	CR	ASR	n	CR	ASR
1980	5,154	28.3	23	3,446	18.9	14.8	1,524	8.4	6.7	702	3.9	2.8	1,734	9.5	7.9	1,464	8	6.5
1981	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1982	5,120	27.6	22.3	3,641	19.6	15	1,547	8.3	6.6	716	3.9	2.8	1,830	9.9	8.3	1,397	7.5	6
1983	5,386	28.7	23.1	3,664	19.5	14.8	1,796	9.6	7.5	726	3.9	2.8	1,856	9.9	8.1	1,478	7.9	6.2
1984	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1985	6,147	32.3	26.1	3,795	19.9	15.1	2,029	10.6	8.4	714	3.7	2.6	2,150	11.3	9.4	1,522	8	6.3
1986	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1987	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1988	6,513	33.6	26.8	4,045	20.9	15.5	2,200	11.3	8.8	758	3.9	2.7	2,333	12	9.7	1,731	8.9	6.9
1989	6,706	34.5	27.5	4,097	21.1	15.5	2,166	11.1	8.5	702	3.6	2.5	2,370	12.2	9.9	1,718	8.8	6.8
1990	6,649	34	26.8	4,323	22.1	16.1	2,301	11.8	9	763	3.9	2.6	2,404	12.3	10	1,747	8.9	6.8
1991	7,343	37.4	29.2	4,198	21.4	15.5	2,626	13.4	10.1	776	4	2.7	2,680	13.7	10.9	1,787	9.1	6.9
1992	7,671	39	30	4,429	22.5	16.2	2,611	13.3	10.1	781	4	2.6	2,765	14.1	11.2	1,850	9.2	6.9
1993	8,416	42.6	32.3	4,381	22.2	15.7	2,858	14.5	10.9	724	3.7	2.4	2,982	15.1	12	1,880	9.5	7.2
1994	8,458	42.8	32.3	4,449	22.5	15.9	3,001	15.2	11.3	762	3.9	2.5	2,876	14.5	11.3	1,794	9.1	6.6
1995	9,173	46.3	35.3	4,665	23.6	16.3	2,980	15	11.3	763	3.9	2.5	2,993	15.1	11.8	1,840	9.3	6.8
1996	9,681	48.8	35.9	4,738	23.9	16.1	3,043	15.3	11.1	842	4.2	2.7	3,220	16.2	12.2	1,909	9.6	6.7
1997	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1998	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1999	10,903	54.9	38.8	4,553	22.9	14.8	3,260	16.4	11.4	761	3.8	2.3	3,151	15.9	11.4	1,959	9.9	6.7
2000	11,853	59.7	41.8	4,712	23.7	15	3,496	17.6	12	808	4.1	2.4	3,157	15.9	11.2	2,032	10.2	6.7
2001	12,118	61	42.4	4,825	24.3	14.9	3,675	18.5	12.4	776	3.9	2.2	3,193	16.1	11.2	2,152	10.8	6.9
2002	12,132	61.5	42	4,825	24.5	15	3,796	19.3	12.6	757	3.8	2.2	3,267	16.6	11.3	2,171	11	6.9
2003	11,733	59.6	40.2	4,942	25.1	15	3,953	20.1	13	783	4	2.2	3,371	17.1	11.5	2,271	11.5	7.1
2004	12,049	61.2	40.7	4,887	24.8	14.5	4,193	21.3	13.4	794	4	2.2	3,264	16.6	10.9	2,273	11.5	7
2005	13,385	67.9	44.5	5,112	26	14.9	4,196	21.3	13.3	770	3.9	2	3,355	17	11.1	2,357	12	7
2006	13,322	67.6	44.2	5,212	26.5	14.8	4,376	22.2	13.7	814	4.1	2.2	3,291	16.7	10.8	2,390	12.1	7
2007	14,484	73.5	47.7	5,255	26.7	14.6	4,640	16.3	10.4	848	4.3	2.2	3,214	16.3	10.4	2,485	12.6	7.2
2008	14,576	74	47.2	5,362	27.2	14.7	4,820	16.6	10.6	952	4.8	2.4	3,280	16.6	10.6	2,507	12.7	7.1
2009	15,752	79.8	50.4	5,241	26.6	14.1	5,061	17.6	11.1	969	4.9	2.4	3,474	17.6	11.1	2,510	12.7	7
2010	15,784	79.4	49.6	5,226	26.3	13.7	5,125	18.1	11.3	1,042	5.2	2.5	3,587	18.1	15.2	2,547	12.8	9.9
2011	16,534	83.2	51.8	5,437	27.4	14.2	5,251	17.8	10.9	1,085	5.5	2.5	3,527	17.8	14.6	2,558	12.9	9.8
2012	17,000	85.5	51.9	5,574	28	14.1	5,426	17.8	10.8	1,162	5.8	2.7	3,544	17.8	14.6	2,432	12.2	9.1
2013	17,142	86.3	51.8	5,816	29.3	14.5	5,706	18.3	11	1,243	6.3	2.8	3,639	18.3	14.8	2,603	13.1	9.6
AAPC (CI)	1980–1990: 2.14$ (1.2 to 3.1) 1990–1996: 4.71$ (2.4 to 7.1) 1996–2013: 2.21$ (1.8 to 2.6)			1980–1994: 0.52$ (0.2 to 0.9) 1994–2013: –0.66$ (–0.9 to –0.5)			1980–1994: 3.70$ (3.2 to 4.2) 1994–2013: 1.93$ (1.6 to 2.2)			1980–2006: –1.12$ (–1.4 to –0.9) 2006–2013: 3.74$ (2.1 to 5.4)			1980–1994: 2.98$ (2.5 to 3.5) 1994–2013: –0.49$ (–0.8 to –0.2)			1980–1989: 1.13$ (0.1 to 2.2) 1989–2009: 0.19 (–0.1 to 0.5) 2009–2013: –1.60 (–4.4 to 1.2)		

Notes: §Coding according to the International Statistical Classification of Diseases and Related Health Problems (ICD), ninth revision; §§coding according to the ICD, tenth revision; $$P<0.05$.

Abbreviations: CR, crude ratio; ASR, age-standardized ratio; AAPC, average annual percentage change; CI, confidence interval.

the mid-study period, followed by an increase at the end of observation (Table 2).

Ovarian cancer

OC incidence varied from 7.9 to 2.2, and the mortality rate ranged from 6 to 9.8. OC incidence increased from 1980 to 1994 (AAPC 2.98, $P<0.05$). During the same period, a significant but moderate increase in OC mortality was also found (AAPC 0.52, $P<0.05$) (Table 1, Figure 3). From 1994 until the end of the study, we observed a decrease in both OC incidence (AAPC –0.49, $P<0.05$) and mortality (AAPC –0.66, $P<0.05$) (Table 1, Figure 3).

Age-related analysis of OC incidence showed descending trend lines among women ≤34 years old during the study period. In women 35–59 years old, we observed a large, significant increase in OC incidence until the early 1990s, followed by a moderate, significant decrease until the end of the study period (Table 2).

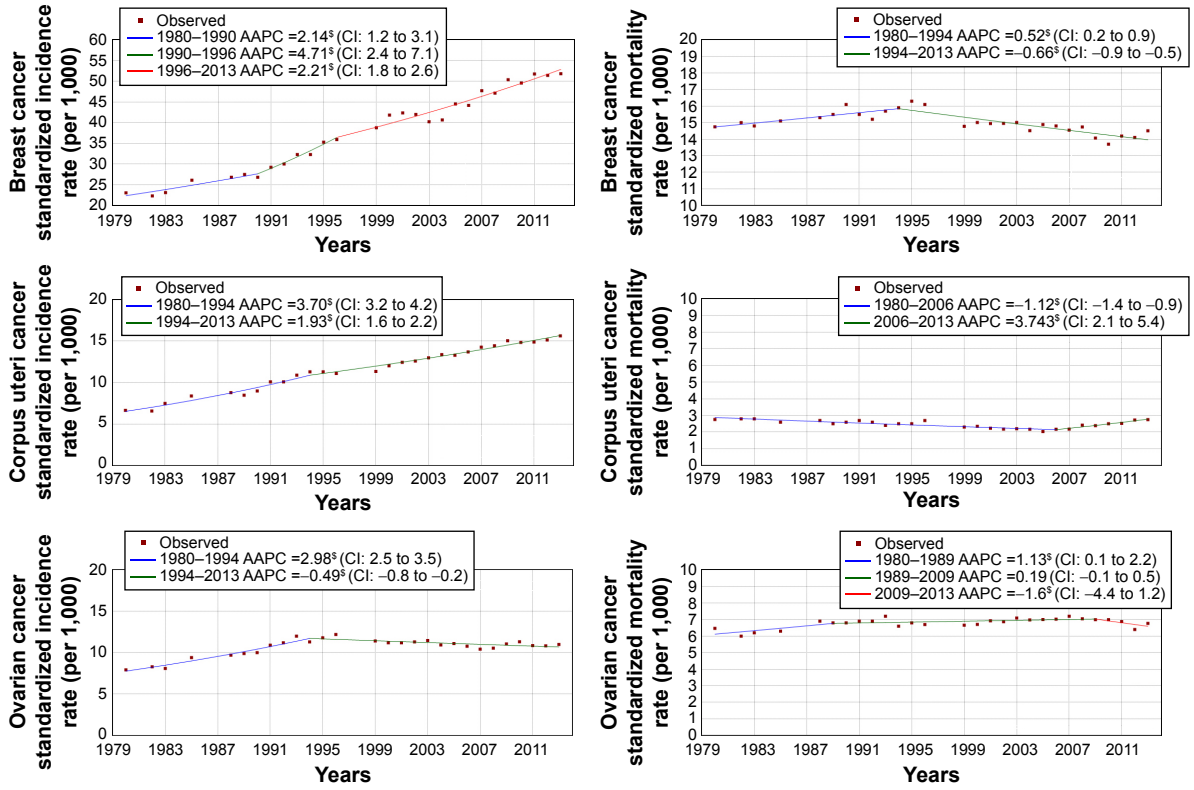

Figure 3 Standardized incidence and mortality trends in breast, corpus uteri, and ovarian cancers, 1980–2013.
Note: $$P<0.05.
Abbreviations: AAPC, average annual percentage change; CI, confidence interval.

Table 2 The age-specific incidence and mortality of breast, corpus uteri, and ovarian cancers in Poland, 1980–2013

Age, years	Breast cancer trends#		Corpus uteri cancer trends#		Ovarian cancer trends#	
	Incidence	Mortality	Incidence	Mortality	Incidence	Mortality
	AAPC, % (CI)	AAPC, % (CI)	AAPC, % (CI)	AAPC, % (CI)	AAPC, % (CI)	AAPC, % (CI)
0–4	–	–	–	–	–	–
5–9	–	–	–	–	–	–
10–14	–	–	–	–	–	–
15–19	–	–	–	–	1980–2013: –1.06 (–2.5 to 0.4)	–
20–24	1980–2013: –2.1$ (–3.6 to –0.6)	–	–	–	1980–2013: –0.86 (–1.7 to 0)	1980–2013: –3.55$ (–6.0 to –1.1)
25–29	1980–2013: 1.17$ (0.4 to 1.9)	1980–2013: –3.12$ (–4.8 to –1.4)	–	–	1980–2013: –0.2 (–1 to 0.6)	1980–2013: –3.59$ (–4.9 to –2.3)
30–34	1980–2013: 1.42$ (0.9 to 1.9)	1980–2013: –1.82$ (–2.6 to –1.1)	1980–2013: 1.44 (–0.5 to 3.4)	–	1980–2013: –0.45 (–1.1 to 0.2)	1980–2013: –2.51$ (–3.7 to –1.3)
35–39	1980–2013: 1.57$ (1.3 to 1.9)	1980–1991: –0.25 (–2.5 to 2.5) 1991–2013: –3$ (–3.7 to –2.3)	1980–2013: 1.79$ (0.9 to 2.7)	–	1980–1990: 0.05 (–2.9 to 3.1) 1990–1993: 6.65 (–23.6 to 48.8) 1993–2013: –1.29$ (–2.2 to –0.3)	1980–2013: –2.47$ (–3.0 to –2.0)
40–44	1980–1988: 4.82$ (2.4 to 7.3) 1988–2013: 1.24$ (1.80 to 1.5)	1980–1991: 1.6 (–0.3 to 3.6) 1991–2013: –2.84$ (–3.4 to –2.2)	1980–1996: 2.82$ (1.5 to 4.1) 1996–2001: –4.02 (–28.4 to 28.1) 2001–2013: 3.97$ (2.2 to 5.8)	1980–2013: –3.6$ (–4.7 to –2.4)	1980–1991: 3.62$ (1.9–5.4) 1991–2013: –1.39$ (–1.9 to –0.9)	1980–1992: 1.52 (–0.8 to 3.9) 1992–2013: –2.59$ (–3.5 to –1.7)

(*Continued*)

Table 2 (*Continued*)

Age, years	Breast cancer trends[#]		Corpus uteri cancer trends[#]		Ovarian cancer trends[#]	
	Incidence	Mortality	Incidence	Mortality	Incidence	Mortality
	AAPC, % (CI)	AAPC, % (CI)	AAPC, % (CI)	AAPC, % (CI)	AAPC, % (CI)	AAPC, % (CI)
45–49	1980–1983: −1.24 (−8.4 to 6.5) 1983–1996: 4.81[$] (3.6 to 6.1) 1996–2013: 0.27 (−0.4 to 0.9)	1980–1995: 0.66 (−0.2 to 1.5) 1995–2013: −2.69[$] (−3.3 to −2.1)	1980–2013: 1.31[$] (0.9 to 1.7)	1980–2013: −2.58[$] (−3.5 to −1.7)	1980–1993: 3.37[$] (2.5 to 4.3) 1993–2013: −1.18[$] (−1.6 to −0.7)	1980–2013: −1.05[$] (−1.5 to −0.6)
50–54	1980–1990: 1.32 (−0.1 to 2.8) 1990–2000: 6.34[$] (4.5 to 8.2) 2000–2013: 0.77 (−0.1 to 1.6)	1980–1996: 0.29 (−0.4 to 1) 1996–2013: −1.75[$] (−2.4 to −1.1)	1980–1993: 3.64[$] (2.5 to 4.7) 1993–2013: 0.53[$] (0 to 1.1)	1980–2013: −2.32[$] (−2.9 to −1.7)	1980–1995: 3.1[$] (2.2 to 4.0) 1995–2013: −0.95[$] (−1.6 to −0.3)	1980–2013: −0.15 (−0.5 to 0.2)
55–59	1980–1992: 1.56[$] (0.6 to 2.6) 1992–2001: 6.66[$] (4.9 to 8.5) 2001–2013: 1.1[$] (0.2 to 2.0)	1980–2002: 0.21 (−0.2 to 0.6) 2002–2013: −1.14 (−2 to −0.3)	1980–2002: 2.39[$] (1.9 to 2.9) 2002–2013: 0.61 (−0.5 to 1.7)	1980–2006: −2.23[$] (−2.8 to −1.7) 2006–2013: 3.5 (0 to 7.1)	1980–1995: 3.16[$] (2.5 to 3.9) 1995–2013: −0.62[$] (−1.1 to −0.1)	1980–2013: −0.02 (−0.2 to 0.2)
60–64	1980–1988: 1.31 (−1.1 to 3.7) 1988–2004: 3.65[$] (3.1 to 4.2) 2004–2007: 11.37 (−1.3 to 25.6) 2007–2013: 0.37 (−1.7 to 2.4)	1980–2013: 0.15 (−0.1 to 0.4)	1980–2009: 3.05[$] (2.8 to 3.3) 2009–2013: −2.55 (−6.2 to 1.2)	1980–1983: 9.15 (−1 to 20.4) 1983–2000: −1.8[$] (−2.9 to −0.7) 2000–2013: 1 (0 to 2.0)	1980–1996: 2.33[$] (1.7 to 2.9) 1996–2013: 0.11 (−0.5 to 0.7)	1980–2013: 0.38[$] (0.1 to 0.6)
65–69	1980–2003: 3.07[$] (2.7 to 3.5) 2003–2013: 5.6[$] (4.4 to 6.9)	1980–2013: 0.1 (−0.1 to 0.3)	1980–1993: 5.67[$] (4.4 to 6.9) 1993–2013: 2.61[$] (2.0 to 3.2)	1980–1996: 0.99[$] (0 to 2) 1996–2004: −2.99 (−7.8 to 2.1) 2004–2013: 4.66[$] (2.5 to 6.9)	1980–1991: 4.01[$] (2.2 to 5.9) 1991–2013: 0.65[$] (0.1 to 1.2)	1980–2013: 1.09[$] (0.8 to 1.4)
70–74	1980–1988: 1.15 (−1.4 to 3.8) 1988–1993: 6.94[$] (2.6 to 11.4) 1993–2013: 1.43[$] (1.0 to 1.8)	1980–1983: 10.91[$] (3.1 to 19.4) 1996–2013: 0.04 (−0.2 to 0.3)	1980–1994: 6.53[$] (5.6 to 7.4) 1994–2013: 2.98[$] (2.4 to 3.5)	1980–2009: −0.11 (−0.5 to 0.3) 2009–2013: 12.04[$] (4.5 to 20.1)	1980–1993: 4.47[$] (3.1 to 5.9) 1993–2013: 0.51 (−0.2 to 1.2)	1980–2013: 1.62[$] (1.3 to 1.9)
75–79	1980–1996: 3.95[$] (3.0 to 4.9) 1996–2013: 1.83[$] (0.9 to 2.8)	1980–1994: 2.04[$] (1.4 to 2.6) 1994–2013: −0.04 (−0.4 to 0.3)	1980–2013: 4.19[$] (3.8 to 4.6)	1980–2006: −0.13 (−0.7 to 0.5) 2006–2013: 4.82[$] (0.8 to 9.0)	1980–2002: 4.77[$] (3.8 to 5.8) 2002–2013: 0.4 (−0.3 to 1.1)	1980–2008: 2.77[$] (2.4 to 3.2) 2008–2013: −2.36 (−6.6 to 2)
80–84	1988–2013: 2.39[$] (2.0 to 2.8)	1980–2001: 1.89[$] (1.3 to 2.5) 2001–2013: −0.31 (−1.4 to 0.8)	1980–1983: −6.19 (−20.4 to 10.5) 1983–2013: 4.56[$] (4.0 to 5.2)	1980–2003: −0.11 (−1 to 0.7) 2003–2013: 3.79[$] (1.2 to 6.4)	1980–2002: 3.58[$] (2.7 to 4.4) 2002–2013: −0.22 (−2.2 to 1.8)	1980–2013: 2.87[$] (2.5 to 3.5)
85+	1988–2013: 1.51[$] (0.7 to 2.4)	1980–1992: 1.51[$] (0.3 to 2.8) 1992–2001: 4.42[$] (2.2 to 6.7) 2001–2013: 0.18 (−0.9 to 1.3)	1980–2013: 3.17[$] (2.5 to 3.8)	1980–2013: 1.98[$] (1.2 to 2.8)	1980–1995: 5.8[$] (4.1 to 7.5) 1995–2013: 0.3 (−1 to 1.6)	1980–2013: 3.58[$] (2.8 to 4.4)

Notes: [$]$P<0.05$; [#]missing data for 1981, 1985–1986, and 1997–1998.
Abbreviations: AAPC, average annual percentage change; CI, confidence interval.

In women younger than 55 years, we observed a significant decrease in OC mortality, except among patients aged 40–44 years, who showed an insignificant increase between 1980 and 1992 (Table 2). OC mortality remained stable among women aged 55–59 years for the entire study period. However, in women over 59 years old, significantly increasing OC mortality trends were present, with slopes differing from low to high (Table 2).

Discussion

This study provides population-based information on incidence and mortality trends for BC, CUC, and OC during the years 1980–2013 among the female Polish population. This study confirmed changes in incidence and mortality trends for all the analyzed cancers among the total sample, as well as by age.

The incidence of BC is increasing worldwide, predominantly in developed countries, results that are supported by our findings. For example, Torre et al reported an increase in the age-standardized incidence of BC (35–135) among women in the US in 1992–2012, and an increase in the incidence of BC was also reported in the Nordic countries, UK, Germany, and France.[23–25] This may be because increasing income, which acts as a surrogate for economic factors, along with decreasing fertility and birth rates, promoted a rise in BC incidence in the studied population. Furthermore, in women born after 1920, the BC mortality rate was stable or started to decline in 18 European countries, the US, and Canada.[26] These data are consistent with Levi et al, who found that BC mortality decreased in 38 countries during 1970–2000.[27] Results from these studies are in agreement with our findings, which showed an increase in BC mortality among Polish women until 1994, followed by a significant though minimal decrease. Furthermore, a significant, large decrease in BC mortality was observed among young women with BC during the analyzed period. The decrease in BC mortality observed in the welfare population is a result of diagnostic and treatment improvement.

In 2006, Poland started a national screening program against BC for women aged 50–69 years and based on screening mammography every 2 years.[28] As the program ran for only 10 years, with response rates varying between 35% and 50% depending on region (still lower than the 70%–75% response rate recommended by the World Health Organization), its population effects in decreased mortality will be due to occur in the next two or three decades.[28] However, the awareness of BC in women is rising. Additionally new surgical modalities, including breast-conserving therapy with adjuvant radiotherapy followed by hormonal treatment in ER- and PR-positive women and immunotherapy in HER2-positive patients resulted in improved therapeutic effects.

In Poland, CUC malignancies are the third-most common neoplasm affecting women following BC and lung cancer.[28] Recent research has shown a decline in nonendometrioid uterine adenocarcinomas and stable incidence rates for uterine sarcomas and carcinosarcomas; therefore, the increase in CUC is most likely caused by an upsurge in endometrioid adenocarcinomas.[29] Our results are consistent with data from two studies reporting an increase in the incidence of endometrial cancer in the UK and Norway.[30,31] However, another study showed relatively constant incidence of endometrioid adenocarcinoma in the Netherlands.[32] On the other hand, a reduction in endometrioid adenocarcinoma mortality was observed in Germany, the UK, Norway, and France, as well as the US.[31,32] Interestingly, subsequent detailed analyses showed that CUC mortality increased among women over 54 years old from the late 1990s to the early 2000s, followed by a decrease. However, these findings may be related to an increase in lifestyle-related comorbidities that overwhelm favorable disease prognoses and health care improvements, and thus need further evaluation.

Ovarian epithelial tumors are responsible for the vast majority of ovarian malignancies, as ovarian germ cells and sex-cord tumors are in the minority and have a stable incidence and mortality rate.[32,33] Our study confirmed a small but significant decrease in OC incidence from the mid 1990s that resulted in a slight but insignificant decline in mortality rate. Similar results were found by Waldmann et al, who reported a decrease in incidence and mortality of OC among a German population during the last two decades.[34] Another study reported stable OC incidence and mortality rates in Nordic countries for 1964–2003.[35] Interestingly, despite the decreasing fertility rate and parity, we observed a decrease in the OC incidence in the analyzed population. Additional analyses, however, showed an increasing incidence among women over 59 years old. On the other hand, there was a gradual decrease in OC incidence among women aged 35–59 years beginning in the early 1990s. Women aged 20–40 years use hormonal contraception as first-choice birth control, and although detailed data concerning prescribing hormonal contraception were unavailable, this is a strong protective factor playing a pivotal role in reduction in OC incidence despite reduced parity.[36]

Although our results are consistent with data from other studies among European and North American populations, several limitations exist. For example, in this study, cancers

were not classified histologically. Therefore, we could not distinguish between type I and II endometrial cancers nor between uterine sarcomas. While CU sarcomas account for 6%–8% of uterine cancers, type II endometrial cancer accounts for another 20%, and thus most data reflect the trends of endometrial cancer. Similarly, we were unable to distinguish between epithelial and nonepithelial OC. In addition, tumor grading and staging data were also unavailable for general access in the PNCR. Although such a detailed and comprehensive analysis would be of great interest for many physicians and epidemiologists, not including this information did not affect the final results in our opinion. Moreover, data were missing for 5 years of the total 34-year period. However, these missing data were scattered throughout the study period, limiting any influence on bias in the final analysis. Furthermore, changes to the ICD classification during the study period may have introduced a reporting bias; however, we did not observe a significant difference in incidence and mortality rates after the ICD change, indicating a lack of reporting bias. Additionally, socioeconomic data were not directly related to cancer cases; therefore, a straight-line analysis of their possible impact on incidence and mortality rates was impossible. Therefore, these data should be considered as surrogates of socioeconomic changes in the population, rather than having a direct impact on particular cancer cases. Finally, the completeness of reported data is essential to cancer epidemiology. World Health Organization recommended incidence/mortality rate as a simple tool for evaluating registry comprehensiveness. Completeness of registration is defined as estimated percentage of registered cancers, and calculated as follows:[28]

$$C = \begin{cases} 100\%, if\ C_R \geq 100 \\ K\%, if\ C_R < 100 \end{cases} \qquad C_R = \frac{R^W_{\frac{1}{D}}}{R^S_{\frac{1}{D}}} * 100$$

$R^S_{\frac{1}{D}}$ – standard incidence/death ratio[28]

In 1990, when data collection was computerized, incidence/mortality rate in women was 1.25 (lower compared to Finland, with its good cancer registry similar to the Polish population, where this ratio was 1.58) with 80% of registration completeness.[28] Since then, a gradual increase in completeness of reports has been observed, with incidence/mortality rate in the female population reaching 1.55 in 2011 with 94% completeness and 1.67 in 2013 for the total population (separate data for female population and completeness were not published).[28] Although that completeness of registered cancer incidence improved significantly, the PNCR still recommend the term "registered incidence" instead of "incidence", as incidence data are still biased by underregistration.[28]

The strength of this study are reliable data on cancer mortality, as the PNCR collects mandatory cancer-death notification. Therefore, the 34-year-long study period allowed for a comprehensive and accurate mortality-trend analysis, even if data in some years were missing.

Conclusion

The results of the present study indicate a significant increase in the incidence of BC and CUC, while the incidence of OC initially increased and then decreased. Fortunately, the mortality rates for women with BC, CUC, and OC decreased in the last decade of the study. The data also showed that age, apart from the type of malignancy, was the major factor influencing incidence and mortality trends.

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Author contributions

TB was the chief investigator and was responsible for the study concept and design, as well as data collection, analyses, and writing the manuscript. KP shared in the initial conception of the study, and drafted and critically reviewed the manuscript. GJ, DN, AL, AC participated in the study design and data analysis and reviewed the final draft. All authors read and approved the final manuscript.

Disclosure

The authors report no conflicts of interest in this work.

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