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The reversed social gradient: Higher breast cancer mortality in the higher educated compared to lower educated. A comparison of 11 European populations during the 1990s

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ABSTRACT

Higher socioeconomic position has been reported to be associated with increased risk of breast cancer mortality. Our aim was to see if this is consistently observed within 11 European populations in the 1990s. Longitudinal data on breast cancer mortality by educational level and marital status were obtained for Finland, Norway, Denmark, England and Wales, Belgium, France, Switzerland, Austria, Turin, Barcelona and Madrid. The relationship between breast cancer mortality and education was summarised by means of the relative index of inequality. A positive association was found in all populations, except for Finland, France and Barcelona. Overall, women with a higher educational level had approximately 15% greater risk of dying from breast cancer than those with lower education. This was observed both among never- and ever-married women. The greater risk of breast cancer mortality among women with a higher level of education was a persistent and generalised phenomenon in Europe in the 1990s.

1. Introduction

Socioeconomic differences in breast cancer mortality are of interest for several reasons. Firstly, the cancer site by far most prevalent in adult women in both developed and developing countries is cancer of the breast.[1] Secondly, breast cancer is the only major cause of death with a consistently positive social gradient, and this has been reported in several countries,

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Table 1 – Characteristics of the study populations, for women aged 30–69 years

Population	Follow-up period	Number of women	Percentage of women with		No. of breast cancer deaths	No. of person-years	Rate per 100,000 person-years*
			High/middle education	High education			
Finland	1991–1995	1,296,959	51	12	2309	6,414,832	35.99
Norway	1990–1995	987,441	18	8	1989	4,857,298	40.95
Denmark	1991–1995	1,274,530	46	13	3831	6,242,145	61.37
England and Wales	1991–1996	129,074	16	5	384	723,576	53.07
Belgium	1991–1995	2,530,405	32	14	6923	12,030,270	57.55
France	1990–1995	123,237	39	10	363	731,626	49.62
Austria	1991–1992	1,957,865	28	8	792	1,954,072	40.53
Switzerland	1991–1995	1,096,329	65	8	2563	5,435,184	47.16
Turin	1991–1996	265,095	26	7	723	1,255,406	57.59
Barcelona	1992–1996	437,104	26	15	1086	2,137,516	50.81
Madrid	1996–1997	1,251,541	32	15	525	1,978,308	37.95**

* Mortality rates are not age-adjusted.
** Multiplied by the factor 1/0.7 = 1.43 due to incomplete data.

including Brazil,[2] Denmark,[3,4] Czech Republic,[5] Finland,[6] France,[7] Italy,[8,9] Norway,[10,11] Spain,[12,13] Sweden[14] and the USA.[15,16] It is suggested that this positive educational gradient is mainly because the higher educated are older at the time of first childbirth.[4,11] Thirdly, breast cancer survival is higher among higher educated women,[17] and this is partly explained by stage at diagnosis,[18] but possibly also by access to screening and other factors.

Comparison of breast cancer mortality by socioeconomic position (SEP) in different populations with similar follow-up times has been done in one previous study.[19] For all populations together, a significant positive gradient in breast cancer by educational level was found for women younger than 75 years, but not for older women.

We used the same longitudinal data as Huisman et al.[19] but extended the analysis in the following ways: First, we included two additional populations (Denmark and France). Second, we looked specifically at variations between countries in educational inequalities in breast cancer mortality. Third, we distinguished between women aged 30–49 years and 50–69 years, and between married and non-married women.

We hypothesised that lower educational level is associated with decreased breast cancer mortality across all European populations. However, we expect variations between age groups (reflecting cohort effects, with smaller inequalities in younger age groups) and between marital status groups (with smaller inequalities among non-married, where the role of birth history is strongly attenuated).

2. Materials and methods

We used mortality data from an international study,[20] which obtained longitudinal data on mortality by educational level, marital position, and 5-year age groups for 11 European populations: Finland, Norway, Denmark, England and Wales, Belgium, France, Switzerland, Austria, Turin, Barcelona and Madrid. Participants were enumerated during censuses in the early 1990s and followed up for different periods (Table 1). Most data sets covered the entire national population, except France (data from the Echantillon Démographique Permanent, a 1% representative sample of the French population), Madrid (regional), Barcelona (urban), Switzerland (population living in predominantly German-speaking areas), England and Wales (data from the ONS Longitudinal Study, a 1% representative sample of the population), and Turin. For France, subjects born overseas were excluded. The present study includes women aged 30–69 years at the start of the follow-up (except the life-table calculations in Table 4, where the age range is 30+). The data sets used were described in Huisman et al.[20]

Educational level was used as a measure of socioeconomic position, and was chosen because of its wide availability across the relevant data sets, and because it has been found to be a reliable measure of socioeconomic position in European countries.[21] Education was first coded according to national classification categories. The number of educational categories ranged from 4 (in most populations) to 13 in Belgium. On the basis of the contents of these educational categories, they were converted into categories of the International Standard Classification of Education (ISCED-97).[22] In our analyses, we distinguished between three broad groups of educational categories. These groups approximately corresponded to ISCED levels 0–2 (pre-primary, primary, and lower secondary education), 3 (upper secondary education), and 4–6 (postsecondary education). Barcelona, Madrid and Belgium had the highest share of women with high education, while England and Wales and Turin had the lowest share (Table 1). Some populations had missing values for education: Denmark 11% missing, Madrid and Norway 3%, Barcelona and Switzerland 2%, while the other studies had no missing values for education.[k] Subjects with missing education were excluded from the analyses.

[k] For England and Wales information on the level of education lower than A level was not available from the census. For those with 'missing' level of education there were the following possibilities: they had received no qualifications whatsoever, they had received qualifications lower that A level, or they had received a qualification of A level or higher, but had not filled in the question at the census. We assigned those with 'missing' information to the lowest educational level for England and Wales. The possibility that this group contained some records of people with higher education that did not fill in the question cannot be excluded.

A dichotomous measure of marital position was used, classifying women as never married in one group and as married, divorced, separated or widowed in the other group. Information about marital position was missing for France and Barcelona.

Breast cancer was defined as code number 174 of the International Classification of Diseases, 9th Revision, except in Denmark and Switzerland, where both the 8th Revision (174) and the 10th Revision (C50) codes were used.

Breast cancer mortality rates were calculated for each population and educational level. The population and education specific rates were age-adjusted using the direct method. The European population of 1995, in 5-year age groups was used as the standard population (Fig. 1).

Due to data restrictions, the pooled rate for the total population was estimated by meta-analysis methodology, based on the estimate for each population and the corresponding standard error.[23] A random effects model was used (Fig. 1 and Table 2), assuming that studies were a random sample from all possible studies. In the meta-analyses, studies of small size count less, and large studies are given greater weight.

The relationship between breast cancer mortality and education was summarised by means of the relative index of inequality (RII).[24,25] This index measures the size of differences in mortality across all SEP levels, in this case educational levels. The RIIs were calculated by Poisson regression, in which each socioeconomic category was given a socioeconomic position (SEP) rank score indicating the proportion of the population having lower SEP level. Separate SEP rank scores were calculated for each population. The RII can be interpreted as comparing the hypothetical best off with the worst off person in the SEP hierarchy (for a more elaborate explanation of how to calculate the RII see: www.health-inequalities.nl). The analyses were performed separately for each population, for the age groups 30–49 years, 50–69 years and for all ages combined.[30–57] Age was included in the regression model as a control variable. Stata 8.0 was used for the analyses.

To estimate the potential impact of eliminating breast cancer on life expectancy at age 30 years, for women with high/medium and low education, the cause-elimination life table method was applied. First the total life expectancy at age 30 for the low and middle/high education groups was calculated. Then, we calculated the life expectancy if breast cancer mortality would be eliminated, and we calculated how many years would have been gained in each education group. This method requires input of the mortality rates for all age groups above 30 years, not limited to 69 years. However, for Danish data the age-range was limited to 30–69 years, therefore Denmark was left out of this life-table analysis.

3. Results

Women in Denmark had the highest breast cancer mortality rate, followed by Turin, Belgium, and England and Wales (Table 1). The lowest rates were found in Finland, Madrid and Austria. In between were Norway, Switzerland, France and Barcelona.

The age-adjusted breast cancer mortality rates among women with low education were lower than the mortality rates among those with a middle or high educational level in all populations, except in Finland, France and Barcelona. In Finland there were no differences, and in France and Barcelona the middle educated had the lowest rates (Fig. 1). Rates among women with middle or high education were often similar. Overall, higher educated women had 51.4 breast cancer deaths per 100,000 person-years, and the corresponding number was 44.8 among those with a low educational level, implying a 15% greater risk among the higher educated.

Table 2 shows the RIIs for breast cancer mortality, as a summary measure of the magnitude of mortality differences

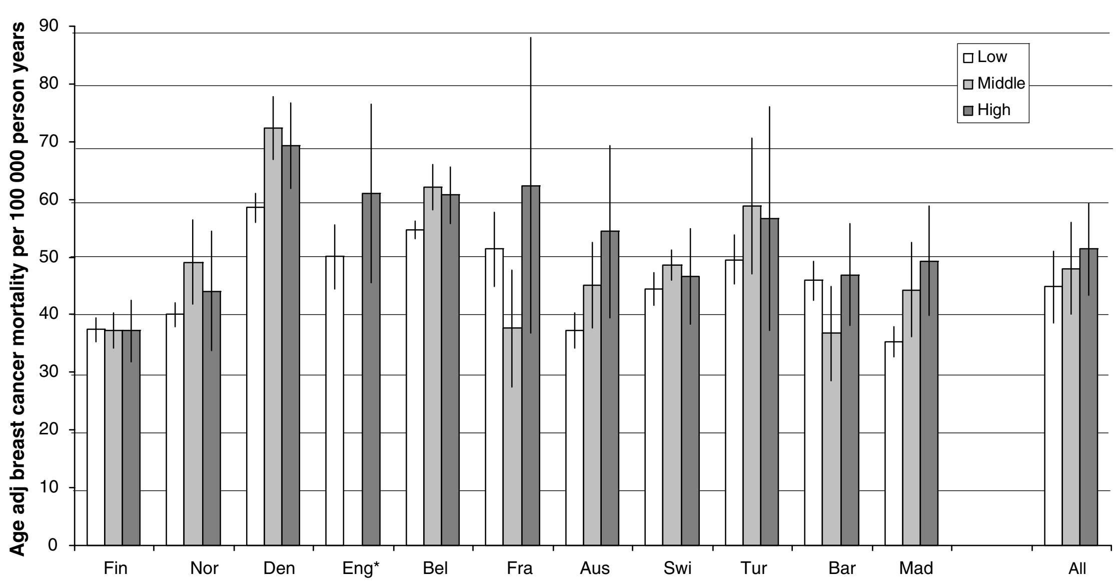

Fig. 1 – Breast cancer mortality rates among women aged 30–69 years per 100,000 person years by education and population, age adjusted (95% confidence interval).

Table 2 – Educational inequalities in breast cancer measured by RII[a] by population and age group among women aged 30–69 years

Population	30–49 years	50–69 years	Total
Finland	0.98 (0.75–1.28)	1.04 (0.83–1.30)	1.00 (0.84–1.19)
Norway	1.36 (0.94–1.97)	1.40 (1.00–1.98)	1.39 (1.07–1.79)
Denmark	1.04 (0.82–1.32)	1.60 (1.34–1.91)	1.37 (1.19–1.58)
England and Wales	2.15 (0.94–5.02)	1.24 (0.61–2.55)	1.53 (0.88–2.65)
Belgium	1.12 (0.92–1.35)	1.30 (1.13–1.49)	1.23 (1.10–1.38)
France	0.59 (0.27–1.27)	0.91 (0.49–1.71)	0.78 (0.47–1.28)
Austria	0.85 (0.46–1.60)	1.98 (1.38–2.84)	1.60 (1.17–2.20)
Switzerland	1.07 (0.79–1.46)	1.16 (0.97–1.39)	1.14 (0.98–1.34)
Turin	1.31 (0.66–2.59)	1.36 (0.87–2.14)	1.35 (0.92–1.97)
Barcelona	1.51 (0.94–2.42)	0.67 (0.43–1.04)	0.95 (0.69–1.30)
Madrid	1.40 (0.74–2.66)	1.92 (1.13–3.27)	1.69 (1.12–2.56)
All[b]	1.13 (0.87–1.47)	1.29 (1.03–1.62)	1.23 (1.01–1.51)

a RII estimated in Poisson regression models adjusted for age (RII expresses high education compared to low education).
b Pooled estimate based on meta-analysis of all populations.

Table 3 – Age adjusted breast cancer mortality rates (per 100,000 person-years) by education and marital position, and RII[a] for education by marital position among women aged 30–69 years

Education	Never married (11%)	Ever married (89%)
Low	56.54	46.10
Middle	58.12	50.06
High	62.17	53.61
RII	1.13 (0.84–1.52)	1.23 (1.06–1.42)

Barcelona and France are not included due to data restrictions. For England and Wales middle and high education were combined into high education.
a RII estimated in weighted Poisson regression models, adjusted for age (each country equal weight), (RII expresses high education compared to low education).

according to relative educational level. Most of the populations had a 23–69% excess mortality risk for the highest educated, among the women aged 30–69, while in Finland, France and Barcelona breast cancer mortality was not associated with education. The largest educational inequalities were found in Madrid and Austria. All populations combined showed a significant 23% excess mortality risk for the highest educated.

The lack of a positive association between breast cancer mortality and education in Finland and France was found for all age groups (Table 2). In Norway and Turin the positive association was stable across cohorts, while in Denmark, Belgium, Austria, Switzerland and Madrid the positive association was less for the youngest cohort compared to the older cohort. Barcelona and England and Wales were the only populations showing an increase in the association for younger compared to older ages. In the case of England and Wales the small sample size makes age-specific estimates imprecise. All the populations when combined showed a tendency for decreasing inequalities for the youngest compared to the older age cohort.

Never-married women had significantly higher breast cancer mortality than ever-married women, after adjustment for age and education (Table 3). A positive association between educational level and breast cancer mortality was found both for never- and ever-married women. The socioeconomic inequalities observed did not differ significantly between the two marital groups ($p = 0.417$, results not shown in Table 3).

In the combined study population, the difference in life expectancy at age 30 years between women with middle/high and low education was 2.19 years (Table 4). If breast cancer mortality was eliminated, the higher educated would expect to live about nine months longer. In comparison, those with low education would expect to live approximately seven months longer. In this hypothetical situation, the difference in life expectancy would increase to 2.32 years. In Finland, France and Barcelona, where the educational inequalities in breast cancer mortality were small, there would be small (less

Table 4 – Life expectancy (LE) at age 30 among the high and low educated

Population[a]	Observed LE, years		LE if breast cancer eliminated, years		LE gained if breast cancer eliminated, years	
	Education		Education		Education	
	High/medium	Low	High/medium	Low	High/medium	Low
Finland	49.80	47.43	50.32	47.88	0.52	0.45
Norway	51.21	48.76	51.91	49.28	0.70	0.52
England and Wales	49.81	47.55	50.64	48.18	0.83	0.63
Belgium	50.78	48.35	51.67	49.03	0.89	0.68
France	52.48	50.07	53.15	50.77	0.67	0.70
Austria	52.63	50.32	53.34	50.85	0.71	0.53
Switzerland	52.32	50.46	53.10	51.12	0.78	0.66
Turin	51.74	49.96	52.57	50.64	0.83	0.68
Barcelona	55.06	52.39	55.78	53.07	0.72	0.68
Madrid	56.40	55.03	57.06	55.46	0.66	0.43
All	52.22	50.03	52.93	50.63	0.73	0.60

Observed life expectancy and life expectancy in the hypothetical situation where breast cancer mortality would be completely eliminated.
a Denmark is not included due to missing data among the oldest.

than one month) differences in years gained across educational groups. In contrast, in Madrid, where the educational difference was large, the gap in life expectancy between high and low educated would increase by about three months.

4. Discussion

A positive relationship between breast cancer mortality and educational level was found in most of the 11 populations, but not in Finland, France and Barcelona. There was a tendency for the observed positive relationship to be less marked for younger women than for older women. Similar relationships were observed both among never- and ever-married women. Eliminating breast cancer mortality would give a greater gain in life expectancy for highly educated than for those with low education, resulting in a slightly larger disparity in life expectancy.

Most previous studies in the 1990s also found higher breast cancer mortality among women with higher education than with a lower level of education.[2–4,8–12,14–16,19] Studies from Finland and France have reported narrowing and disappearing educational disparities in breast cancer mortality.[6,7] Our analyses confirm the results from the studies of Finland and France, but suggest that these results were exceptional rather than representative of most European populations in the 1990s.

4.1. *Evaluation of data and methods*

Comparison of mortality data across countries is not unproblematic, as has been found in earlier studies using similar data but focusing on other causes of death.[19,20,26–30] A number of limitations should be considered. Firstly, the follow-up time between countries differed. The studies for Austria and Madrid covered one and two years, respectively, while other countries covered a period of four to five years. As a result the Austria and Madrid studies refer to a slightly younger population, which may have contributed to the observed lower mortality rates. It may also have resulted in a small overestimate of relative mortality inequalities in these populations. However, not only the relative inequalities, but also the absolute inequalities in these two populations are among the highest. Although differences in follow-up time might affect comparisons across populations, previous evaluations indicate that mortality differences by education are not strongly related to follow-up time.[31]

Secondly, the degree of misclassification of cause of death can differ between countries because of differences in certification and coding practices.[32] However, this is less likely to be a main problem since our main focus is educational inequalities in breast cancer mortality. It is unlikely that cause of death assignment is related to the educational level of deceased women. However, since people of lower educational level are likely to have more co-morbid conditions, it may be more difficult to assign the correct cause of death when there is a choice.

Thirdly, there are differences between the countries of Europe in educational qualifications and in the distribution of women according to the level of education, and hence in the meaning of the educational levels represented here as high, middle or low. However, except in Switzerland, where the proportion of highly educated people was larger, the distribution by educational levels was roughly comparable between the populations. Furthermore, the analysis was carried out by computing the relative index of inequality,[25] a measure that is based on all educational levels and that takes into account differences in the educational distribution. Thus, results between populations are likely to be approximately comparable. Nevertheless, we cannot guarantee that the findings would have been identical if all educational classifications had been optimally comparable.

For Spain and Italy, data of mortality by educational level were not available for the whole population and we had to focus on some urban areas. We are not sure that the urban populations studied are comparable to the national populations. This might be an issue if residents of rural areas had different patterns of age at first birth (leading to differences in incidence), or differences in access to screening or high quality breast cancer services (leading to differences in survival). This would especially be important if socioeconomic differences in risk factors and health service access varied according to urban-rural status. We do not have empirical evidence to support or reject this possibility for either Italy or Spain.

4.2. *Trends and cohort differences in inequalities in breast cancer mortality*

Previous studies have reported increasing breast cancer mortality rates from 1970 to 1995, both in Finland[6] and in Denmark.[3] In Finland there was a larger increase among the less educated – leading to diminishing educational differences. However, in Denmark there was an increase in breast cancer mortality for all socioeconomic groups, although as in the Finnish study there was a tendency for a larger increase among the lower SEP groups, and the socioeconomic gradient did not disappear.[3] In France, a weakening of the positive association between educational level and breast cancer mortality towards the 1990s has been reported.[7]

Why does the association between educational level and breast cancer mortality change in some countries? There is probably no easy answer to this question, but we suggest a possible explanation related to delayed first birth, which is associated with increased breast cancer risk.[33] There has been a uniform shift towards later childbearing in most European countries. A widening occurred in the difference in age at first birth between educational groups in England and Wales and Norway, while the opposite has been the trend in France and Finland.[6,34,35] This is in line with our finding of positive association of breast cancer and education in England and Wales and Norway, and the small and narrowing inequalities in Finland and France.

In most of the populations, the educational inequalities observed were smaller for the youngest cohort. The overall pattern of declining inequalities in the young age cohorts is also reflected in the pooled analysis (Table 2). The cause of the difference between the age cohorts is difficult to identify, but it has been suggested that it may be due in part to narrowing differences in reproductive behaviour among the younger birth cohorts.[7] Another explanation is that some determinants of the observed inequalities do not manifest in observed mortality until older ages.

Denmark was not an exception from the major tendency in the other European populations with regards to relative inequalities, only with regards to high absolute levels. A possible explanation for the higher absolute breast cancer rates in Denmark could be the high alcohol consumption among Danish women. In the EPIC study, a study of 10 European countries, the highest total alcohol consumption for women was observed in Denmark.[36]

4.3. *Marital status is associated with breast cancer mortality*

If the educational gradient was fully determined by birth history, we would expect a smaller gradient among the never married, as most of these women are childless. Indeed this was the case in our study. For all educational levels, there was a higher mortality rate among the never married than the ever married. There was indication of a smaller educational difference in breast cancer mortality among the never married than among the ever married, although this difference was not statistically significant.

4.4. *Larger socioeconomic inequalities in breast cancer incidence than in mortality*

In our paper, we used mortality as the outcome. Other studies have used incidence, and generally found a stronger association with social position than for mortality.[4,37–41] A previous analysis of breast cancer in England and Wales found that incidence was around 30% higher in the most affluent groups, but that there was no significant gradient in mortality.[42] This discrepancy between mortality and incidence suggests a better breast cancer survival for higher SEP women. Indeed, several studies observed higher breast cancer survival rates among higher educated women.[17,18,43–51]

In one study, stage at diagnosis was found to be the most important determinant of the SEP survival differences,[18], while in two other studies, stage distribution explained only a minor proportion of the variation in survival by social class.[43,47] Thus, it seems that difference in stage at diagnosis plays an important role, but not the only role, behind the disparities in incidence and mortality.

It might be hypothesised that differences in survival by social position may be because women in higher socioeconomic groups can utilise health services more effectively than women in lower groups. However, no support for this was found in a US study.[49] But the health care system in the US is different from those in Europe, and this finding might not be generalised to Europe. However, a recent review including European studies concluded that neither stage at diagnosis nor differential treatment between social groups can completely explain the observed socioeconomic difference in survival.[17]

An additional explanation for the higher social inequality in breast cancer incidence compared to breast cancer mortality could be that cancers detected by mammography, which are more frequent in the upper social classes,[52–55] have better prognosis for survival.[17,56,57] Thus, the fact that higher educated take up screening more could lead to a higher reported incidence of breast cancer, but also better chances of survival.

5. Conclusion

A positive relationship between breast cancer mortality and educational level (i.e. higher risks for higher educated women) was found in most of our studied European populations. However, there was a tendency for smaller inequalities in younger compared to older age cohorts. Our findings tend to support the theory that time of child-bearing is an important part of the observed socioeconomic gradient. Policies and programs to reduce breast cancer incidence and case-fatality should ensure that they will not lead to increasing socioeconomic inequalities in mortality. Equity is of course not the only consideration, but inequalities should be a concern in addition to the overall aim to reduce breast cancer incidence and mortality.

Conflict of interest statement

None declared.

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