

Research Article

Comparing Total Neoplasms, Breast & Prostate Cancer Mortality Rates of the UK and 20 Major Developed Countries 1989-91 v 2013-15 - Identifying Progress

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Abstract

Introduction: Britain's cancer survival results have been criticised as being significantly higher than twenty Major Developed Countries (MDC). Hence this comparison of current UK Total Age-Standardised-Death-Rates (ASDR), female Breast and Prostate cancer mortality rates with twenty (MDC) between 1989 to 2015 to determine any significant change.

Method: WHO data ASDR per million (pm) for Total, Breast and Prostate cancer mortality rates examined for

the years 1989-91 to 2013-15. Confidence Intervals (+/- 95%) are used to determine any significant differences between the UK and other country's outcomes over the period. Chi square tests for each nation's Breast and Prostate mortality.

Results: Every country's Total ASDR, Breast and Prostate cancer mortality fell except Greece and Japan. Total ASDR Male cancer mortality rates ranged from Portugal 1653pm to Sweden 1232pm. UK at 1475pm were 10th but had been 6th highest. Total ASDR Female

rates went from Denmark's 1176pm to Japan's 740pm, the UK 1092pm now 5th but previously had been second highest. No country's Total rates fell significantly more than Britain's who had significantly bigger reductions than four other countries for both sexes. *Breast* mortality ranged from Ireland's 206pm to Japan's 99pm, UK rates fell significantly more than five countries. Whilst Breast mortality fell in every country Norway and UK had significantly bigger reductions in Breast than Prostate deaths, conversely France's Prostate rates fell more than Breast mortality. *Prostate* mortality went from Norway 213pm Japan's 60pm, the UK 167pm and five countries had greater reductions than Britain.

Conclusions: Results reflect well on UK services for Total and Breast cancers, showing the NHS achieving more with proportionately less as Britain spends less on health than most MDC. The need how to improve UK prostate results are briefly discussed, such as a public information campaign to match the successful Breast cancer aware programme of the 1990's.

Keywords: Prostate Cancer; Breast Cancer; International Comparison

1. Introduction

UK cancer survival rates have been found to be poorer than some other developed countries [1-3]. However, survival rates as a measure of improved treatment have been criticised as being less accurate [4, 5] and that measuring mortality rates provides a better indication of relative effectiveness [6]. Moreover, over the past two decades there have been major reductions in cancer mortality in most of twenty-one Major Developed Countries (MDC) [6-8]. These improvements are associated with reduced smoking, a confirmatory indicator that life-style behaviour is linked to the development of cancer [9, 10]. This is exemplified by

the association of raised BMI with neoplastic disease [11], and the multiplicity of contributory causes for cancer, the role of both genetic and epigenetic factors being readily acknowledged [12-14]. However, findings both in the USA and the UK point towards the importance of strong socio-economic factors. Thus, variations in cancer mortality between people in higher and lower socio-economic groups and in the richer and poorer regions of Britain, highlight the significance of wider environmental factors in addition to any underlying genetic predisposition [15-18].

One intriguing finding is that Western Europe - which contains 9% of the world population - has 25% of the world incidence of cancer [8]. Is this because of the greater availability of diagnostic services?. For example, with prostate cancer rates have never been so high but this is ascribed to the use of PSA testing and improved diagnosis. Moreover, some have stated that the use of screening may have resulted in an over diagnosis of prostate cancer, with the detected cancer often being of low malignant potential and with no need for invasive treatment [19-21]. In a study of the current incidence of cancer in Europe there were 3.91 million new cases in 2018, the most prevalent sites being breast, colorectal, lung and prostate [8]. A recent study on the projections of cancer in Europe from 2015 up to 2035 suggested that there will be a slight decrease in male cancer rates (0.03%) but an increase of 0.11% in female cancer rates [7]. This raises the question of why? Thus, although any long- term study of cancer mortality rates will show that female cancer mortality is generally still lower than males - the gap has narrowed. It also suggests that macro socio-economic changes, perhaps related in- part to the greater integration of women into the work place, has led to a situation where they too are now at a similar risk of exposure to any work related environmental carcinogenic triggers, as their male counterparts [11, 13, 14].

These questions have led to this explorative study that examines changes in Total cancer rates, as reported using WHO Age-Standardised-Death-Rates (ASDR), which control for age, gender and population and of the archetypal gender cancers of female breast and prostate disease in the UK compared with the twenty other MDC [22]. We have placed the analysis within an international comparative perspective because earlier research on post-diagnosis cancer survival was quite critical of the UK *survival* results [1-3]. However, there are inherent problems in measuring survival rates, which were often based upon different baselines [4, 5], whereas it has been shown that counting actual *mortality* rates resolves this dilemma and provides a firmer comparative parameter [6]. Consequently, we ask whether over the past twenty-five years, have there been any significant differences in the reductions between total ASDR for ALL cancers by gender with a separate analysis of female breast and prostate mortality rates in the UK compared to the other twenty MDC. The working null hypothesis is that there will be no statistically significant difference in the reductions between male and female total cancer mortality and between female breast and prostate cancer deaths, between the UK and other MDC over the period 1989-91 and 2013-15.

2. Methods

This is a population-based study. All mortality data is drawn from the latest WHO annual statistics, updated May 2018 [22]. The output of national efforts to effectively prevent and treat cancer, can be seen in the current WHO Total cancer mortality statistics based upon Age-Standardised-Death-Rates (ASDR) per million (pm) for ALL Malignant Neoplasm deaths by sex in the International Classification of Diseases (coded C00 – C97) [23]. This is used in WHO data and for ASDR for Prostate cancer deaths (ICD 10 coded C61) and female Breast cancer (ICD 10 coded C50)

rates per million (pm) [23]. Age-Standardised-Death-Rates (ASDR) are used to compare between different countries, crucially based upon estimates of the average world population age-structure constructed for the period 2000-2025. The use of an average world population as well as a time series of observations, removes the effects of historical events such as wars and famine on population age composition [22]. It should be noted that the WHO Age-Standardized-Death-Rates based on the new standard are not comparable to previous estimates that are based on some earlier standard [22]. However, WHO acknowledge that to some extent for European countries, there is a slight inherent emphasis on how elderly rates contribute to the final ASDR. The real value of using ASDR is that it creates an equality between rates in different countries highlighting the true variation between countries after controlling for age, sex, population and disease patterns. Thus, the use of ASDR is a more powerful comparative rate enables comparisons to be made between countries of differing size, age structure from which to produce a percentage or ratio of change in mortality rates over the period.

The baseline years are the 3years averages for 1989-91, compared with the index 3year average for 2013-15. Four countries have earlier index years, Canada and New Zealand 2011-13 and France and Ireland for 2012-14. Any significant differences between the UK and the other MDC are tested by calculating Confidence Intervals (+/- 95%) using the SPSS programme. In addition, any variation between a country's female Breast and Prostate outcomes are compared by using chi square tests, with probability levels of <0.05 (2-tailed) which were considered statistically significant using data from the breast and prostate mortality tables. The study provides a profile of how well each nation has improved its cancer mortality, in particular for Breast and Prostate cancers, which was a major aim of the

'Strategy for Cancer' of the UK government [24] and compares the UK outcomes between 1989-91 v 2013-15 with the twenty other MDC.

3. Results

3.1 Total (ASDR) cancer mortality by sex

3.1.1 Total male neoplasm ASDR: These are shown in Table 1 and demonstrates that every country reduced its Total mortality rates over the period 1989-91 to 2013-15. The highest rates were seen in Portugal at 1653pm, followed by France at 1613pm and Greece at 1607pm down to lows in Sweden at 1232pm, Finland at 1241pm and Switzerland at 1255pm The UK was 10th highest at 1475pm with the current average of the other MDC (minus the UK) being 1439pm. The UK improved its mortality relative position from previously being sixth highest to falling to tenth, even as all the other countries reduced their mortality rates.

The average MDC reduction in Total male mortality rates was 27% to the UK's 31%. Confidence Interval results showed that UK males had significantly bigger reductions in mortality than Portugal, Greece, Spain and Sweden, whilst no country had significantly bigger falls in total male cancer mortality rates than the UK over the period

3.1.2 Female total neoplasm ASDR: The highest female Total ASDR was seen in Denmark at 1176pm followed by Ireland at 1152pm and the Netherlands at 1143pm down to Japan at 740pm, Spain at 775pm and Portugal at 814pm, the other MDC averaged 946pm. The UK is now 5th at 1092pm after been third highest in the 1989-91 period. The other MDC average reduction was 16% to the UK's 25%. Confidence Intervals showed that the UK had statistically significant larger reductions over the period than Australia, France, Greece, Italy and the Netherlands, whilst again no other country had bigger falls in total

female cancer mortality than the UK.

3.1.3 Female breast cancer ASDR: Every country, except Japan had substantial reductions over the period, with falls ranging from -27% to -45%, with the other MDC averaging -35%. The highest current rates are in Ireland at 206pm, the Netherlands at 190pm and Germany and New Zealand at 177pm, down to lows of 99pm in Japan, 118pm in Norway, and 123pm in Spain, the other MDC averaged 156pm. The UK were fifth at 174pm but previously had been second highest. The other MDC average reduction was 34% to the UK's 47% over the period. Confidence Interval results showed that the UK had significantly bigger reductions over the period than France, Germany, Greece, Japan and Portugal. Furthermore, no other nation had significantly greater falls in breast cancer mortality than the UK.

3.1.4 Prostate cancer ASDR: Every country, except Greece (+6%) and Japan (+20%) had substantial falls in prostate mortality, ranging from -17% to -49%, the other MDC averaging 32% to the UK's 22% fall over the period. Highest prostate cancer mortality rates were seen in Norway at 213pm, Sweden at 210pm and Denmark at 207pm. The lowest was 60pm in Japan, 93pm in Italy and 108pm in the USA, the other MDC averaged 143pm. The UK's position relatively worsened as Britain is now fifth highest at 167pm having previously been 15th of the twenty-one countries. Confidence Intervals showed that Austria, Belgium, Canada, France, and the USA had statistically significant bigger reductions in prostate cancer mortality than the UK over the period.

3.1.5 Changes in national breast and prostate mortalities: In comparing each country's breast and prostate outcomes over the period only France had a greater reduction in prostate deaths compared with falls

in breast cancer mortality ($p < 0.02$). Conversely, there were significantly greater reductions in breast cancer compared to prostate cancer mortality in Norway (< 0.04) and the UK ($p < 0.01$). Thus, with these three exceptions the archetypal of male and female cancers had relatively similar improvements over the period in the majority of MDC.

Country, Year, & Current rank	Males 1989-91	Males 2013-15	% of change	CI Lower	CI Upper
1.Portugal	1704	1653	-3	1.27	1.54
2.France 2012-14	2371	1613	-32	0.89	1.07
3.Greece	1652	1607	-3	1.27	1.54
4.Netherlands	2284	1577	-31	0.91	1.09
5.Spain	2006	1544	-23	1.01	1.22
6.Denmark	2186	1541	-30	0.92	1.11
7.Belgium	2339	1510	-35	0.85	1.02
8.Ireland 2012-14	2052	1504	-27	0.96	1.16
9.Italy	2227	1490	-33	0.88	1.06
10.UK	2124	1475	-31	0.91	1.10
11. Germany 1990	2103	1475	-30	0.92	1.11
12. New Zealand 2011-13	1986	1422	-28	0.94	1.13
13.Austria	2093	1418	-32	0.89	1.07
14.Japan	1977	1375	-30	0.91	1.10
15.Canada 2011-13	1986	1360	-32	0.90	1.09
16.Australia	1883	1330	-29	0.92	1.12
17.Norway	1741	1318	-24	0.99	1.20
18.USA	1949	1310	-33	0.88	1.07
19.Switzerland 1993-95	1773	1255	-29	0.92	1.12
20. Finland	1837	1241	-32	0.88	1.07
21.Sweden	1555	1232	-21	1.03	1.26
MDC Average (-UK)	1985	1439	-27		

Correlating ranks of % reduction with %GDPEH $Rho = +0.4573$ $p < 0.025$.

UK: MDC Significantly different CI in BOLD

Table 1: Male Total Neoplasms ASDR per million 1989-2015. Ranked by Highest rates. Confidence Intervals Compares UK Reductions to Other Major Developed Countries.

Country, Year & Current rank	Female 1989-91	Female 2013-15	% of Change	CI Lower	CI Upper
1.Denmark	1634	1176	-28	0.86	1.06
2.Ireland 2012-14	1410	1152	-28	0.97	1.21
3. Netherlands	1278	1143	-21	1.06	1.33

4. N. Zealand 2011-13	1451	1095	-25	0.90	1.12
5.UK	1448	1092	-25	0.89	1.12
6.Canada 2011-13	1272	1040	-19	0.97	1.21
7.Germany 1990	1272	978	-23	0.91	1.14
8.USA	1279	976	-25	0.90	1.13
9.Sweden	1148	962	-18	0.99	1.25
10.Belgium	1199	957	-23	0.94	1.19
11.Norway	1186	947	-22	0.94	1.19
12.Austria	1273	938	-27	0.87	1.10
13.Italy	1148	922	-20	1.13	1.41
14. Australia	1157	904	-19	0.92	1.16
15.France	1054	893	-23	1.00	1.27
16. Finland	1091	842	-23	0.91	1.15
17. Greece	883	841	-8	1.12	1.43
18. Switzerland 1993	1052	823	-21	0.92	1.17
19. Portugal	1011	814	-19	0.95	1.21
20. Spain	962	775	-19	0.94	1.21
21. Japan	913	740	-19	0.95	1.22
Average (-UK)	1120	946	-16		

Correlating ranks of % reduction with %GDPEH Rho= +0.15999 n.sig.

UK: MDC Significantly different CI in BOLD

Table 2: Female Total Neoplasms ASDR per million 1989-2015 ranked by highest rates. Confidence Intervals

Compares UK Reductions to Other Major Developed Countries.

Country, Years & Current rank	Breast 1989 v 2015	% Change	CI UK:MDC	
			Lower	Upper
1. Ireland 2012-14	336 – 206	-39	0.89	1.48
2. Netherlands	303 – 190	-37	0.91	1.52
3. Germany 1990	244 – 177	-27	1.04	1.78
3. New Zealand 2011-13	298 – 177	-40	0.86	1.45
5.UK	326 - 174	-47	0.77	1.30
6. Denmark	288 – 172	-40	0.86	1.45
7. France 2012-14	219 – 170	-28	1.11	1.91
8. Italy	233 – 160	-31	0.98	1.69
9. Austria	247 – 158	-36	0.91	1.57
10. Greece	171 – 157	-8	1.29	1.72
11. Canada 2011-13	266 – 155	-42	0.83	1.43

11. Switzerland 93	281 – 155	-45	0.79	1.39
13. Belgium	297 – 154	-48	0.74	1.27
14.USA	249 – 150	-40	0.89	1.48
15. Australia	235 – 143	-42	0.86	1.50
16. Portugal 2012-14	194 – 139	-28	1.01	1.79
17. Sweden	198- 134	-32	0.95	1.69
18. Finland	186 – 131	-30	0.99	1.76
19. Spain	192 – 123	-36	0.90	1.61
20. Norway	212 – 118	-46	0.78	1.39
21. Japan	68 - 99	+46	1.90	3.91
MDC Average (-UK)	236- 156	-34		

Correlating ranks of % reduction with %GDPEH Rho= -0.0872 n.sig.

UK:MDC Significantly different CI in BOLD

Table 3: Female Breast Cancer Deaths ASDR per million 1989-91 v 2013-15 ranked by highest rates. Confidence intervals Compares UK with Other Major Developed Countries.

Country, Years & Current rank	Prostate 1989 v 2015	% Change	CI UK: MDC	
			Lower	Upper
1.Norway	280- 213	-24	0.74	1.28
2.Sweden	267- 210	-21	0.77	1.32
3.Denmark	249 - 207	-17	0.81	1.40
4.New Zealand 2011-13	237- 168	-29	0.68	1.21
5.UK	214 – 167	-22	0.75	1.33
6.Ireland 2012-14	230 - 163	-29	0.68	1.21
7.Netherlands	237 - 161	-32	0.65	1.16
8.Switzerland 93	248- 156	-37	0.61	1.07
9.Finland	236- 155	-34	0.63	1.12
10.Portugal 2012-14	185 – 154	-17	0.79	1.43
11.Australia	230 - 147	-36	0.61	1.09
12.Germany 1990	212 - 145	-32	0.65	1.17
13.Austria	231 - 130	-44	0.54	0.97
14.Belgium	238 - 123	-49	0.49	0.89
15.France 2012-14	223- 122	-45	0.52	0.95
16. Canada 2011-13	217 - 120	-45	0.52	0.96
17.Greece	108- 115	+6	0.98	1.90
18.Spain	170 – 111	-35	0.61	1.14
19.USA	218- 108	-50	0.47	0.86

20.Italy	149- 93	-38	0.58	1.11
21.Japan	50 – 60	+20	1.00	2.36
Average (- UK) % change	210-143	-32		

Correlating ranks of % reduction with %GDPEH Rho= +0.15378 p<0.01

UK: MDC Significantly different CI in BOLD

Table 4: Prostate Cancer Deaths ASDR per million 1989-91 v 2013-15. Ranked by highest rates. Confidence intervals Compares UK with Other Major Developed Countries.

Country & Years	Breast Ratio of Change	Prostate Ratio of Change	Chi Square P value
1.UK	0.53	0.78	7.43 - p<0.006
2.Denmark	0.60	0.83	6.05 – p<0.02
3.Norway	0.54	0.76	4.56 – p<0.04
4.France	0.72	0.55	5.30 - p<0.03
6=.Japan	1.46	1.20	2.19 - p<0.2
6=.New Zealand	0.60	0.71	1.63 - p<0.2
6=.USA	0.60	0.50	1.56 - p<0.2
9=Ireland	0.61	0.71	1.15 - p<0.3
9=.Sweden	0.68	0.79	1.07 - p<0.3
9=.Portugal	0.72	0.83	0.93 - p<0.3
12=.Greece	0.92	1.06	0.73 - p<0.4
12=.Switzerland	0.55	0.63	0.85 - p<0.4
12=.Austria	0.64	0.54	0.74 - p<0.4
15=.Netherlands	0.63	0.68	0.33 - p<0.6
15=.Italy	0.69	0.62	0.33 - p<0.6
17=.Germany	0.73	0.68	0.16 - p<0.7
17=.Finland	0.70	0.66	0.23 - p<0.7
19.Canada	0.58	0.55	0.12 - p<0.8
20=.Spain	0.64	0.65	0.13 - p<0.9
20=.Belgium	0.52	0.51	0.10 - p<0.9

Significant in BOLD

Table 5: Chi Square Results Comparing Changes in Breast v Prostate Mortality 1989-2015. Ranked By Widest Breast v Prostate Reduction.

4. Discussion

4.1 Limitations

This study is inevitably a broad-brush analysis. Whilst it demonstrates there have been differences between

British female breast and prostate cancer outcomes, we do not know about any changes in cancer deaths in other male sites, which might have accounted for the comparatively good Total cancer outcomes for UK

males. Furthermore, this study cannot explain the reasons for the significant differences that have been identified between the UK and other countries which will require country-specific further research. Notwithstanding, the study provides a baseline to measure any future progress. The null hypothesis can be partly rejected as UK male and female Total cancer mortality rates fell proportionally more than four other major developed countries and none had improved more than Britain. However, whilst the UK did significantly better than five other MDC for breast cancer mortality the UK had a substantially worse outcome than five nations for prostate cancer over the period. Thus, relatively and comparatively, British males did less well than UK females. In relation to prostate and breast cancer France and Norway had relatively different outcomes for their exemplar male female cancer rates. We can only speculate as to why this might have happened.

One salient finding is that every country has reduced its Total male and female cancer deaths which reflects well on cancer services in most countries and should be a boost for the morale of patients and front-line staff. It is noteworthy that reductions of UK Total male and female plus female breast cancer rates were better than the average falls of the other countries. This should provide a more positive message than studies of poorer UK survival rates [1-3]. However, despite these undoubted improvements, UK actual mortality rates are still slightly higher than the average of the other MDC total, breast and prostate cancers. Nevertheless, it should be remembered that the UK had the lowest average %GDPEH over the 1980-2016 period which is a nation's fiscal context in which all services operate. Indeed it has been found that whilst currently the UK is 13th highest of the twenty-one MDC in terms of current percentage of GDP on health, over the period from 1980 to 2016, the UK still has the lowest average of all

nations over the period [25, 26]. Whilst this reflects very positively on the total male and female reductions in cancer mortality, it highlights the relatively weaker outcome of the UK's prostate results, which must be a matter of concern. The importance of an effective early diagnosis for both prostate and breast cancers is recognised and it has been argued that PSA screening is the most effective way forward [19, 20], although some have expressed concern about cost [21]. MRI approaches might be superior in determining the risk related to aggressive prostate cancer but cost and access are potential issues although the role of MRI in prostate cancer screening is to be the study of an upcoming trial (ReIMAGINE) [27].

However, there continues to be a problem of over-diagnosis and some unnecessary invasive treatment [2]. For whilst prostate cancers are a major cause of European mortality, twenty years after testing it was found that around 100 men need to be screened to prevent one prostate cancer death although PSA testing has contributed to reduced prostate cancer mortality [29] as well as a strategy of active surveillance that reduces unnecessary invasive procedures [19, 20]. Against this background of an encouraging reduction in prostate cancer deaths, it is difficult to explain the relative anomaly of the UK results, especially against general improvements in overall UK male cancer outcomes, in comparison with British female breast cancer results over the period. The medical and technological developments related to urology and cancer treatments are recognised across the Western world, so might the UK's worsened position be due to British urology services being proportionately less well funded than others, though a recent direct comparison on 24 mortality categories, the UK had significantly lower overall rates than the USA [30].

One barrier to early PSA testing and screening is the

concern about possible stress to the patient surrounding such a potential diagnosis. However, a British study found most men were quite resilient, though results were negatively influenced by socio-economic factors [31] but relatively easy access to a GP can help in avoiding these problems [15]. Indeed, apart from disproportionate high anxiety about colorectal cancer, anxieties surrounding screening for cancer are relatively quickly resolved [32]. This brings us to the conclusion that there is need for UK specific research to seek to explain this apparent anomaly so that urology services for prostate cancer, whilst undoubtedly improved, can match the successes seen with UK breast and total cancer services.

One possible reason for the slower improvements in prostate cancer outcomes may be due to a lack of a sustained public campaign, as it does not seem that British men are more anxious about screening for prostate [30]. Such an approach should and could be positive, highlighting that prostate cancer mortality rates have never been lower and treatment more effective and that the PSA test is very simple although PSA screening is not endorsed by the British Association of Urological Surgeons. However, a new initiative by *Prostate Cancer UK* has called for a March for Men, similar to the *Breast Cancer UK awareness project* as it recognised the apparent reluctance of men to recognise problems and seek help for them. Crucially anything that would encourage men to come forward earlier to their GP's 'well-men' project, may lead to British prostate mortality rates being even lower. However, overall, these results should be encouraging for patients, their families and front-line staff, especially in the UK, which continues to clinically achieve proportionally more with financially relatively less [30].

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Ethical Statement

This study was an original analysis of secondary data and no people or animals were involved so no ethical approval was required.

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