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Cancers attributable to overweight and obesity in the UK in 2010

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In 2002, the International Agency for Research on Cancer Handbook on Weight Control and Physical Activity concluded that overweight and obesity are related to cancers of the colon, endometrium, kidney and oesophagus (adenocarcinomas), as well as postmenopausal breast cancer. Since that report, continuing epidemiological investigation has suggested that other cancers are related to obesity and overweight. In addition to those listed above, the report by the World Cancer Research Fund (WCRF) Panel on Food, Nutrition, Physical Activity, and the Prevention of Cancer (WCRF, 2007) considered that there was convincing evidence for an association with cancers of the pancreas and rectum (as well as colon), and a probable association with cancers of the gall bladder. The fraction of these cancers occurring in 2010 attributable to overweight and obesity in the UK population is estimated in this section.

METHODS

The estimates of risk associated with overweight (BMI $25 < 30\,kg\,m^{-2}$) and obesity (BMI $30+\,kg\,m^{-2}$), relative to a BMI $\leqslant 25\,kg\,m^{-2}$, for the seven cancers, are shown in Table 1. The estimates of relative risk for an increase of $5\,kg\,m^{-2}$ from the meta-analyses by WCRF (2007) have been used for the category 'overweight'. Assuming a constant rate of increase in risk with BMI, the square of this value was taken for the category 'obese'. For postmenopausal breast cancer, WCRF reported that the increase in risk was 8% per BMI increase of $5\,kg\,m^{-2}$ for cohort studies (17 considered) and 13% per BMI increase of $5\,kg\,m^{-2}$ for case–control studies (48 considered). The estimates from the meta-analyses of Bergstrom *et al* (2001) and Renehan *et al* (2008) were almost identical (12% per BMI increase of $5\,kg\,m^{-2}$), and thus this value has been selected.

The latent period, or interval between 'exposure' to overweight/obesity and the appropriate increase in risk of these cancers, is not known. Renehan *et al* (2008) calculated the geometric mean duration of follow-up in the cohort studies available for a meta-analysis of relative risks due to overweight and obesity. The periods ranged from 8.4 years (for breast cancer) to 12.7 years (for gall bladder cancer). We therefore chose to assume that the latency between 'exposure' and outcome would be, on average, 10 years, and thus examine the effects on cancers occurring in 2010 from suboptimal levels of body mass in 2000. The proportion of adults in the age group of 19 – 64 who were overweight or obese in Great Britain in 2000 – 2001 is available from the National Diet and Nutrition Survey (FSA, 2004; Table 4.1). For older adults (aged $\geqslant 65$), we used the values for 2000 from the Health Survey for England (Health and Social Care Information Centre, 2010). The results are shown in Table 2.

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Table 1 Relative risks associated with overweight and obesity

	Relative risks		Excess relative risks	
Cancer (site)	**Overweight**	**Obese**	**Overweight**	**Obese**
Breast (post-menopausal)[a,b]	1.12	1.25	0.12	0.25
Colorectum[c]	1.15	1.32	0.15	0.32
Oesophagus (adenocarcinoma)[c]	1.55	2.40	0.55	1.40
Kidney[c]	1.31	1.72	0.31	0.72
Endometrium[c]	1.52	2.31	0.52	1.31
Gall bladder[c]	1.23	1.51	0.23	0.51
Pancreas[c]	1.14	1.30	0.14	0.30

[a]From Bergstrom *et al* (2001). [b]From Renehan *et al* (2008). [c]From WCRF (2007).

Table 2 Prevalence of overweight and obesity in Great Britain in 2000 – 2001

	Prevalence of overweight and obesity by age group (years)					
BMI	**19 – 24[a]**	**25 – 34[a]**	**35 – 49[a]**	**50 – 64[a]**	**65 – 74[b]**	**⩾75[b]**
Men						
25 < 30 (overweight)	0.25	0.42	0.45	0.46	0.50	0.52
⩾30 (obese)	0.18	0.18	0.25	0.32	0.24	0.17
Women						
25 < 30 (overweight)	0.25	0.28	0.31	0.41	0.41	0.41
⩾30 (obese)	0.14	0.16	0.23	0.22	0.30	0.23

Abbreviations: BMI = body mass index. [a]From the National Diet and Nutrition Survey (ages 19 – 64). [b]From Health Survey for England (ages > 65).

Table 3 Cancer cases diagnosed in 2010 attributable to overweight and obesity in 2000

				Cases attributable to obesity for each cancer																					
Age (years)		Proportion overweight or obese in 2000		Oesophagus (adeno-carcinoma)[a,b]			Gallbladder			Pancreas			Colon-rectum			Breast			Corpus uteri			Kidney		
At exposure	At outcome (+10 years)	Over-weight	Obese	PAF	Obs.	Excess attributable cases	PAF	Obs.	Excess attributable cases	PAF	Obs.	Excess attributable cases	PAF	Obs.	Excess attributable cases	PAF	Obs.	Excess attributable cases	PAF	Obs.	Excess attributable cases	PAF	Obs.	Excess attributable cases
Men																								
19–24	25–34	0.25	0.18	0.28	4	1	0.13	0	0.0	0.08	9	0.7	0.09	133	11.6							0.17	31	5.3
24–34	35–44	0.42	0.18	0.33	27	9	0.16	1	0.2	0.10	67	6.8	0.11	397	42.9							0.21	206	42.4
35–49	45–59	0.45	0.25	0.37	358	134	0.19	24	4.5	0.12	587	71.1	0.13	2921	376.9							0.24	1142	275.9
50–64	60–74	0.46	0.32	0.41	1405	579	0.21	83	17.6	0.14	1771	244.6	0.15	9481	1392.8							0.27	2368	641.7
65–74	75–84	0.50	0.24	0.38	963	589	0.19	59	11.5	0.13	1188	149.2	0.13	6774	905.6							0.25	1418	352.7
⩾75	⩾85	0.52	0.17	0.34	371	227	0.17	22	3.8	0.11	460	50.6	0.12	2388	279.7							0.22	472	104.0
Total (%)		—	—	—	5713	1538 (26.9)		191	37.5 (19.7)		4084	523.1 (12.8)		22 127	3009.4 (13.6)								5697	1422.0 (25.0)
Women																								
19–24	25–34	0.25	0.14	0.25	1	0.2	0.11	1	0.1	0.07	11	0.8	0.08	136	10.2	0.00	634	0.0	0.24	38	9.0	0.15	29	4.3
24–34	35–44	0.28	0.16	0.27	4	1.2	0.13	8	1.0	0.08	53	4.2	0.09	402	34.4	0.00	4012	0.0	0.26	211	55.3	0.17	110	18.4
35–49	45–59	0.31	0.23	0.33	50	16.5	0.16	73	11.6	0.10	437	44.1	0.11	2292	246.8	0.09	15 203	1328.0	0.32	1926	609.2	0.21	554	114.6
50–64	60–74	0.41	0.22	0.35	267	93.0	0.17	198	34.0	0.11	1520	166.9	0.12	6116	715.3	0.10	18 120	1724.3	0.33	3844	1283.9	0.22	1275	282.5
65–74	75–84	0.41	0.30	0.39	320	125.9	0.20	143	28.6	0.13	1374	177.4	0.14	5527	759.3	0.11	7855	881.0	0.38	1570	594.8	0.26	903	231.2
⩾75	⩾85	0.41	0.23	0.36	220	78.5	0.18	86	15.2	0.11	884	100.2	0.12	3283	396.3	0.10	4410	433.4	0.34	605	207.2	0.23	428	97.6
Total (%)		—	—		2819	315.3 (11.2)		509	90.5 (17.8)		4280	493.6 (11.5)		17 787	2162.4 (12.2)		48 385	4366.7 (9.0)		8195	2759.3 (33.7)		3365	748.6 (22.2)
Persons																								
19–24	25–34	—	—		0	1.2		1	0.1		20	1.5		269	21.8		634	0.0		38	9.0		60	9.6
24–34	35–44	—	—		31	10.0		9	1.2		120	11.0		799	77.3		4012	0.0		211	55.3		316	60.8
35–49	45–59	—	—		408	150.4		97	16.1		1024	115.3		5213	623.7		15 203	1328.0		1926	609.2		1696	390.5
50–64	60–74	—	—		1672	672.4		281	51.6		3291	411.5		15 597	2108.1		18 120	1724.3		3844	1283.9		3643	924.2
65–74	75–84	—	—		1283	714.4		202	40.0		2562	326.6		12 301	1664.9		7855	881.0		1570	594.8		2321	
⩾75	⩾85	—	—		591	305.1		108	19.0		1344	150.8		5671			4410			605	207.2		900	
Total (%)		—	—		8532	1853 (21.7)		700	128 (18.3)		8364	1017 (12.2)		39 914	5172 (13.0)		48 385	4367 (9.0)		8195	2759 (33.7)		9062	2171 (24.0)

Abbreviations: Obs = observed cases; PAF = population-attributable fraction. [a]Observed cases are for adenocarcinoma only. [b]Total observed cases (and percentages) are for all oesophageal cancers, and so are greater than the sum of observed cases.

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The number of oesophageal cancers diagnosed in 2010 was partitioned by histological subtype, according to the age- and sex-specific distribution observed in the UK Cancer registries reporting to Cancer Incidence in Five Continents, Volume VIII (Parkin *et al*, 2002). These age-specific proportions were scaled to correspond to the crude proportions observed in the UK registries in 2000–2002 (Curado *et al*, 2007), when adenocarcinomas comprised 69.9% of oesophageal cancers in men and 39.9% in women.

The population-attributable fraction (PAF) was calculated for each sex–age group, corresponding to the level of overweight/obesity 10 years previously, according to the usual formula:

$$\mathrm{PAF} = \frac{(p_1 \times \mathrm{ERR}_1) + (p_2 \times \mathrm{ERR}_2)}{1 + [(p_1 \times \mathrm{ERR}_1) + (p_2 \times \mathrm{ERR}_2)]}$$

where p_1 is the proportion of population overweight, p_2 the proportion of population obese, ERR_1 the excess relative risk (RR−1) for overweight and ERR_2 the excess relative risk (RR−1) for obesity.

RESULTS

Table 3 shows the calculation of attributable fractions, and corresponding numbers of attributable cases, by age group and sex, for seven cancer types accepted to be causally related to excess body weight, assuming a 10-year latency between the presence of excess body mass and cancer risk.

Table 4 summarises these results. An estimated 17 294 excess in cancer cases occurring in 2010 were due to overweight and obesity (5.5% of all cancers). The sites contributing most to this excess are large bowel (5172) and breast (4194).

Table 4 Numbers and proportion of cases occurring at selected sites attributable to overweight and obesity (UK 2010)

	Excess attributable cases (PAF)		
Cancer	**Male**	**Female**	**Persons**
Oesophagus	1538 (26.9)	315 (11.2)	1853 (21.7)
Gallbladder	381 (9.7)	91 (17.8)	128 (18.3)
Pancreas	523 (12.8)	494 (11.5)	1017 (12.2)
Colorectum	3009 (13.6)	2162 (12.2)	5172 (13.0)
Breast	—	4194 (8.7)	4194 (8.7)
Endometrium	—	2759 (33.7)	2759 (33.7)
Kidney	1422 (25.0)	749 (22.2)	2171 (24.0)
All cancers[a]	6530 (4.1)	10 764 (6.9)	17 294 (5.5)

Abbreviations: PAF = population-attributable fraction (%). [a]Excluding non-melanoma skin cancer.

DISCUSSION

The list of cancers that have been selected as being related to excess body mass (overweight and obesity) is a conservative one. It corresponds to those in the consensus statements of IARC (2002) and WCRF (2007). Needless to say, other studies have identified a large number of other cancers to be associated with excess body mass. In the recent meta-analysis of prospective studies (cohort studies and clinical trials) by Renehan *et al* (2008), there was a positive (statistically significant) association between BMI and cancer of the thyroid, leukaemia, malignant melanoma (men only), non-Hodgkin lymphoma and multiple myeloma. Others have reported significant associations with cancers of the prostate (Bergstrom *et al*, 2001), ovary (Reeves *et al*, 2007; Schouten *et al*, 2008; Lahmann *et al*, 2010) and brain (Benson *et al*, 2008), as well as cancers of the liver (Larsson and Wolk, 2007) and gastric cardia (Calle and Kaaks, 2004).

In common with most reviews, we have chosen to ignore possible differences in risk between men and women, although for some cancers – especially colorectal cancers – a greater effect in men than in women is found in some studies (Calle and Kaaks, 2004; Renehan *et al*, 2008) but not others (Bergstrom *et al*, 2001).

The 10-year 'latency' used to define the relevant time period at which to measure population prevalence of overweight and obesity is somewhat arbitrary. It was based on the average period of follow-up in the large cohort studies from which the estimates of relative risk are derived (as reported by Renehan *et al*, 2008).

Several previous estimates of the fraction of cancer in the UK attributable to overweight and obesity have been published. Bergstrom *et al* (2001) considered a similar range of cancers to those in this paper, but included cancers of the prostate as related to BMI, and excluded oesophageal adenocarcinoma; based on relative risks from their own meta-analyses, they estimated that 2.7% of cancers diagnosed in men and 4.9% in women in the UK in 1995 were related to overweight/obesity during 1983–6. Renehan *et al* (2010) include a much wider range of cancers, as noted earlier, based on their meta-analysis of 2008 (Renehan *et al*, 2008); their estimate of attributable fraction (for 2002, based on overweight/obesity (single category) in 1992 (from WHO)) was 4.01% in women and 3.42% in men. Reeves *et al* (2007) used the results of the Million Women Study to estimate that 5% of cancers in postmenopausal women in 2004 were related to overweight and obesity (based on prevalence in England in the same year), and including nine cancers observed to have a significant trend of increasing risk with increasing BMI (including leukaemia, ovary, multiple myeloma and non-Hodgkin lymphoma, but excluding colorectal cancers). The estimate of the proportion of cancers related to 'body fatness' in the UK in 2002 by WCRF/AICR (2009) is given only for the seven sites analysed in this paper: 18% of the five cancers in men and 16% of the seven in women. This would be equivalent to an overall AF (for all cancers) of 4.2% in men and 8.7% in women. There are several reasons for this larger estimate. WCRF selected 'representative' studies from which to take the relative risks – almost all are in excess of the pooled values from their own meta-analyses. Exposure prevalence was taken from data for the same year as outcome (2002); exposure prevalence would have been lower if prevalence at an earlier period had been used, given the continuously rising trend of overweight and obesity in recent years. Finally, the baseline category (not overweight or obese) was not always $\leqslant 25\,\mathrm{kg\,m^{-2}}$, but for some cancers (breast and pancreas) it was $\leqslant 23\,\mathrm{kg\,m^{-2}}$.

See acknowledgements on page Si.

Conflict of interest

The authors declare no conflict of interest.

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