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Original Research Article

Cancers in France in 2015 attributable to high body mass index

Melina Arnold[a], Marina Touillaud[b], Laure Dossus[c], Heinz Freisling[d], Freddie Bray[a], Irène Margaritis[e], Valérie Deschamps[f], Isabelle Soerjomataram[a,*]

[a] Section of Cancer Surveillance, International Agency for Research on Cancer, 150 Cours Albert Thomas, 69008, Lyon, France
[b] Léon Bérard Cancer Centre, Lyon, France; Cancer Research Centre of Lyon, UMR Inserm 1052 CNRS 5286 Centre Léon Bérard, 28 Prom. Léa et Napoléon Bullukian, 69008, Lyon, France
[c] Nutrition and Metabolism Section, Biomarkers Group, International Agency for Research on Cancer, 150 Cours Albert Thomas, 69008, Lyon, France
[d] Nutrition and Metabolism Section, Nutritional Methodology and Biostatistics Group, International Agency for Research on Cancer, 150 Cours Albert Thomas, 69008, Lyon, France
[e] Nutrition Risk Assessment Unit, French Agency for Food, Environmental and Occupational Health & Safety (ANSES), 14 rue Pierre et Marie Curie, 94701, Maisons-Alfort Cedex, France
[f] Agence Nationale de Santé Publique, Université Paris 13, Centre de Recherche en Epidémiologie et Statistiques, COMUE Sorbonne Paris Cité, 74 rue Marcel Cachin, 93017 Bobigny Cedex, France

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ABSTRACT

Background: Overweight, as defined by high body mass index (BMI), is an established risk factor for various morbidities including cancer. Globally, its prevalence has increased markedly over the past decades. The aim of this study was to estimate the proportion and number of cancers that were attributable to high BMI in France in 2015.

Methods: Population attributable fractions (PAFs) and numbers of cancer cases attributable to high BMI (a population mean BMI above the optimum of 22 kg/m^2) were estimated by age and sex, for cancer sites with convincing or probable evidence of an established causal link. Assuming a 10-year lag-period, PAFs were calculated using mean BMI estimates from a cross-sectional French population survey, and relative risk estimates from published *meta*-analyses.

Results: An estimated 18,639 cancer cases diagnosed in France in 2015 were attributable to high BMI, corresponding to 5.3% of all cancer cases (6.7% in women and 4.1% in men). This included 4507 cases of postmenopausal breast and 3380 cases of colon cancer. The highest estimated PAFs were for oesophageal adenocarcinoma and corpus uteri cancer (37% and 34%, respectively).

Conclusion: High BMI is associated with a substantial number of cancer cases in France, a country with a low but increasing prevalence of overweight and obesity when compared to other European countries. Assuming that the association between high BMI and cancer is causal, these results highlight the need to prioritise the prevention of this risk factor as part of cancer control planning in France and elsewhere in Europe.

1. Introduction

Overweight and obesity are established risk factors for cancer and other chronic diseases with reports of an increasing prevalence over the past few decades in most parts of the world [1]. According to recent global estimates, about half a million cancer cases were attributable to a high body mass index (BMI) in the year 2012 alone [2]. To-date, the effects of this development have become most evident in high-income regions, including North America and Western Europe, where levels of overweight and obesity have been consistently high, in relative terms. However the prevalence of obesity (defined as BMI ≥ 30 kg/m^2) continues to increase: in France, prevalence has doubled from 10% to 22% between 1975 and 2014, while in other Western European countries the increases are even more marked, in the UK, an estimated 28% of the population is currently obese [1].

Continuous updates of the literature have confirmed the association between overweight, obesity and the risk of oesophageal adenocarcinoma and cancers of the gastric cardia, colon, rectum, liver, gallbladder, pancreas, postmenopausal breast, ovary, endometrium and kidney [3–12]. Additional cancer sites associated with overweight and obesity were recently identified by the International Agency for Research on Cancer (IARC) working group on the preventive effects of avoidance of excess body fatness on cancer risk [13].

In order to inform cancer control on a national level using most

* Corresponding author at: Section of Cancer Surveillance, International Agency for Research on Cancer, 150 Cours Albert Thomas, 69372, Lyon, France.
E-mail address: soerjomatarami@iarc.fr (I. Soerjomataram).

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Table 1
Estimated proportion (%) of men and women in France by WHO body mass index (BMI) category and corresponding mean BMI (ENNS 2006/2007).

	Age (years)											
	Men						Women					
	20–29	30–39	40–49	50–59	60–69	70+	20–29	30–39	40–49	50–59	60–69	70+
% underweight (BMI < 18.5)	0.7	0	2.1	0.6	0	0	10.2	6.3	4.9	1.4	2.9	1.1
% normal weight (BMI 18.5–24.9)	61.6	49.6	35.3	32	27.9	16.6	67.7	59.3	60.5	44.7	40.7	37.8
% overweight (BMI 25–29.9)	26.1	33.8	46.1	51.7	46	60.5	14.9	16.5	24.8	26.5	34.2	38.2
% obese (BMI ≥ 30)	11.6	16.6	16.5	15.7	26.1	22.9	7.2	17.9	9.8	27.4	22.2	22.9
Mean BMI	24.5	26	26.4	26.7	27.5	28	23	24.7	24	28.8	26.4	26.7
Standard deviation (SD)	3.3	3.5	3.7	6.5	3.7	2.9	3.3	7.7	5.4	6.3	5.5	5.5

recent data, the aim of this study was to estimate the proportion and numbers of cancer cases attributable to high BMI in France in 2015 by cancer site and sex.

2. Material and methods

2.1. Exposure prevalence

Data on mean BMI in the French population by sex and age group (20–29, 30–39, 40–49, 50–59, 60–69, 70+ years) were obtained from measurements of height and weight of participants in the 2006 National Nutrition and Health Survey (*Etude nationale nutrition santé*, ENNS) (Table 1) [14]. ENNS is a nationally representative cross-sectional dietary and health survey conducted between February 2006 and March 2007 by the French Institute for Health Surveillance involving 3115 adults aged 18–74 residing in France. Anthropometric information, taken by nurses or dieticians during house visits or at the study centre, is available for 77.5% (n = 2413) of the study population.

2.2. Relative risk estimates

The study focused on the association between high BMI and the risk of cancer types for which there was convincing or probable evidence of association, as reported by the World Cancer Research Fund (WCRF) and the French National Cancer Institute (INCa) up until June 2016: oesophageal adenocarcinoma, gastric cardia, colon, rectal, kidney, pancreatic, gallbladder, liver, postmenopausal breast, corpus uteri and ovarian cancers were thus included [3–10,15,16]. Sex-specific relative risks (RR) for these sites were obtained from published standardized *meta*-analysis estimates by the WCRF Continuous Update Project (CUP) and were transformed into RR to evaluate the effect of an incremental increase of one unit in BMI (kg/m^2), assuming a log-linear relationship between exposure and risk.

Other cancer sites, previously identified as being linked to overweight and obesity, were not included due to the lack of availability of incidence data at the level of detail required (i.e., advanced stage prostate cancer [17]) or due to a lack of robust risk summary estimates (i.e. non-Hodgkin lymphoma, leukaemia and multiple myeloma [16]). Moreover, the inverse association between high BMI and premenopausal breast cancer risk was not considered given the study aims of estimating the potentially avoidable cancer burden caused by overweight and obesity. All cancer sites included and corresponding meta risk estimates are presented in Annex Table 1 in Supplemenary material.

2.3. Cancer incidence data

The most recent data on new cancer cases in France by age, sex and cancer site for the year 2013 were obtained from the French Cancer Registries Network (FRANCIM). Age-, sex- and site-specific incidence rates were computed and applied to the 2015 national French population [18] in order to obtain an estimate of the national number of new cases of that year.

2.4. Statistical analysis

The lag time between the onset of overweight or obesity and the occurrence of cancer is uncertain and may potentially vary by cancer site. In our analyses, we used prevalence data from 2006/2007 and cancer incidence estimates from 2015, thereby assuming a lag time of approximately 10 years, based on scientific evidence that high BMI is not an initiator of cancer but rather a promoter of cancer to clinical presentation over several years [19]. To account for population ageing with time from exposure to clinical onset, we mapped prevalence data to the age group 10 years younger than the corresponding ages at diagnoses of the cancer cases. For example, cancers diagnosed in the 40–49 years age group in 2015 were mapped to high BMI within the 30–39 years age group in 2006–2007.

Age-, sex- and cancer site-specific population attributable fractions (PAF) were calculated based on the approach suggested by the *Comparative Risk Assessment Collaborative Group*, using the following formula [20]:

$$PAF = \frac{\int \mathrm{RR}_x \mathrm{p}_x \mathrm{d}x - \int \mathrm{RR}_x \mathrm{p}_x^* \mathrm{d}x}{\int \mathrm{RR}_x \mathrm{p}_x \mathrm{d}x}$$

Where p_x is the population distribution of BMI, p^*_x is the distribution of theoretical minimum BMI and RR_x the relative risk of cancer associated with BMI at level x, while dx denotes that the integration was done with respect to each *x level.*

The theoretical minimum distribution of BMI was defined as a population mean of 22 kg/m^2 and a standard deviation of unity, the value where the disease burden is assumed to be lowest at the population level [21,22] and the mid-point of the normal weight category (ranging from BMI 18.5–24.9). As this is a recognized public health goal, this approach has been adopted from a recent analysis on the PAF for high BMI at the global level [2]. A log-logit function was used to characterize the shape of the RR across BMI units. As RR estimates beyond these points were scant, no risk for BMI below 22 kg/m^2 and no risk increase above BMI 40 kg/m^2 were assumed.

The number of cancer cases attributable to a population BMI level above 22 kg/m^2 was derived by multiplying age-, sex- and cancer-specific PAFs by the corresponding cancer incidence estimates in 2015. Overall national estimates of the total attributable proportion of cancer related to high BMI were calculated by summing up the number of attributable incident cases and dividing them by the total number of cancer cases in the same year. In secondary analyses, PAFs were recalculated using categorical BMI (differentiating separate exposure levels for overweight (BMI 25–29.9 kg/m^2) and obesity (BMI ≥ 30 kg/m^2)) and the method suggested by Hanley [23] in order to compare our results to earlier studies.

3. Results

Estimates of the population mean BMI and its associated prevalence