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Cancers in France in 2015 attributable to insufficient physical activity

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ABSTRACT

Introduction: Insufficient physical activity is a known risk factor for various co-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 insufficient physical activity in France in 2015.
Methods: Population attributable fractions (PAFs) and numbers of cancer cases attributable to insufficient physical activity (< 30 min daily of moderate-to-vigorous physical activity) were estimated by age, sex and cancer site. Assuming a 10-year lag-period, PAFs were calculated using physical activity prevalence from a cross-sectional French population survey and cancer-specific relative risks.
Results: About half of all French adults were found to be insufficiently physically active, with great variation by age and sex. In 2015, an estimated 2973 cancer cases diagnosed in French adults aged 30y + were attributable to insufficient physical activity, corresponding to 0.8% of all cancer cases (0.2% in men and 1.6% in women). This comprised 3.8% of all postmenopausal breast cancers (1620 cases), 3.6% of all colon cancers (902 cases) and 6.0% of all cancers of the corpus uteri (450 cases). If at least half of the recommended physical activity level was achieved, 1095 cancer cases could have been avoided.
Conclusion: Insufficient physical activity is associated to about 3000 cancer cases in France, a country with comparatively low but increasing prevalence of this risk factor. This result is important for setting priorities in cancer prevention programmes aiming to increase physical activity in France and Europe in general.

1. Introduction

Lack of physical activity is a known risk factor for various co-morbidities, including cancers of the colon, postmenopausal breast and corpus uteri [1–7]. Physical activity is defined as any movement of the skeletal muscles that increases energy expenditure above the resting energy expenditure, including all movements performed in the daily life. Physical activities are furthermore classified into groups according to their light, moderate or vigorous intensity. While insufficient physical activity refers to the lack of moderate-to-vigorous physical activity, physical inactivity relates to an excess of light activities. Globally, the prevalence of insufficient physical activity varies substantially across world regions, but has increased markedly over the past decades [8,9].

The World Health Organization [10] recommends a minimum of 30 min of moderate-to-vigorous physical activity at least five days a week (i.e., accumulating 150 min per week) that can be sequenced in periods of at least 10 min. In France, the most recent guidelines for optimal health from the framework of the National Health and Nutrition Program [11] recommend at least 30 min per day of moderate-to-vigorous physical activity (equivalent to 210 min per week of brisk walking). In 2016, an estimated 29.3% of the French adult population was considered insufficiently physically active (defined as less than 150 min of moderate-to-vigorous, or 75 min of vigorous-intensity

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Table 1
Estimated proportion (%) of sufficient and insufficient physical activity relatively to the reference level of 21 MET-hours per week (corresponding to 0.5 h × 7 days × 6 MET) by sex in France.
Source: ENNS 2006/2007 [11].

	Deficit in MET-hrs	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+
Insufficient physical activity (≤21 MET-hrs/week)	17.5–21	18.6	28.6	31.4	34.9	28.7	41.7	31	31.9	23	31.6	33.2	38.9
	14– < 17.5	7.4	8.6	8.9	2.9	4.3	7.0	8.6	5.8	7.1	4.5	7.1	8.0
	10.5– < 14	4.5	4.3	6.0	2.4	6.1	5.9	7.6	6.0	5.1	9.3	7.1	7.9
	7– < 10.5	6.9	4.5	2.4	2.8	6.0	1.1	11.2	6.3	6.5	7.4	4.7	4.6
	3.5– < 7	6.6	6.8	5.2	5.4	5.7	2.0	5.7	7.2	7.2	7.3	4.8	6.8
	> 0– < 3.5	16.3	1.5	3.4	2.7	1.8	0.8	4.6	3.3	5.0	3.9	3.8	3.2
Sufficient physical activity (> 21 MET-hrs/week)	0	39.7	45.7	42.7	48.9	47.4	41.5	31.3	39.5	46.1	36	39.3	30.6

physical activity per week, or any equivalent combination of the two), which is slightly above the global average (27.5%) [9]. When the French guidelines are used, less than half of French adults attain the recommended level of physical activity [12]. Increasing physical activity levels in the French population may thus have a beneficial impact on the future cancer burden, especially since the affected sites such as colon and breast cancers are the most commonly diagnosed cancers in France. In this study, we aimed to estimate the proportion and number of cancer cases that were attributable to insufficient physical activity in France in 2015 by cancer site and sex.

2. Methods

2.1. Prevalence of insufficient physical activity

Data on physical activity levels in the French population, by sex and age group (20–29, 30–39, 40–49, 50–59, 60–69, 70+ years) were obtained from self-reported assessments of the National Nutrition and Health Survey (*Etude nationale nutrition santé,* ENNS) in 2006 (Table 1) [11]. ENNS is a national cross-sectional survey with a multi-stage sampling design conducted between February 2006 and March 2007 by the French Institute for Health Surveillance (formerly *Institut National de Veille Sanitaire,* now *Santé Public France*) among 3115 adults aged 18–74 years and residing in France. Detailed sampling strategy has been reported elsewhere [13]. In brief, three-stage sampling was performed: firstly, 190 geographic areas were randomly selected throughout France followed by a random selection of dwellings based on randomly generated phone lists and the selection of eligible subjects to be included in the study. ENNS reported the prevalence estimates of different types of physical activity according to their intensity measured in metabolic equivalents (METs) in 2971 individuals: fast walking or other moderate physical activity (3–6 METs) and vigorous physical activity (> 6 METs) [11], derived from the International Physical Activity Questionnaire (IPAQ, short version) administered during face-to-face interviews [14]. One MET represents resting energy expenditure, which equals about 3.5 mL O_2/kg when measured in terms of oxygen consumption or expenditure of 4.184 kJ per hour. The intensity of all types of physical activity is generally expressed as multiples of the resting energy expenditure (1 MET) using a standard reference of energy costs of activities.

In the main analysis, we estimated the proportion of cancer cases attributable to insufficient physical activity. Here, sufficient physical activity was defined according to the French recommendations corresponding to a daily minimum of 30 min of moderate-to-vigorous physical activity. We assumed that moderate-to-vigorous physical activities had an average intensity of 6 METs that represent the midpoint of moderate (3–6 METs) and vigorous (> 6 METs) physical activity [15,16]. Assuming that physical activity of at least moderate intensity was performed 30 min every day for seven days a week, the reference level of sufficient physical activity was defined as 21 MET-hours per week (MET-h/week; 0.5 h × 7 days × 6 MET). Doing so, we adopted a similar approach to that applied in previous studies on this topic [15,16]. Using the ENNS data, we estimated six categories of insufficient physical activity: > 0– < 3.5; 3.5– < 7; 7– < 10.5; 10.5– < 14; 14– < 17.5 and 17.5–21 MET-hour per week (Table 1). In secondary analyses, we estimated the proportion and number of cancer cases attributable to insufficient physical activity where the latter was defined following the recommendation of the World Health Organization (WHO), corresponding to 30 min of moderate-to-vigorous physical activity five days per week (15 MET-hours per week computed as 0.5 h × 5 days × 6 METs). Furthermore, we investigated the number of cancer cases that could have been avoided if everybody would achieve at least half of the physical activity level recommended in France (10.5 MET-hours per week).

2.2. Relative risk estimates

Cancer sites with convincing or probable evidence to be causally associated with insufficient physical activity as reported by the World Cancer Research Fund (WCRF) and the French Cancer Institute (INCa) were included, namely colon (ICD-10: C18), postmenopausal breast (C50) and corpus uteri (C54) cancer [1–3,7]. Relative risks (RRs) for recreational physical activity were obtained from the WCRF Continuous Update Project for postmenopausal breast and colon cancer [1,2] and from a published meta-analysis for endometrial cancer [4]. The sources and RRs are presented in Annex Table 1 in Supplementary material.

The increase in risk for the reduction of 1 MET-hour of physical activity per week was estimated by assuming a log-linear relationship between exposure and risk, so that:

$$\textit{Excess risk per 1 MET-hour deficit per week} = \ln(1/RR_x)/x \quad (1)$$

where x is the exposure level (in MET-hours per week) and RR_x is the relative risk for x MET-hours per week.

The increase in risk for a decrease of 1 MET-hour of moderate-to-vigorous physical activity per week for colon cancer, post-menopausal breast cancer and endometrial cancer were 4.041e-3, 4.351e-3 and 6.734e-3, respectively. RRs were then calculated for every MET-hour deficit category using the following formula:

$$RR = \exp(\textit{excess risk per 1 MET-hour deficit per week} * \textit{deficit in MET-hours per week}) \quad (2)$$

where the deficit in MET-hours per week is the midpoint of the MET-hours deficit category (e.g., a deficit of 8.75 MET-hours in the 7–10.5 MET-hour deficit category).

2.3. Cancer incidence data

The number of new cancer cases in France in 2013 by age, sex and

site was obtained from the national network of cancer registries (FRANCIM). Age-, sex- and site-specific incidence rates were computed and applied to the 2015 national French population to obtain an estimate of the national number of new cases in that year.

2.4. Statistical analysis

The lag time between the cumulative insufficient physical activity and the occurrence of cancer is uncertain and may potentially vary by cancer site (AICR-WCRF 2007). 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. This is based on scientific evidence that insufficient physical activity is not an initiator of cancer but rather a promotor of cancer to clinical presentation over several years. To account for population ageing with time since exposure and lag time, we mapped prevalence data to the cancer incidence age group that was 10 years older (e.g., cancer incidence in the 40–49 age group in 2015 was attributed to insufficient physical activity in the 30–39 age group in 2006/7). The following formula was used to compute age-, sex- and cancer-specific population attributable fractions (PAFs):

$$PAF = \frac{\sum (p_x \times (RR_x - 1))}{1 + \sum (p_x \times (RR_x - 1))} \quad (3)$$

where p_x is the proportion of population with insufficient physical activity category x and RR_x the relative risk (from Eq. (2)*) for insufficient physical activity category x.*

The number of cancer cases attributable to insufficient physical activity was derived by multiplying age-, sex- and cancer-specific PAFs by the corresponding cancer incidence estimates in 2015. The total proportion of cancer attributable to insufficient physical activity was calculated by summing up the number of attributable incident cases and dividing them by the total number of cancer cases (excluding non-melanoma skin cancers).

3. Results

Estimates of the proportion of French adults meeting the physical activity recommendations ranged between 40–49% in men and 31–46% in women depending on age (Table 1). While overall activity levels were rather constant across age groups, larger physical activity deficits were observed at ages 70y+.

In 2015, an estimated number of 2973 cancer cases were attributable to insufficient physical activity in French adults aged 30y+, corresponding to 0.8% of all cancer cases (Table 2). This comprised 1620 postmenopausal breast cancer cases, 902 colon cancer cases (463 in men and 439 in women) and 450 corpus uteri cancers. The overall PAF was higher in women than in men (1.6% vs 0.2%, respectively) and ranged from 3.6% for colon, to 3.8% for postmenopausal breast and 6.0% for corpus uteri cancers.

Secondary analyses, using the WHO recommendation of 15 MET-hours per week for physical activity as reference, resulted in 1786 cases attributable to insufficient physical activity (PAF = 0.5%) (Table 2). If at least half of the recommended *physical activity* level was achieved in the French population (10.5 MET-hours per week), about 1095 cancer cases (PAF = 0.3%) could have been avoided.

4. Discussion

In 2015, an estimated number of 2973 cancer cases diagnosed in French adults were attributable to insufficient levels of physical activity, corresponding to 0.8% of all cancer cases. In absolute terms, the greatest numbers of cancer cases attributable to insufficient physical activity were postmenopausal breast cancer (1620 cases, or 3.8% of the total breast cancer diagnoses) and colon cancer (902 cases, or 3.6% of the total colon cancer diagnoses in 2015).

These estimated PAFs are lower than those estimated in France for the year 2000, which were 4.1% (0.5% for men and 4.7% for women) [17]. These results are not directly comparable because the 2000 estimates for France only included breast and colon cancers, applied different RRs and used vigorous recreational physical activity as a reference. These PAFs are also lower than those estimated in the United Kingdom in 2010, where they were 1.0% (0.4% for men and 1.7% for women) [15], and those estimated in Australia being 1.6% (0.5% for men and 2.9% for women) [16]. However, these results are not directly comparable because differences in the RRs used for PAF estimation and in the reference levels used to define the lack of physical activity (15 MET-hours per week in the UK study and 30 MET-hours per week in the Australian study). When we used 15 MET-hours per week as reference, the French estimates were still lower than the UK estimates (0.5% vs 1%, respectively).

The preventive effects of physical activity on cancer incidence might be due to several mechanisms. Direct effects of physical activity on circulating levels of various hormones and growth factors, including decreased plasma levels of insulin and IGF-1, which promote cell proliferation and increase with overweight and obesity, could be one plausible causal pathway [1,7]. Physical activity also indirectly contributes to reducing cancer risk by reducing the risk of overweight or obesity, by limiting body fat and by promoting lean body mass. It might specifically reduce colon cancer risk by accelerating gut transit, thus reducing the exposure time of the gastrointestinal mucosa to foodborne carcinogens [2,7]. Physical activity might reduce the risk of postmenopausal breast cancer and endometrial cancer notably by decreasing oestrogen levels, stimulating immunity and decreasing inflammation (increase in numbers and/or activity of macrophage and lymphocytes) [7].

In their 2015 update of the evidence, the National cancer institute in France additionally rated the level of evidence between physical activity and lung and premenopausal breast cancers as probable [7]. Similarly, a recent meta-analysis showed that leisure-time physical activity is associated with lower risks of 13 cancer sites [18]. Yet, these sites were not included in the analysis due to the lack of robust RRs that match with the exposure (measured in MET/hours), a prerequisite to perform PAF calculations.

Nationally representative data on physical activity were used in this study [11], together with robust estimates of the relationship between insufficient physical activity and cancer. As such, the results of this study give an indication of the potential impact of prevention measures on the reduction of the cancer burden. Even if half of the recommended minimum of physical activity (10.5 MET-hours per week) would be attained, more than 1000 cancer cases could be avoided each year.

We acknowledge that the present study has a number of limitations. First, it was affected by inherent limitations to measuring exposure. Physical activity data were obtained from a population survey and are therefore subject to several biases, such as coverage and participation bias, but also to recall error and social desirability bias [19,20]. Information on physical activity was available from close to 3000 participants, and although this number is relatively large, for the analysis this group was categorised into subgroups according to sex, age and physical activity. The number of persons in each category may thus be small with less stable estimates. On the other hand, the PAFs here are reported for the whole group, i.e. based on a more stable average. Furthermore, data on physical activity prevalence were obtained at a given time and may not reflect the level of physical activity throughout the relevant biological exposure period. Second, although RRs used in the PAF calculations were taken from published meta-analyses and were adjusted for a range of other related exposures, most importantly for body fatness, residual confounding cannot be ruled out. Moreover, while RR estimates are based on Caucasian populations, they might not be fully applicable to France, especially if the prevalence of effect modifiers differs between settings [21]. Third, this analysis did not

Table 2
Estimated proportion (%) and numbers of cancer cases attributable to insufficient physical activity in France in 2015, by sex, cancer site and reference.

	Men			Women			Both sexes		
Cancer site	Attr. Cases (N)	PAF (%)	PAF all (%)[a]	Attr. Cases (N)	PAF (%)	PAF all (%)[a]	Attr. Cases (N)	PAF (%)	PAF all (%)[a]
French reference: 21 MET-hrs (main scenario)									
Colon	463	3.5	0.2	439	3.8	0.3	902	3.6	0.3
Breast (postmenopausal)				1620	3.8	1.2	1620	3.8	1.2
Corpus Uteri				450	6.0	0.3	450	6.0	0.3
Total of all included sites[b]	463	3.5	0.2	2510	4.1	1.6	2973	4.0	0.8
WHO Reference: 15 MET-hrs									
Colon	284	2.1	0.1	265	2.3	0.2	549	2.2	0.2
Breast (postmenopausal)				966	2.3	0.7	966	2.3	0.7
Corpus Uteri				270	3.6	0.2	270	3.6	0.2
Total of all included sites[b]	284	2.1	0.1	1502	2.5	0.9	1786	2.4	0.5
Counterfactual reference: 10.5 MET-hrs[c]									
Colon	182	1.4	0.1	163	1.4	0.1	344	1.4	0.1
Breast (postmenopausal)				586	1.4	0.4	586	1.4	0.4
Corpus Uteri				165	2.2	0.1	165	2.2	0.1
Total of all included sites[b]	182	1.4	0.1	913	1.5	0.6	1095	1.5	0.3

[a] Proportion out of all cancer cases (excluding non-melanoma skin cancers).
[b] Totals may differ because of rounding.
[c] Half of the recommended level of physical activity in France.

estimate the effects of sedentary behaviour that includes very low-intensity activities. However, while there has been less research on sedentary behaviour and cancer risk, there is accumulating evidence that sedentary behaviour is associated with an increased risk of several cancers [3,22] – something that should be considered in futures studies. Also, only the direct effect of insufficient physical activity on cancer occurrence was estimated in this study. Indirect effects, including mediation through co-factors such as obesity, may further increase our estimates. Fourth, the physical activity recommendations in the French population were used to define the minimum risk exposure level, however this does not preclude that higher levels of total physical activity may provide additional optimum risk reduction for some cancer sites. Finally, the estimation of the PAF was based on the assumption that the association between insufficient physical activity and the studied cancer sites is causal [23]. We thus assume that increasing physical activity at the population level would lead to a decline in the incidence of these cancers.

In conclusion, our study showed that insufficient physical activity is an important modifiable risk factor of cancer in France and further underpins the need for continuing targeted prevention efforts on the population level. In addition, lack of physical activity has also been causally associated with cardiovascular diseases, metabolic disorders, type 2 diabetes, depression and falls [24]. As a result, the decrease in the prevalence of insufficiently active persons would also decrease the burden of these diseases [25].

Contributors

MT, MA and IS contributed to data collection, study design, analysis, and wrote the first draft of the paper. VD contributed to study design, data collection and finalising the report. LD, HF, FB and IM contributed to study design and drafting of the report. All authors read and approved the final report.

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Conflicts of interest statement

None declared.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.canep.2019.02.009.

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