Cancer Epidemiology 43 (2016) 100–104

Contents lists available at ScienceDirect

Cancer Epidemiology

The International Journal of Cancer Epidemiology, Detection, and Prevention

journal homepage: www.cancerepidemiology.net

Perceived physical strain at work and incidence of colorectal cancer: A nested case–control study

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ARTICLE INFO

Article history:
Received 15 March 2016
Received in revised form 23 June 2016
Accepted 4 July 2016
Available online 13 July 2016

Keywords:
Epidemiology
Colon cancer
Physical workload

ABSTRACT

The evidence for a relationship between colon cancer incidence and physical activity is not fully convincing, and the association between physical activity and rectal cancer is also unclear.

We studied the association between perceived physical workload (PPWL) at work and colorectal cancer, stratified by subsite, in a nested case–control setting in the Nordic Occupational Cancer (NOCCA) data from Finland, Iceland, Norway and Sweden. Five population controls were selected for each cancer patient.

PPWL showed a bigger protective effect on colon cancer for males (odds ratio [OR] 0.74 in the highest PPWL decile as compared with the lowest PPWL category, 95% confidence interval [95% CI]: 0.72–0.77) than for females (OR 0.87, 95% CI: 0.81–0.95), with a significant trend for different levels of PPWL for both males and females. In males, the OR of cancer in the descending colon for the highest PPWL decile of males was 0.61 (95% CI: 0.54–0.69). For females the protective effect was most notable in the transversal part of the colon (OR 0.83, 95% CI: 0.67–1.03). The OR for rectal cancer in the highest PPWL decile for males was 0.87 (95% CI: 0.85–0.90) and for females 0.93 (95% CI: 0.83–1.04). Inclusion of further agents in multivariate analyses did not alter the ORs for PPWL.

The incidence of colon cancer and, to a lesser extent, rectal cancer is lowest in professions with the highest PPWL. The association is clearer in males than in females. The biggest protective effect appears to be in the descending colon in males.

1. Introduction

Globally colorectal cancers are among the most common cancers. Their incidence is particularly high in the Western World [1] and in the developed Asian countries [2]. The incidence has increased in most countries over the past decades, possibly due to lifestyle changes and changes in diet [3].

Physical activity can be one of the key lifestyle factors that may significantly reduce the risk of colon cancer. According to a meta-analysis published in 2009 [4] both men and women benefit from the protective effect of exercise. When comparing the most and the least active individuals across all studies, the protective effect in men seemed a bit more pronounced than in women (24% versus 21%). Physical activity also reduces the risk of rectal cancer, but the effect is not as strong as that in colon cancer [5,6].

Reduced incidence of colon cancer has been reported in those with professions that required continuous daily physical activity, such as people involved in agricultural and related jobs, farmers, fishermen and hunters [6,7]. In a Japanese study Isomura et al. observed that the protective effect of physical activity was greatest

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http://dx.doi.org/10.1016/j.canep.2016.07.001
1877-7821/

in the distal part of colon, especially in women [8]. Nilsen et al. detected a hazard ratio (HR) of 0.44 (95% CI: 0.25–0.78) for cancer in the transverse colon, comparing people who reported high versus no leisure-time physical activity [9]. For cancer in the sigmoid colon the HR was 0.48 (95% CI: 0.31–0.75).

The aim of the current study is to confirm that there is a protective effect related to physical activity at work, and that this effect is stronger in men than in women. We also assess the variation of this effect between colon and rectum, and between subsites of the colon.

2. Materials and methods

This study employed a case–control design nested in the Nordic Occupational Cancer Study (NOCCA) cohort. The NOCCA study cohort consists of 14.9 million people from Nordic countries (Finland, Iceland, Norway, Denmark, and Sweden) who participated in population censuses in 1960, 1970, 1980/1981, and/or 1990. A detailed description of the NOCCA cohort has been given by Pukkala et al. [10]. Because we did not have access to the individual records of the Danish part of the cohort, their data were not included. Occupational information was obtained from digital census records from 1960 and later censuses in Sweden and Norway, and from 1970 and later censuses in Finland. In Iceland, the only computerized census records available were from a 1981 census [10].

Unique personal identity codes for all residents were first introduced in Sweden in 1947, last in Denmark in 1968, and in other countries between these time points. Personal identity codes were used for linking the census records with the data from cancer registries and national population registries for information on cancer, death, and emigration [10].

The cancer registries in all Nordic countries collect information on almost 100% of cancer cases diagnosed in each country [11]. We have no reason to expect that there would have been occupation-related selection in the missing cancer cases. The cancer cases have been collected in all participating Nordic countries since the 1950s.

For this study, all incident colon and rectal cancer cases diagnosed between the first available census and 2005 were extracted from the NOCCA cohort. Five controls for each cancer case were randomly selected among persons who were alive and free from colon and rectal cancer on the date of diagnosis of the case (hereafter the 'index date' of the case–control set). Cases and controls were matched for the year of birth, sex, and country. Individuals with a minimum age of 20 years at the index date, and having occupational information from at least one census record before the index date, were included in the present study.

For each case and control, the exposure to occupational factors was estimated on the basis of conversions of occupational codes to quantitative amounts of exposure with the NOCCA job exposure matrix (JEM). It is used for defining the specific occupational exposures to different, potentially harmful or beneficial, workplace conditions, e.g., exposure to different chemicals or the physical stress of the work [12].

The exposure is characterized by probability of being exposed, P, and the average exposure level among the exposed persons, L (e.g. mg/m^3). The physical activity at work was expressed as (estimate of) 'perceived physical workload' (PPWL), and it was based on physical workload as reported in national interview surveys. The unit of exposure was defined as a score among those workers reporting heavy or rather heavy physical work in a national interview survey, which was conducted in 1990 as a part of the national 'Quality of Work Life Survey' in Finland [13]. When most workers in an occupational category report very heavy workload in their profession, the value approaches one. If most respondents report only fairly heavy work, the value approaches zero. If <10% persons in the occupation report heavy or rather heavy physical work, the PPWL was set to zero ('unexposed').

We quantified the cumulative exposure to PPWL for all cases and controls. Physical workload of all individuals was calculated by using the time (T) between the age of 20 (typical age to start working in non-academic occupations) and the age of 65 (typical retirement age) or index date as a multiplier for the P * L exposure of the profession of the individual (Table 1). After this, the individuals (cases and controls) with PPWL above the baseline level, which was defined as P * L * T being zero, were divided into low (lowest 50% of the non-zero P * L * T; <4.28 PPWL years), moderate (between 50 and 90%; 4.28–17.2 PPWL years) and high (highest 10%; >17.2 PPWL years) categories. If there were different occupational codes in census records for an individual, he/she was assumed to have changed occupations in the middle of the period between known census years.

The following agents have in some studies been found to be related to either colon or rectal cancer: aromatic hydrocarbon solvents (benzene, and cyclic hydrocarbon solvents) [14], wood dust [15], diesel engine exhaust [15], ionizing radiation [16], chromium [17], formaldehyde [18]; all of these were considered as potential confounders in the analysis. The NOCCA JEM-based exposure categories were defined for these factors using a procedure similar to that described above for PPWL.

We estimated hazard ratios and 95% confidence intervals for each exposure by conditional logistic regression. Individuals with baseline PPWL (or no exposure for the co-exposures) were used as the reference group.

Variable selection for the final main-effect models was based on the 'purposeful covariate selection' procedure [19]. We used univariate analyses to assess which agents were associated with colorectal cancer risk, and considered such agents as potential confounders. Variable selection suggested that co-exposures to benzene, formaldehyde, ionizing radiation, wood dust, chlorinated hydrocarbon solvents and chromium (in addition to PPWL) could be of interest as they can have a moderate effect on the incidence of colorectal cancers. A correlation check was then done between these cofactors: benzene was highly correlated with chlorinated hydrocarbon solvents and chromium, and therefore these cofactors were not used for same model. The resulting models were (1) PPWL + benzene + formaldehyde + ionizing radiation and wood dust and (2) PPWL + chlorinated hydrocarbon solvents + chromium + formaldehyde + ionizing radiation and wood dust.

Table 1
Annual Physical Workload for *Probability (P) and Level* (L) of being exposed to physical workload in different professions (all professions with a value of P * L ≥ 0.28) NOCCA Job Exposure Matrix.

Occupation	P * L
Reinforced concrete layers, stonemasons etc.	0.69
Concrete shutterers and finishers	0.68
Rod layers	0.58
Labourers	0.56
Assisting construction workers, nec	0.54
Assisting building workers	0.51
Butchers and sausage makers	0.50
Farmers, silviculturists, horticulturists	0.45
Bath attendants etc.	0.43
Homehelps (municipal)	0.42
Building occupations, nec	0.40
Sheet metal workers	0.37
Bricklayers, plasterers and tile setters	0.36
Forestry workers and lumberjacks	0.34
Charworkers	0.31
Fur farm workers	0.31
Headwaiters, restaurant waiters	0.28
Metal smelting furnacemen	0.28
Insulation workers	0.28