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OCCUPATIONAL PHYSICAL ACTIVITY AND RISK FOR CANCER OF THE COLON AND RECTUM IN SWEDEN AMONG MEN AND WOMEN BY ANATOMIC SUB-SITE

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Abstract

BACKGROUND—The inverse association between physical activity and colon cancer is well established, at least in men. We investigated the association of occupational physical activity with subsite- specific colorectal cancer risk.

METHODS—Based on occupational titles from the Swedish nationwide censuses in 1960 and 1970, we defined a cohort of women and men with the same work-related physical demands in 1960 and 1970. The incidence of colon and rectum cancer during 1971–1989 was ascertained through linkages to the Cancer Register. Relative risks were estimated through Poisson regression.

RESULTS—The risk for colon cancer increased with decreasing occupational physical activity. RR among sedentary women and men was 1.2 and 1.3 (p for trend=0.08 and <0.001). For men, the risks for proximal and distal colon increased by 20% and 40% (p for trend=0.005 and <0.001). Inactivity appeared to be particularly associated with descending colon cancer (RR =2.4, p for trend<0.001). In women the inverse association with activity was concentrated to proximal parts of colon; RR for cancer in the proximal and transverse colon among sedentary women was 1.4 and 2.0 (p for trend <0.07 and <0.01). Cancer of the rectum was not associated with activity in either sex.

CONCLUSION—We confirmed the well known inverse relationship between activity and risk of colon but not rectal cancer in both sexes. Data suggest that the physical activity-related variation in risk among women is greatest in the proximal and middle parts of colon, while the corresponding peak in men seems to be more distal. Gender specific anatomical and motility differences of the colon might contribute to this sub-site difference.

Keywords

Colon and rectal neoplasm; sub-site; cohort; occupational physical activity; Sweden

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INTRODUCTION

The protective effect of physical activity on colon cancer is well established among men. The inverse association is slightly less striking among women (Friedenreich and Orenstein 2002; Vainio, Kaaks et al. 2002; Slattery 2004; Samad, Taylor et al. 2005). Apart from sufficiently different physiology between men and women that warrants separate analysis (Silvaggio and Mattison 1994), there is evidence that distal and proximal colon cancers have a distinct etiology (Iacopetta 2002), different embryological origin (Glebov, Rodriguez et al. 2003), and have different incidence by gender (Jensen 1984; Breivik, Lothe et al. 1997; Cheng, Chen et al. 2001; McCashland, Brand et al. 2001; Takada, Ohsawa et al. 2002; Jubelirer, Wells et al. 2003). Furthermore, the observed proximal shift in the distribution of cancers of the large bowel both in Western countries (Bonithon-Kopp and Benhamiche 1999) and in Japan (Takada, Ohsawa et al. 2002) parallel with the observed even more increasing proximal colon cancer among African Americans (Troisi, Freedman et al. 1999) support distinct pathogenic mechanisms in the carcinogenesis of the proximal and distal colon and thus, etiologic distinction by anatomic sub-site within the colon. Furthermore, life style factors such as major dietary patterns (Kim, Sasaki et al. 2005; Mizoue, Yamaji et al. 2005), carbohydrates (Borugian, Sheps et al. 2002), vegetable and fruit consumption (Voorrips, Goldbohm et al. 2000), red meat consumption (Larsson, Rafter et al. 2005), cigarette smoking and alcohol use (Toyomura, Yamaguchi et al. 2004), and reproductive factors (Yoo, Tajima et al. 1999) are differently associated with proximal and distal colon and with gender. Hence, they deserve distinct risk factor evaluation to enhance both prevention and diagnostic strategies. Several studies of the relationship between physical activity and colorectal cancer have differentiated between anatomic sub-sites (Garabrant, Peters et al. 1984; Vena, Graham et al. 1985; Gerhardsson, Norell et al. 1986; Brownson, Zahm et al. 1989; Fredriksson, Bengtsson et al. 1989; Peters, Garabrant et al. 1989; Severson, Nomura et al. 1989; Gerhardsson de Verdier, Steineck et al. 1990; Kato, Tominaga et al. 1990; Arbman, Axelson et al. 1993; Fraser and Pearce 1993; Chow, Malker et al. 1994; Marcus, Newcomb et al. 1994; Giovannucci, Ascherio et al. 1995; Longnecker, Gerhardsson le Verdier et al. 1995; Thune and Lund 1996; Martinez, Giovannucci et al. 1997; Tavani, Braga et al. 1999; Colbert, Hartman et al. 2001; Slattery, Edwards et al. 2003). However, interpretation is often hampered by small sample size or case-control design. Furthermore, to our knowledge, no study has conclusively addressed possible gender differences with regard to the site where the physical activity-related variation in risk has its maximum.

To improve our understanding of how physical activity affects colorectal carcinogenesis by sub site and gender, we have investigated this in a large cohort of Swedish men and women, whose occupational activity was uniform at two assessments, ten years apart. Moreover, because of the size of our cohort and the long follow-up time, we had enough power to disentangle the effect of physical activity on ascending, transverse, descending, sigmoid colon and rectum separately for the first time among women.

MATERIALS AND METHODS

Census Data

The Swedish Census of the Population and Housing collected information about demographic, occupational (including employment status, job title, industry and work address), and socioeconomic factors for every Swedish resident during one week in October 1960 and again in 1970. The censuses are more than 99 percent complete, since participation was mandatory by law, and great efforts were made to recruit non-respondents.

The Cancer and Cancer-Environment Register

The national Swedish Cancer Register, established in 1958, includes more than 98 percent of all diagnosed cancer cases in the country {Mattsson, 1984 #79}. Malignant diseases are coded according to the International Classification of Disease, seventh revision (ICD-7) during the entire period of study. The proportion of cancers that were histologically verified was 98% and 97% for women and men respectively for colon cancer (ICD-7 153 or 153.0–153-4) and 99% and 98% for women and men respectively for rectum cancer (ICD-7 154) in 1991 {CENTER FOR EPIDEMIOLOGY, 1991. #80}. Proximal colon cancers in this study included tumours of the caecum and ascending colon (coded together in the cancer register 153.0) and tumors of transverse and flexures (coded together in the cancer register 153.1). Distal colon cancers included tumours in the descending (code 153.2) and sigmoid colon (code 153.3). The proportion of colon cancers that were unspecified sub-sites was around 17% in 1991{CENTER FOR EPIDEMIOLOGY, 1991. #80}. The Cancer Register contains demographic and tumor data and it is annually linked to the Swedish Register of Causes of Death.

The Cancer–Environment Register III (CERIII) merges data from the Cancer Register of 1971–1989 with the census of 1960 {Official Statistics of Sweden, 1965 #82}and 1970 {Official Statistics of Sweden, 1974 #83}. The national registration number - a unique 10-digit personal identifier assigned to all Swedish residents – allows linkage between these two registers. The CERIII includes only cancer cases. Those included were cancer patients who had resided in Sweden both in 1960 and in 1970, and thus were recorded in both censuses. Missing data (individuals found in the cancer register but not in the censuses) was estimated to be less than 0.9% (EPIDEMIOLOGISKT CENTRUM 1994). To allow calculation of person-years at risk and expected numbers of detected cancers, we established a background register, encompassing all individuals who were registered in both the 1960 and the 1970 censuses. After record linkages, the national registration numbers were removed to ensure confidentiality.

Classification of occupational physical activity and covariates

Occupational physical activity was used as a proxy for total physical activity (or energy expenditure). The occupations reported in the census questionnaires were coded into 245 categories in the 1960 and 248 categories in the 1970 census, using a three-digit-coding scheme, devised by the National Labor Market Board in Sweden. We classified each occupation as demanding very high and high (e.g. charworkers, cleaners and related workers, nursing personnel not elsewhere classified, general farmworkers, farm machinery operators, livestock workers, dockers and freight workers), moderate (e.g. maids and related housekeeping service workers, waitress, bartenders, professional nurses, cooks), light (e.g. sewing machine operators, elementary school teachers, hairdressers and barbers, wholesalers, cashiers), or sedentary (e.g. bookkeepers, secretaries, telephone operators, tellers, workers in telephone-answering services) physical activity. Assessments were done independently by three Swedish specialists in occupational medicine with extensive experience of job classification. To reduce misclassification, we only considered occupations consistently classified by the three experts. Absolute agreement between at least two of the experts was required, while the third was allowed to diverge by no more than one category. A total of 202 occupations were thus unequivocally classified. The two highest categories of physical activity were merged, to gain statistical power, since few were classified as having very high occupational physical activity. A validation study in a historic cohort of twins showed good agreement between the experts' scoring and self-reports of occupational physical activity (Moradi, Adami et al. 1999).

Socioeconomic status was categorized into four levels (unskilled blue-collar, skilled blue-collar, less educated white-collar, educated white-collar occupations), based on the occupational title, as described in detail elsewhere (Statistics Sweden 1995). Based on the residential municipality we categorized the place of residence into two categories: Urban: the capital, Stockholm, and the second and third largest cities in Sweden, Gothenburg and Malmo; and Non-urban: the other large municipalities, southern and central Sweden (except the above cities and large municipalities) and northern densely populated areas and northern sparsely populated areas.

Study Cohorts

1,343,696 men and 699,519 women reported employment in 1960 census (but not necessarily also in the 1970 census) in a job we could unequivocally classify with regard to physical activity. There were 1,373,770 men and 982,226 women with such jobs reported in the 1970 census (but not necessarily also in the 1960 census). We further identified the 670,066 men and 252,200 women who had jobs classified as demanding the same physical activity level both in 1960 and 1970 censuses.

Follow-up

Person-years of follow-up were calculated from January 1, 1971 until the diagnosis of any malignant tumor, death, or end of follow-up (December 31, 1989), whichever occurred first.

Analyses

We analyzed data in a grouped form. Attained age (age at follow-up) was divided into 14 5-year categories (<25, 25–29, …, 80–84, 85+). The nineteen calendar years of follow-up were divided into three 5-year intervals and one 4-year (January 1, 1971 – December 31, 1974 – December 31, 1975–1979, ……, January 1, 1985 – December 31, 1989). We estimated the risk of colon cancer in relation to physical activity by performing internal comparisons between exposure strata within the cohorts, using rate ratios as the measure of relative risk (RR). The “exposed” group (with sedentary jobs) was compared to the “reference” group (very high/high occupational activity). Adjustment was made for available co-variates such as age at follow-up, calendar year of follow-up, place of residence and socioeconomic status using multivariate Poisson models, estimated by the maximum likelihood method (Preston 1995). In an attempt for the analyses of men and women who changed their occupational activity between the assessments, we did not find enough power to meaningfully estimate the risks for those who had switched their occupation from physical activity level high/very high to sedentary.

RESULTS

During 19 years of follow-up, we observed 21,367 men and 8,729 women with a diagnosis of colon and rectal cancer who reported employment in 1960 census and who could be classified into one of the physical activity levels. These numbers were 15,471 for men and 8,319 for women in the 1970 census. We further observed 10,106 male and 3,122 female colorectal cancers among those who had jobs classified as demanding the same physical activity level in both the 1960 and 1970 censuses.

Tables I and II show the risk for cancer of colon and rectum by sub-sites among men and women, correspondingly, in relation to occupational physical activity during different calendar periods. In simple age-adjusted models we found an increase in risk for colon cancer as well as most sub sites with decreasing physical-activity level in both sexes. Among men the RR for colon cancer was 1.4 (95%CI 1.4–1.5) and 1.3 (95%CI 1.2–1.4) with the estimated physical activity level in 1960 and 1970 respectively for sedentary as compared with high/very high activity level. Women with sedentary level of occupational physical activity had a 10% increased in risk for cancer of the colon compared with high/very high activity level in both 1960 and 1970. Further adjustment for socio-economic status, place of residence and calendar year of follow-up changed the results only slightly. Cancer of the rectum was unaffected by the level of physical activity at work.

Table III shows the relative risks associated with occupational physical activity for cancer of the colon and rectum and by sub-sites and by gender adjusted for age, calendar year of follow-up, place of residence and socioeconomic status. The risks were estimated among those who had the same level of occupational physical activity. The relative risk for colon cancer was 1.3 (95% CI 1.2 to 1.5) among men and 1.2 (95% CI 1.0 to 1.5) among women classified as holding sedentary jobs both in 1960 and in 1970, relative to those estimated as having the physically most demanding jobs.

In men, both distal- and proximal colon cancer risk were elevated among those with sedentary jobs compared with men having very high/high job activities. Cancer of the descending colon was most affected (RR=2.4; 95% CI 1.4 to 3.9) by sedentary jobs followed by cancers of the ascending and sigmoid colon, with 30% higher risk for sedentary jobs relative to men having the physically active jobs. Risk for cancers of the transverse colon and rectum with sedentary jobs in both 1960 and 1970 was the same as in men with physically most challenging jobs. In women only cancer of proximal colon was affected by sedentary jobs. Cancer of the transverse colon was inversely significantly associated with physical activity where cancer of ascending colon was not associated with level of activity at work. Women with sustained sedentary jobs in both 1960 and 1970 had twice the risk (95% CI 1.1 to 3.5) of transverse colon cancer of women with physically active jobs. Cancer of the rectum remained unaffected by occupational physical activity in both sexes.

DISCUSSION

This study further confirms the prior consistent observations that physical activity decreases the risk of colon but not rectal cancer in both sexes. Among men we found an inverse association between estimated work-place activity and risk for ascending colon, descending colon, and sigmoid colon cancer. Descending colon showed the strongest inverse association. Our study supports evidence of a dose-dependent inverse association between estimated work place activity and risk for transverse colon cancer among women. The finding is novel and has not been explored in as much detail before in women.

The unique characteristics of our study includes the long and complete follow-up of colorectal cancer occurrence, the large size of the cohort, and the exposure assessment on two occasions 10 years apart, not based on self-report. The large number of colorectal cancer allowed us to evaluate colon cancer risk among men and women separately by subsite. Misclassification of exposure through job titles is likely. However, since the reporting of occupation occurred long before occurrence of any outcome, any exposure misclassification would be non-differential. Although we lacked information on other potential factors associated with the risk of colon cancer, an inverse association with physical activity observed in other studies was not confounded by body mass index, diet, smoking, aspirin use, education, family history of colorectal cancer, menopausal hormone use, alcohol consumption and sun exposure (Gerhardsson de Verdier, Steineck et al. 1990; Giovannucci, Ascherio et al. 1995; Le Marchand, Wilkens et al. 1997; Martinez, Giovannucci et al. 1997; Slattery, Potter et al. 1997; Steindorf, Jedrychowski et al. 2005) {Calton, 2006 #77}. Random error is of concern in subsite analyses where the analyses could for example be hampered by lack of statistical power. Misclassification of subsite categories is another concern since it is based on routine diagnosis that has not been confirmed. Our finding of different subsite effects among men and women could therefore be subject to these errors and thus warrant further investigation. We lacked information on leisure time physical activity. It is reasonable to assume that such exercise has effects in the same direction as exercise at work. Our inability to take leisure time physical activity into account may bias our risk estimates in an unpredictable direction. The true association would be attenuated if women with sedentary jobs are more- and overestimated if they are less- physically active after work than women with more strenuous occupations. The former of these alternatives may be more likely, but reliable population-based data on leisure time activity in different occupational groups is lacking. In any case, it is highly unlikely that work time-leisure time differences in physical activity could create a spurious association between physical activity and cancer risk.

Our risk estimates based on maintenance of the same occupational physical activity at both censuses would be biased if maintenance of sedentary occupations is related to worst health. The observed estimates would be exaggerated if the prevalence of conditions such as cholecystectomy or ulcerative colitis were related to maintenance of sedentary occupations. However, the estimates for those who maintained sedentary occupation at two censuses were in the same direction as for those with sedentary occupation at each census. Therefore, any major bias due to differences in health status appears unlikely.

Our finding of no association between occupational physical activity and risk for rectal cancer in either sexes is in agreement with the result of the meta-analyses of studies published through 2001 {Samad, 2005 #43} and one recent study not included in the meta-analyses {Larsson, 2006 #76}. Another recent study has showed a significant inverse association between vigorous occupational physical activity and risk for rectal cancer among women and no significant association among men {Slattery, 2003 #17}.

Cancer of the distal colon, a predominant cancer in the large bowel in men (de Jong, Day et al. 1972; Iacopetta 2002), was associated with a stronger effect for the descending than the sigmoid colon in our study, consistent with an early study (Garabrant, Peters et al. 1984) but in contrast with other studies finding the highest risk in the transverse colon (Gerhardsson, Norell et al. 1986), the ascending colon (Vena, Graham et al. 1985) or in all parts of the colon (Kato, Tominaga et al. 1990). Borader subsite analysis in a cohort of male smokers revealed a significant inverse association with occupational activity in the distal but not the proximal colon (Colbert, Hartman et al. 2001) similar to the non-significant inverse association of a recent study {Zhang, 2006 #78} where the contrast was found in another study (Thune and Lund 1996). No association of self-reported occupational physical activity was found in the cohort of Swedish men, where leisure time physical activity was inversely associated with risk of colon cancer in this studyand, similar to our result, stronger for distal colon than for proximal colon {Larsson, 2006 #76}.

Contrary to men, we found a more pronounced inverse association of physical activity in the proximal colon, a leading cancer in the large bowel among women (de Jong, Day et al. 1972; Iacopetta 2002), with a statistically significant association only in transverse colon. Although, to our knowledge there has been no study investigating the possible association between physical activity and cancer of the colon by comparable fine subsites, assessment of the association among women by broader subsite categories in one study has shown a result similar to our study with a stronger inverse association between leisure time physical activity for the proximal than the distal colon (Thune and Lund 1996). Other studies have revealed an inverse association between physical activity and distal colon (Martinez, Giovannucci et al. 1997), and finally no significant decrease in risk was found for either proximal or distal colon in other studies (Marcus, Newcomb et al. 1994) {Calton, 2006 #77} {Zhang, 2006 #78}.

Although the protective effect of physical activity has been hypothesized to influence several factors relevant to colon carcinogenesis such as, the immune system, the bile acid metabolism, insulin, insulin-like growth factor-I (IGF-I), IGF binding proteins (IGFBPs)(Sandhu, Dunger et al. 2002), prostaglandin levels and colon transit time (Oettle 1991), serum cholesterol and gastrointestinal and pancreatic hormone profiles (Quadrilatero and Hoffman-Goetz 2003), there is little empirical data to support them. The observed differences in the effect of physical activity between genders and sub-site specific add complications to an already complicated unknown mechanism. Anatomical and functional differences might contribute to the sub site difference seen in men and women. The female colon is inherently longer despite women's smaller stature. The length difference is caused by a longer transverse colon which topography has a different rout in women reaching the true pelvis significantly more often than in men (Saunders, Fukumoto et al. 1996). Moreover, colonic transit is slower in women something which is further enhanced in the luteal phase of the menstrual cycle (Jung, Kim et al. 2003; Sadik, Abrahamsson et al. 2003) indicating that hormonal factors influence motility. These observations might explain why the increased risk of transverse colon cancer is seen in women but not in men with sedentary jobs. The transit through transverse colon might therefore be more dependent of physical activity in women than in men. Less physical activity then further enhance the exposure of the colonic mucosa to the fecal content (Lampe, Fredstrom et al. 1993). (might be deleted) There are clear evidence of the demographic and geographic differences in the incidence of distal and proximal colon cancer (Jensen 1984; Bonithon-Kopp and Benhamiche 1999; Troisi, Freedman et al. 1999; McCashland, Brand et al. 2001; Takada, Ohsawa et al. 2002; Jubelirer, Wells et al. 2003). Differences in molecular level such as bacterial composition and bacterial activity (Macfarlane, Gibson et al. 1992), as well as differences in clinic pathologic features (Ward, Meagher et al. 2001) such as cell proliferation and apoptotic activity (Anti, Armuzzi et al. 2001) between distal and proximal colon have been observed. In addition patients with cancer of proximal colon appears to have a survival benefit with chemotherapy compared with patients with cancer of distal colon (Elsaleh, Joseph et al. 2000). Thus, the protective effect of physical activity on colon cancer risk that differs by anatomic sub-sites and gender observed in this study and others, although with unclear mechanism, would be expected. However, additional finding in our study of an inverse association between physical activity level and the risk for descending in distal colon cancer in men and for transverse in proximal colon cancer in women further complicates the issue and remains to be confirmed by other studies.

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Table I

Relative risk (RR) with 95 percent confidence interval (CI) for cancer of the colon and rectum among *men* by sub site and by estimated physical activity in 1960 and 1970. Results obtained by Poisson regression.

		Census 1960					Census 1970				
Anatomic subsite (ICDO-7)	**Occupational PA**	**Cases**	**RR[a]**	**95 % CI**	**RR[b]**	**95 % CI**	**Cases**	**RR[a]**	**95 % CI**	**RR[b]**	**95 % CI**
Colon (153)	Very high/high	4415	1.0	Ref.	1.0	Ref.	2668	1.0	Ref.	1.0	Ref.
	Moderate	2294	1.2	1.1–1.3	1.2	1.1–1.2	1728	1.1	1.0–1.2	1.0	1.0–1.2
	Light	4161	1.4	1.3–1.4	1.3	1.2–1.3	3424	1.3	1.2–1.3	1.2	1.1–1.3
	Sedentary	1668	1.4	1.4–1.5	1.3	1.2–1.4	1150	1.3	1.2–1.4	1.2	1.1–1.3
			p<0.001		p<0.001			p<0.001		p<0.001	
Proximal (153.0-.1)	Very high/high	2064	1.0	Ref.	1.0	Ref.	1240	1.0	Ref.	1.0	Ref.
	Moderate	1094	1.2	1.1–1.3	1.1	1.0–1.2	802	1.1	1.0–1.2	1.1	1.0–1.2
	Light	1910	1.3	1.2–1.4	1.2	1.1–1.4	1588	1.3	1.2–1.4	1.2	1.1–1.4
	Sedentary	766	1.4	1.3–1.5	1.3	1.1–1.4	524	1.3	1.2–1.4	1.2	1.1–1.4
			p<0.001		p<0.001			p<0.001		p=0.0042	
Ascending+ Cecum (153.0)	Very high/high	1467	1.0	Ref.	1.00	Ref.	880	1.0	Ref.	1.00	Ref.
	Moderate	747	1.2	1.1–1.3	1.1	1.0–1.2	579	1.1	1.0–1.3	1.1	1.0–1.2
	Light	1398	1.4	1.3–1.5	1.3	1.1–1.4	1155	1.3	1.2–1.5	1.3	1.1–1.5
	Sedentary	567	1.5	1.3–1.6	1.3	1.1–1.5	376	1.3	1.2–1.5	1.3	1.1–1.5
			p<0.001		p=0.002			p<0.001		p=0.0038	
Transverse+ Flexures (153.1)	Very high/high	597	1.0	Ref.	1.0	Ref.	360	1.0	Ref.	1.0	Ref.
	Moderate	302	1.2	1.0–1.3	1.1	1.0–1.2	223	1.1	0.9–1.2	1.0	0.8–1.2
	Light	512	1.2	1.1–1.4	1.2	1.0–1.4	433	1.2	1.0–1.3	1.0	0.9–1.3
	Sedentary	199	1.3	1.1–1.5	1.2	1.0–1.5	148	1.2	1.0–1.5	1.1	0.9–1.5
			p<0.001		p=0.044			p=0.010		p=ns	
Distal (153.2–.3)	Very high/high	1718	1.0	Ref.	1.0	Ref.	1039	1.0	Ref.	1.0	Ref.
	Moderate	902	1.2	1.1–1.3	1.2	1.1–1.3	668	1.1	1.0–1.2	1.1	1.0–1.2
	Light	1663	1.4	1.3–1.5	1.2	1.1–1.4	1341	1.3	1.2–1.4	1.1	1.0–1.3
	Sedentary	666	1.5	1.4–1.6	1.3	1.2–1.5	465	1.4	1.2–1.5	1.2	1.0–1.4
			p<0.001		p<0.001			p<0.001		p=0.016	
Descending (153.2)	Very high/high	214	1.0	Ref.	1.0	Ref.	133	1.0	Ref.	1.0	Ref.

		Census 1960					Census 1970				
Anatomic subsite (ICDO-7)	Occupational PA	Cases	RR[a]	95 % CI	RR[b]	95 % CI	Cases	RR[a]	95 % CI	RR[b]	95 % CI
	Moderate	120	1.3	1.0–1.6	1.1	0.9–1.5	85	1.1	0.8–1.4	1.0	0.7–1.3
	Light	223	1.4	1.2–1.8	1.2	0.9–1.6	192	1.4	1.1–1.7	1.1	0.8–1.5
	Sedentary	115	2.0	1.6–2.5	1.7	1.2–2.3	75	1.7	1.3–2.2	1.3	0.9–1.9
			p<0.001		p<0.001			p<0.001		p=0.0089	
Sigmoid (153.3)	Very high/high	1504	1.0	Ref.	1.0	Ref.	906	1.0	Ref.	1.0	Ref.
	Moderate	782	1.2	1.1–1.3	1.2	1.1–1.3	583	1.1	1.0–1.2	1.1	1.0–1.2
	Light	1440	1.3	1.2–1.5	1.3	1.2–1.5	1149	1.2	1.0–1.4	1.1	1.0–1.3
	Sedentary	551	1.3	1.2–1.5	1.3	1.1–1.5	390	1.2	1.0–1.5	1.1	1.0–1.4
			p<0.001		p<0.001			p<0.001		p=0.12	
Rectum (154)	Very high/high	3492	1.0	Ref.	1.0	Ref.	2151	1.0	Ref.	1.0	Ref.
	Moderate	1608	1.1	1.0–1.1	1.0	1.0–1.1	1353	1.1	1.0–1.1	1.0	1.0–1.1
	Light	2674	1.1	1.0–1.1	1.0	1.0–1.1	2259	1.0	1.0–1.1	1.0	0.9–1.1
	Sedentary	1055	1.1	1.1–1.2	1.1	1.0–1.2	738	1.0	1.0–1.1	1.1	0.9–1.2
			p<0.001		p=ns			p=ns		p=ns	

[a] Relative risk adjusted for age by 5 years interval, and calendar year of follow-up by year.

[b] Relative risk adjusted for age by 5 years interval, calendar year of follow-up by year, place of residence and socioeconomic status.

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Table II

Relative risk (RR) with 95 percent confidence interval (CI) for cancer of the colon and rectum among *women* by sub site and by estimated physical activity in 1960 and 1970. Results obtained by Poisson regression.

		Census 1960					Census 1970				
Anatomic subsite (ICDO-7)	**Occupational PA**	**Cases**	**RR[a]**	**95 % CI**	**RR[b]**	**95 % CI**	**Cases**	**RR[a]**	**95 % CI**	**RR[b]**	**95 % CI**
Colon (153)	Very high/high	1073	1.0	Ref.	1.0	Ref.	1442	1.0	Ref.	1.0	Ref.
	Moderate	1759	1.0	0.9–1.1	1.0	0.9–1.1	1812	1.0	1.0–1.1	1.1	1.0–1.1
	Light	1876	1.1	1.0–1.1	1.1	1.0–1.2	1372	1.1	1.0–1.1	1.1	1.0–1.2
	Sedentary	1033	1.1	1.0–1.2	1.1	1.1–1.3	732	1.1	1.0–1.2	1.2	1.1–1.4
			p=0.014		p=0.0055			p=0.10		p<0.001	
Proximal (153.0–.1)	Very high/high	510	1.0	Ref.	1.0	Ref.	663	1.0	Ref.	1.0	Ref.
	Moderate	850	1.0	0.9–1.1	1.1	0.9–1.2	810	1.0	0.9–1.1	1.0	0.9–1.1
	Light	884	1.1	0.9–1.2	1.1	1.0–1.2	606	1.0	0.9–1.1	1.1	1.0–1.2
	Sedentary	497	1.2	1.0–1.3	1.2	1.0–1.5	344	1.2	1.0–1.3	1.2	1.0–1.5
			p=0.024		p=0.011			p=0.056		p=0.0032	
Ascending + Cecum (153.0)	Very high/high	357	1.0	Ref.	1.0	Ref.	489	1.0	Ref.	1.0	Ref.
	Moderate	633	1.1	1.0–1.2	1.1	1.0–1.3	594	1.0	0.9–1.1	1.0	0.9–1.2
	Light	635	1.1	1.0–1.2	1.1	1.0–1.3	425	1.0	0.9–1.1	1.0	0.9–1.2
	Sedentary	350	1.2	1.0–1.4	1.3	1.0–1.6	238	1.1	0.9–1.3	1.2	0.9–1.4
			p=0.062		p=0.0084			p=ns		p=0.096	
Transverse+Flexures (153.1)	Very high/high	153	1.0	Ref.	1.0	Ref.	174	1.0	Ref.	1.0	Ref.
	Moderate	217	0.9	0.7–1.1	0.9	0.7–1.1	216	1.0	0.8–1.3	1.0	0.8–1.3
	Light	249	1.0	0.8–1.2	1.0	0.8–1.3	181	1.2	0.9–1.4	1.3	1.0–1.6
	Sedentary	147	1.1	0.9–1.4	1.1	0.8–1.5	106	1.3	1.0–1.7	1.5	1.1–2.2
			p=ns		p=ns			p=0.013		p=0.0037	
Distal (153.2–.3)	Very high/high	410	1.0	Ref.	1.0	Ref	563	1.0	Ref.	1.0	Ref.
	Moderate	641	1.0	0.8–1.1	1.0	0.9–1.1	722	1.1	0.9–1.2	1.1	1.0–1.2
	Light	714	1.0	0.9–1.2	1.1	0.9–1.2	526	1.0	0.9–1.2	1.1	1.0–1.3
	Sedentary	383	1.0	0.9–1.2	1.2	1.0–1.4	272	1.0	0.9–1.2	1.1	0.9–1.4
			p=ns		p=0.022			p=ns		p=0.045	
Descending (153.2)	Very high/high	66	1.0	Ref.	1.0	Ref.	80	1.0	Ref.	1.0	Ref.

Anatomic subsite (ICDO-7)	Occupational PA	Census 1960					Census 1970				
		Cases	RR[a]	95 % CI	RR[b]	95 % CI	Cases	RR[a]	95 % CI	RR[b]	95 % CI
	Moderate	80	0.7	0.5–1.0	0.7	0.5–1.0	103	1.1	0.8–1.4	1.0	0.7–1.4
	Light	108	1.0	0.7–1.3	1.0	0.7–1.4	73	1.0	0.7–1.4	0.9	0.6–1.3
	Sedentary	53	0.9	0.6–1.3	1.0	0.6–1.7	41	1.1	0.7–1.6	1.0	0.6–1.7
			p=ns		p=ns			p=ns		p=ns	
Sigmoid (153.3)	Very high/high	344	1.0	Ref.	1.0	Ref.	483	1.0	Ref.	1.0	Ref.
	Moderate	561	1.0	0.9–1.1	1.0	0.9–1.2	619	1.1	0.9–1.2	1.1	1.0–1.2
	Light	606	1.1	0.9–1.2	1.1	1.0–1.3	453	1.0	0.9–1.2	1.1	1.0–1.3
	Sedentary	330	1.1	0.9–1.3	1.2	1.0–1.5	231	1.0	0.9–1.2	1.2	0.9–1.4
			p=ns		p=0.039			p=ns		p=0.070	
Rectum (154)	Very high/high	539	1.0	Ref.	1.0	Ref.	778	1.0	Ref.	1.0	Ref.
	Moderate	937	1.1	1.0–1.2	1.1	1.0–1.2	1012	1.1	1.0–1.2	1.1	1.0–1.2
	Light	986	1.1	1.0–1.2	1.1	1.0–1.3	768	1.1	1.0–1.2	1.1	1.0–1.2
	Sedentary	526	1.1	0.9–1.2	1.1	0.9–1.3	403	1.1	1.0–1.2	1.0	0.9–1.2
			p=ns		p=ns			p=ns		p=ns	

[a]Relative risk adjusted for age by 5 years interval, and calendar year of follow-up by year.

[b]Relative risk adjusted for age by 5 years interval, calendar year of follow-up by year, place of residence and socioeconomic status.

Table III

Relative risk (RR) with 95 percent confidence interval (CI) for cancer of the colon and rectum by sub-site and by occupational physical activity level in 1960 and 1970.

		Female			Male		
Anatomic sub-site (ICD-7)	**Occupational Physical Activity**	**Cases**	**RR**[a]	**95 % CI**	**Cases**	**RR**[a]	**95 % CI**
Colon (153)	Very high/high	359	1.0	Ref.	1989	1.0	Ref.
	Moderate	569	1.0	0.9–1.1	894	1.2	1.1–1.3
	Light	706	1.1	0.9–1.2	2314	1.3	1.1–1.4
	Sedentary	366	1.2	1.0–1.5	703	1.3	1.2–1.5
	p-value for trend		p=0.045			p<0.001	
Proximal Colon (153.0-1)	Very high/high	174	1.0	Ref.	937	1.0	Ref.
	Moderate	269	1.0	0.8–1.2	416	1.2	1.0–1.3
	Light	325	1.1	0.9–1.3	1092	1.3	1.1–1.5
	Sedentary	188	1.4	1.1–2.0	319	1.2	1.0–1.5
	p-value for trend		p=0.029			p=0.0036	
Ascending + Cecum (153.0)	Very high/high	136	1.0	Ref.	660	1.0	Ref
	Moderate	201	1.0	0.8–1.2	297	1.2	1.0–1.4
	Light	228	1.0	0.8–1.2	806	1.4	1.2–1.6
	Sedentary	132	1.3	0.9–1.8	238	1.3	1.1–1.6
	p-value for trend		p=ns			p=0.0024	
Transverse+ Flexures (153.1)	Very high/high	38	1.0	Ref.	277	1.0	Ref.
	Moderate	68	1.1	0.7–1.6	119	1.1	0.8–1.4
	Light	97	1.4	0.9–2.2	286	1.0	0.8–1.4
	Sedentary	56	2.0	1.1–3.5	81	1.0	0.7–1.5
	p-value for trend		P=0.044			p=ns	
Distal Colon (153.2-3)	Very high/high	141	1.0	Ref.	773	1.0	Ref.
	Moderate	215	1.0	0.8–1.2	352	1.2	1.1–1.4
	Light	274	1.1	0.8–1.4	899	1.3	1.1–1.5
	Sedentary	135	1.2	0.8–1.7	285	1.4	1.2–1.7
	p-value for trend		P=ns			p<0.001	
Descending (153.2)	Very high/high	23	1.0	Ref.	97	1.0	Ref.

Anatomic sub-site (ICD-7)	Occupational Physical Activity	Female			Male		
		Cases	RR[a]	95 % CI	Cases	RR[a]	95 % CI
	Moderate	32	0.8	0.4–1.4	48	1.4	1.0–2.0
	Light	40	0.9	0.5–1.6	120	1.6	1.1–2.4
	Sedentary	19	1.1	0.4–2.5	49	2.4	1.4–3.9
	p-value for trend		P=ns			p<0.001	
Sigmoid (153.3)	Very high/high	118	1.0	Ref.	676	1.0	Ref.
	Moderate	183	1.0	0.8–1.3	304	1.2	1.0–1.4
	Light	234	1.1	0.9–1.4	779	1.3	1.1–1.5
	Sedentary	116	1.2	0.8–1.8	236	1.3	1.0–1.6
	p-value for trend		P=ns			p=0.020	
Rectum (154)	Very high/high	194	1.0	Ref.	1581	1.0	Ref.
	Moderate	315	1.0	0.9–1.2	667	1.1	1.0–1.2
	Light	395	1.1	0.9–1.3	1515	1.0	0.9–1.2
	Sedentary	218	1.0	0.8–1.3	443	1.1	0.9–1.2
	p-value for trend		P=ns			p=ns	

[a]Relative risk adjusted for 5- year age and calendar-year intervals of follow-up, place of residence, socioeconomic status