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Occupational physical activity, socioeconomic status, and risks of 15 cancer sites in Turkey

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A multiple-site case-control study of 15 cancers (stomach; colon; rectum; larynx; lung; melanoma; skin; female breast; male breast; cervix; ovary; uterus; prostate; testis; and bladder) was conducted to evaluate their association with occupational physical activity and socioeconomic status (SES). A hospital-based study population (3,486 male cases and 379 female cases, and 2,127 male and 244 female controls) was established in an oncological treatment center in Istanbul, Turkey, from 1979-84. Assessment of physical activity and SES was based on job titles held by the study subjects. Two measures of physical activity were developed based on energy expenditure and 'sitting time' during working hours. Observed risks were adjusted for age, smoking, and SES. Elevated risks were observed among workers who held sedentary jobs for cancers of the colon (odds ratio [OR] = 1.6), rectum (OR = 1.3), melanoma (OR = 1.9), male breast (OR = 1.4), prostate (OR = 5.0), and ovary (OR = 2.0). Cancers of the cervix and uterus showed significantly decreasing risks with decreased activity. Risks of cancers of the colon, rectum, larynx, ovary, and melanoma were enhanced after risks for physical activity indices were adjusted for SES, while the associations between physical activity and cancers of the prostate, cervix, and uterus were weakened after SES adjustment. Risks of melanoma rose significantly with both activity indices after SES adjustment. The results of this study support previously reported associations between physical activity and cancers of the colon and rectum observed in developed countries, and provide additional evidence for cancers of the larynx, prostate, cervix, uterus, and melanoma, and point out the importance of SES in evaluation of physical activity and cancers of the colon, rectum, larynx, prostate, breast, cervix, and melanoma in developing countries.

Key words: Cancer, case-control, colon, larynx, melanoma, occupation, physical activity, prostate, rectum, socioeconomic status, Turkey.

Introduction

Employment in occupations requiring low levels of physical activity has been associated with several cancer sites, including cancers of the colon, rectum, or colon/rectum,[1-25] prostate,[6,12,15,24,26,29,30] lung,[6,12,15,24] melanoma,[6,24] breast,[5,26] cervix,[15] stomach,[6,12,24] bladder,[12,24] pancreas,[6,24] testes,[6,24] and all cancers combined.[6,15,28] Although a negative association has been observed repeatedly for colon cancer, other sites are more incon-

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sistent. Almost all studies, with few exceptions,[7,17,20] have taken place in developed countries, and none of these studies was controlled for socioeconomic status (SES). Because the relative proportion of energy expended in work and leisure-time activities may differ among persons from developed and developing countries,[25] and SES may be a strong confounding factor for some cancer sites, SES-controlled studies in developing countries are needed. We therefore conducted a multiple-site case-control study of 15 cancers to examine associations between physical activity, SES, and these cancer sites among workers in Turkey.

Materials and methods

A hospital-based study population was established at an oncological treatment center of a Social Security Agency hospital in Istanbul, Turkey, from 1979 to 1984. Fifteen cancer sites (stomach; colon; rectum; larynx; lung; melanoma; skin; male and female breast; cervix; ovary; uterus; prostate; testis; and bladder) were selected as cases and compared with controls, which included subjects diagnosed as non-cancers (10 percent of all controls), cancers of the buccal cavity, esophagus, liver, bone, soft tissue, brain, lymphoma, and other cancer sites for which there is no suggestion of an association with physical activity. Work histories, diagnosis with histologic verification, and information on alcohol and tobacco use were obtained for 7,242 cancer cases. Because of the small number (10 percent of all cases) of females in the study population, only cancers of the breast, cervix, ovary, and uterus were evaluated for females. Subjects with incomplete information on occupation or smoking were removed from the study. After these exclusions, there was a total of 3,486 male and 379 female cases and 2,127 male and 244 female controls. Distribution of cases by cancer site is presented in Table 1. The frequencies observed are consistent with other cancer surveys in Turkey.[31-33]

Assignment of occupational physical activity and SES was based on occupations held by the subjects. All jobs were coded using a modified version of the Standard Occupational Classification (SOC) code system.[34] The four-digit SOC codes were expanded into more detailed seven-digit codes and special codes were created to cover job titles observed in Turkey. A job-exposure matrix for occupational physical activity was developed by two of the authors (R.V. and M.D.) based on the modified SOC codes. Two physical activity indices—energy expenditure and sitting-time—were developed for each SOC code. The energy expenditure scale was based on a system developed by Hettinger *et al.*[35] Sedentary activity was defined as work in jobs where energy expenditure was estimated to be of less than 8 kJ/min such as sitting with only hand work, moderate one-arm, or light two-arm work (*e.g.*, office work). Moderate activity was defined as work with an estimated energy expenditure between 8-12 kJ/min, such as walking on a flat surface with a speed of 3 km/h, heavy one-arm work, or moderate two-arm work (*e.g.*, sweeping). High activity was work with an estimated energy expenditure of more than 12 kJ/min, such as walking on a flat surface with a speed of more than 4 km/h, heavy two-arm work, or light to heavy body work (*e.g.*, wall painting). The sitting-time scale was defined as: low activity (sedentary, *i.e.*, sitting more than six hours a day); moderate activity (mod, *i.e.*, sitting two to six hours a day); and high activity (active, *i.e.*, sitting less than two hours a day). These activity scales were similar to those previously used in occupational physical activity studies.[1,3,13,14] Time-weighted, average of physical-activity measures were used in the analysis. Time-weighted average was calculated by dividing the cumulative activity levels by the total duration of jobs held by the subject. Cumulative exposure was calculated as a sum of products of physical activity levels assigned for the jobs and duration of employment on that particular job. Midpoints of physical activity ranges were used as a quantitative value in the calculation of cumulative exposure for both energy expenditure and sitting time indices. Unemployment period was not included in the average, time-weighted activity calculation.

Table 1. Distributions of male and female cases in Turkey by cancer site, 1979-84

Site	No.
Male cases	3,486
Stomach	224
Colon	93
Rectum	120
Larynx	779
Lung	1,148
Melanoma	52
Skin	554
Breast	31
Prostate	27
Testis	191
Bladder	267
Male controls	2,127
Female cases	379
Breast	241
Cervix	58
Ovary	49
Uterus	31
Female controls	244
Total	6,236

Table 2. Frequencies of subjects by socioeconomic status and physical activity indices, Turkey, 1979-84

Exposure categories		Frequency	Percent
Socioeconomic status (SES)			
Low		4,322	69.3
Medium		1,609	25.8
High		305	4.9
Energy expenditure index			
High	(> 12 kJ/min)	1,553	24.9
Moderate	(8-12 kJ/min)	2,594	41.6
Sedentary	(< 8 kJ/min)	2,089	33.5
Sitting time index			
High	(< 2 hr)	3,436	55.1
Moderate	(2-6 hr)	1,977	31.7
Sedentary	(> 6 hr)	823	13.2

An SES level was assigned to each occupational code using a three-level scale (low, medium, and high) based on income and education levels required for that particular occupation.

Maximum likelihood estimates of the odds ratio (OR) were used to estimate the magnitude of risk of cancers associated with the physical activity indices. ORs were adjusted for age (< 45 [29 percent], 45-55 [35 percent], < 55 [36 percent]), smoking (ever [67 percent] *cf* never [33 percent] smoked), and SES (low, medium, high). Gart's method[36] was used to calculate the OR and corresponding 95 percent confidence intervals (CI). Risks for sedentary or moderately active groups were compared with the highly active group. Linear-trend test statistics for ORs were calculated using Mantel's chi-square test,[37] using monotonic scoring scheme (0, 1, 2).

Results

The distribution of study subjects by physical activity and SES is presented in Table 2, and the risks of 15 cancer sites by SES are presented in Table 3. All risks are adjusted for age (< 45, 45-54, 55 +) and smoking (ever *cf* never smoked). Cancers of the larynx ($OR_{low\text{-}SES} = 4.1$) and cervix ($OR_{low\text{-}SES} = 2.3$) showed significant increase in risk with decreasing SES (*P* values for trend = 0.000 and 0.004, respectively), while cancers of the prostate ($OR_{low\text{-}SES} = 0.2$) and female breast ($OR_{low\text{-}SES} = 0.4$) showed significant inverse trend (*P* values of 0.000 and 0.045, respectively). Elevated, but not significant, risks were observed among the lower SES group for cancers of the stomach, male breast, uterus, and for melanoma, while deficits were observed for the cancers of the colon, rectum, and ovary.

Table 3. Risks (odds ratios) of 15 cancer sites by socioeconomic status (SES), adjusted for age and smoking, Turkey, 1979-84

Cancer sites	Odds ratios (No. of cases)			
	High-SES	Medium-SES (CI)[a]	Low-SES (CI)[a]	*P*-value
Males				
Stomach	1.0 (8)	1.5 (61) (0.7-3.5)	1.4 (155) (0.6-3.1)	0.48
Colon	1.0 (7)	0.5 (21) (0.2-1.5)	0.7 (65) (0.3-1.7)	0.31
Rectum	1.0 (9)	0.6 (26) (0.3-1.4)	0.7 (85) (0.3-1.5)	0.33
Larynx	1.0 (11)	3.2 (170) (1.6-6.4)	4.1 (597) (2.1-8.1)	0.00
Lung	1.0 (64)	1.0 (294) (0.7-1.4)	0.9 (790) (0.7-1.3)	0.27
Melanoma	1.0 (2)	1.3 (11) (0.3-9.0)	1.6 (39) (0.4-10)	0.17
Skin	1.0 (28)	1.1 (138) (0.7-1.8)	1.1 (389) (0.7-1.8)	0.38
Breast	1.0 (1)	2.8 (14) (0.4-59.5)	1.6 (16) (0.2-33.1)	0.08
Prostate	1.0 (8)	0.2 (6) (0.1-0.6)	0.2 (13) (0.1-0.4)	0.00
Testis	1.0 (7)	1.1 (48) (0.5-2.9)	1.0 (136) (0.4-2.4)	0.31
Bladder	1.0 (15)	1.1 (70) (0.6-2.1)	1.1 (182) (0.6-2.0)	0.48
Females				
Breast	1.0 (18)	0.4 (86) (0.2-1.1)	0.4 (127) (0.2-1.1)	0.05
Cervix	1.0 (1)	0.8 (13) (0.1-21.3)	2.3 (44) (0.2-57.8)	0.00
Ovary	1.0 (2)	0.7 (16) (0.1-5.0)	0.5 (31) (0.1-4.6)	0.43
Uterus	1.0 (1)	0.8[b] (8) (–)	1.6[b] (22) (–)	0.13

[a] CI = 95% confidence interval.
[b] Unadjusted for age and smoking.

Table 4 presents risk estimates (ORs) by the energy expenditure categories. All risks were adjusted for age and smoking. Risks, with and without SES adjustment, are presented. Without SES adjustment, elevated risks for less active jobs were observed for cancers of the colon ($OR_{sed} = 1.56$); rectum ($OR_{mod} = 1.26$, $OR_{sed} = 1.32$); melanoma ($OR_{mod} = 1.64$, $OR_{sed} = 1.89$); male breast ($OR_{sed} = 1.38$); and prostate ($OR_{mod} = 3.02$, $OR_{sed} = 5.04$). Only cancers of the colon and prostate showed significant increasing risk with decreasing activity (with *P* values of 0.04, and 0.01, respectively). The risk for cervical cancer decreased with reduced energy expenditure ($OR_{mod} = 0.65$, $OR_{sed} = 0.25$, *P* for trend is 0.004). Nonsignificant increasing risk with

Table 4. Age and smoking, with and without socioeconomic status (SES) adjusted risks of 15 cancer sites by energy expenditure index, Turkey, 1979-84

Cancer sites	Odds ratios (OR) without SES adjustment[a]				Odds ratios (OR) with SES adjustment[a]		
	OR [active, > 12 kJ/min]	OR [moderate, 8-12 kJ/min] (CI)[b]	OR [sedentary, < 8 kJ/min] (CI)[b]	(*P* value)	OR [moderate, (8-12 kJ/min] (CI)[b]	OR [sedentary, < 8 kJ/min] (CI)[b]	(*P* value)
Males							
Stomach	1.0 (60)[a]	1.0 (92) (0.7-1.5)	1.0 (72) (0.7-1.5)	0.42	0.9 (92) (0.6-1.4)	1.1 (72) (0.6-1.7)	0.32
Colon	1.0 (21)	1.1 (33) (0.6-2.0)	1.6 (39) (0.9-2.8)	0.04	1.2 (33) (0.6-2.1)	1.8 (39) (0.9-3.8)	0.03
Rectum	1.0 (27)	1.3 (50) (0.8-2.1)	1.3 (43) (0.8-2.3)	0.15	1.3 (50) (0.8-2.2)	1.5 (43) (0.7-2.9)	0.11
Larynx	1.0 (217)	0.9 (305) (0.7-1.1)	0.9 (257) (0.7-1.1)	0.17	1.0 (305) (0.8-1.2)	1.2 (257) (0.9-1.6)	0.09
Lung	1.0 (295)	1.0 (450) (0.8-1.2)	1.1 (403) (0.9-1.3)	0.36	1.0 (450) (0.8-1.2)	1.0 (403) (0.8-1.3)	0.48
Melanoma	1.0 (9)	1.6 (22) (0.7-3.9)	1.9 (21) (0.8-4.5)	0.08	1.9 (22) (0.8-4.5)	2.7 (21) (1.0-7.4)	0.01
Skin	1.0 (140)	1.1 (231) (0.8-1.4)	1.0 (183) (0.8-1.3)	0.39	1.1 (231) (0.8-1.4)	1.0 (183) (0.7-1.5)	0.48
Breast	1.0 (7)	1.1 (11) (0.4-3.1)	1.4 (13) (0.6-3.9)	0.24	1.0 (11) (0.3-3.0)	0.3 (13) (0.0-2.4)	0.34
Prostate	1.0 (2)	3.0 (9) (0.6-20.0)	5.0 (16) (1.1-31.7)	0.01	3.0 (9) (0.6-20.6)	3.6 (16) (0.5-29.3)	0.77
Testis	1.0 (48)	1.2 (89) (0.8-1.9)	1.0 (54) (0.7-1.6)	0.49	1.2 (89) (0.8-1.8)	1.0 (54) (0.5-1.8)	0.35
Bladder	1.0 (71)	0.9 (102) (0.7-1.3)	0.9 (94) (0.7-1.3)	0.32	0.9 (102) (0.6-1.3)	0.9 (94) (0.5-1.4)	0.30
Females							
Breast	1.0 (29)	0.9 (118) (0.5-1.8)	1.1 (84) (0.6-2.1)	0.32	0.9 (118) (0.5-1.7)	0.7 (84) (0.2-3.4)	0.23
Cervix	1.0 (12)	0.7 (35) (0.3-1.6)	0.3 (11) (0.1-0.8)	0.00	0.7 (35) (0.3-1.8)	0.3 (11) (0.0-4.1)	0.20
Ovary	1.0 (3)	2.5 (32) (0.6-10.8)	2.0 (14) (0.4-10.2)	0.44	2.5 (32) (0.6-11.6)	3.8 (14) (0.1-921.0)	0.26
Uterus	1.0 (6)	0.6 (18) (0.2-2.1)	0.5 (7) (0.1-2.1)	0.11	0.7 (18) (0.2-2.2)	0.5 (7) (0.0-9.3)	0.27

[a] No. of cases in parentheses.
[b] CI = 95% confidence interval.

decreased energy expenditure was observed for cancers of the rectum, melanoma, male breast, and ovary. Cancer of the uterus showed nonsignificant decreasing risk with decreased activity. Other cancer sites did not show any association with energy expenditure index. Associations of energy expenditure index and risks for cancers of the colon, rectum, larynx, melanoma, and ovary became stronger after adjustment of risk for SES, while adjustment weakened association with cancers of the prostate and cervix. The associations between risks of male and female breast cancer and physical activity changed direction (from positive to negative) after SES adjustment. Risks of other cancer sites were not affected from SES adjustment.

Risks for the sitting-time index, with and without SES adjustment, are presented in Table 5. Without SES adjustment, elevated risks were observed among workers holding less active jobs for cancers of the colon ($OR_{mod} = 1.52$, $OR_{sed} = 1.51$); rectum ($OR_{sed} = 1.33$); melanoma ($OR_{sed} = 1.75$); male breast ($OR_{mod} = 1.75$); prostate ($OR_{mod} = 2.12$, $OR_{sed} = 3.37$); and female breast ($OR_{sed} = 1.45$). Cancers of the colon and prostate showed increasing risk with decreasing activity among males (with *P* values of 0.03 and 0.008, respectively). Cancer of the rectum, female breast, and melanoma showed positive, but nonsignificant associations with sitting-time index. Risks of cancer of the cervix and uterus decreased significantly with reduced activity ($OR_{mod} = 0.37$, $OR_{sed} = 0.21$; and $OR_{mod} = 0.29$, $OR_{sed} = 0.41$; respectively). Other cancer sites did not

Table 5. Age and smoking, with and without socioeconomic status (SES) adjusted risks of 15 cancer sites by sitting-time index, Turkey, 1979-84

Cancer site	Odds ratios (OR) without SES adjustment[a]				Odds ratios (OR) with SES adjustment[a]		
	OR [active, < 2 hr/day]	OR [moderate, 2-6 hr/day] (CI)[b]	OR [sedentary, > 6 hr/day] (CI)[b]	(*P* value)	OR [moderate, 2-6 hr/day] (CI)[b]	OR [sedentary, > 6 hr/day] (CI)[b]	(*P* value)
For males							
Stomach	1.0 (122)	1.1 (79) (0.8-1.5)	0.9 (23) (0.5-1.4)	0.41	1.1 (79) (0.8-1.5)	0.7 (23) (0.4-1.4)	0.42
Colon	1.0 (42)	1.5 (37) (0.9-2.5)	1.5 (14) (0.8-3.0)	0.03	1.7 (37) (1.0-2.8)	1.4 (14) (0.5-4.1)	0.03
Rectum	1.0 (65)	1.0 (36) (0.6-1.5)	1.3 (19) (0.8-2.3)	0.21	1.0 (36) (0.6-1.7)	1.1 (19) (0.4-2.6)	0.25
Larynx	1.0 (433)	1.0 (271) (0.8-1.2)	0.8 (75) (0.6-1.0)	0.09	1.1 (271) (0.9-1.4)	1.1 (75) (0.8-1.8)	0.07
Lung	1.0 (610)	1.0 (376) (0.8-1.2)	1.2 (162) (0.9-1.5)	0.13	1.0 (376) (0.8-1.2)	1.3 (162) (0.9-1.8)	0.16
Melanoma	1.0 (25)	1.1 (17) (0.6-2.2)	1.8 (10) (0.8-3.9)	0.10	1.2 (17) (0.6-2.5)	3.6 (10) (1.1-12)	0.01
Skin	1.0 (304)	1.0 (184) (0.8-1.2)	0.9 (66) (0.7-1.3)	0.29	0.9 (184) (0.7-1.2)	1.0 (66) (0.6-1.6)	0.37
Breast	1.0 (13)	1.8 (15) (0.8-4.0)	1.0 (3) (0.2-3.7)	0.26	1.4 (15) (0.6-3.4)	1.1 (3) (0.1-11)	0.26
Prostate	1.0 (8)	2.1 (12) (0.8-5.8)	3.4 (7) (1.1-10.6)	0.01	1.7 (12) (0.6-5.2)	1.1 (7) (0.1-12)	0.31
Testis	1.0 (113)	1.0 (55) (0.7-1.4)	1.0 (23) (0.6-1.6)	0.46	0.9 (55) (0.6-1.4)	0.7 (23) (0.4-1.5)	0.35
Bladder	1.0 (146)	0.9 (86) (0.7-1.3)	1.0 (35) (0.6-1.5)	0.34	0.9 (86) (0.7-1.2)	1.2 (35) (0.6-2.2)	0.33
For females							
Breast	1.0 (125)	0.9 (43) (0.5-1.5)	1.5 (63) (0.9-2.4)	0.10	0.9 (43) (0.5-1.6)	1.0 (63) (0.4-2.5)	0.21
Cervix	1.0 (44)	0.4 (10) (0.1-1.0)	0.2 (4) (0.1-0.7)	0.00	0.5 (10) (0.1-1.6)	0.4 (4) (0.1-2.4)	0.05
Ovary	1.0 (32)	0.7 (10) (0.3-1.8)	0.6 (7) (0.2-1.7)	0.13	0.5 (10) (0.2-1.8)	0.4 (7) (0.1-1.9)	0.06
Uterus	1.0 (24)	0.3 (4) (0.1-1.1)	0.4 (3) (0.1-1.7)	0.04	0.3 (4) (0.1-1.7)	0.5 (3) (0.1-4.4)	0.15

[a] No. of cases in parentheses.
[b] CI = 95% confidence interval.

show any association with sitting-time index. When risks were adjusted for SES, cancers of the larynx, lung, and melanoma showed higher risks for the sedentary category, while risks for cancers of the prostate, breast, and cervix were reduced.

Discussion

We evaluated associations among occupational physical activity, SES, and 15 cancer sites in a hospital-based case-control study in Turkey, using two activity indices based on jobs held by study subjects. After adjusting for age and smoking, the risk of cancer of the colon and prostate rose significantly with reduced occupational physical activity, while cancer of the cervix and uterus showed significant negative association when risks were adjusted for age and smoking. When risks were adjusted for SES, only cancer of the colon and melanoma were elevated significantly with reduced activity according to both physical activity indices. Cervical cancer had a significant association only with the sitting-time index after risks were adjusted for SES.

Sedentary jobs have been linked with increased colon cancer risk in several studies.[1-5,8-25] Confirmation of the association in this, and an earlier report,[25] suggests that information on both disease and risk factors used in our study was reliable. This confirmation also

tends to provide confidence about the accuracy of work-history collection. We used the total duration of jobs held by subjects after the age of 20 to determine the completeness of work histories. According to our indirect calculation, 58 percent of the work histories were found to be complete; 42 percent of subjects have a gap of 10 or more years unaccounted for by their work history between the age of 20 and the date of diagnosis. Despite the possible misclassification of exposure due to this limited work-history collection and the lack of information regarding nonoccupational activity, assessment of physical activity was accurate enough to observe the previously established associations.

Cancer of the rectum was associated inversely with energy expenditure, larynx with energy expenditure, and lung with sitting-time, but trend tests for dose-response relationships were not significant. Previous studies have reported conflicting results on the association of physical activity and rectum cancer, including no association,[1,9] decreasing risks,[6,12] or increasing risks[24] with decreased physical activity. As with colon cancer, a deficit risk of cancer of the rectum was observed among low SES subjects, and the association between risk of cancer of the rectum and physical activity was stronger after adjustment for SES.

The risk of laryngeal cancer was greater among those with lower SES. We also observed elevated risk of laryngeal cancer with decreased energy expenditure after age, smoking, and SES adjustment. No significant association between cancer of the larynx and physical activity has been reported previously. Brownson *et al*[24] reported reduced risk of cancer of the larynx among males with low activity levels in Missouri, but this observed risk was not adjusted for SES. Cancer of the larynx is one of the most common tumors in Turkey,[31,33] and the interplay of risk factors may differ from those in developed countries. The association between physical activity and laryngeal cancer deserves further investigation.

Lung cancer has been linked to physical activity in several reports.[6,12,15,24] All reports,[6,12,15] except Brownson *et al*,[24] have shown lung cancer to be associated inversely with physical activity. We found the sitting-time index to be associated slightly with risk of lung cancer, but the energy expenditure index showed no association. The association between sitting-time index and lung cancer was somewhat stronger after adjustment for SES.

An unexpected finding in our study was the significant inverse association between risk of malignant melanoma and physical activity. This association was observed with both activity indices. Among previous studies, only Brownson *et al*[24] reported a slightly increased risk of melanoma with decreased activity. A major risk factor for melanoma is sunlight. Previous studies on melanoma[38-43] suggest that it is the effect of intermittent episodes of acute sunlight exposure rather than cumulative exposure to sunlight that is associated with the development of malignant melanoma. A few reports[38,41-43] have noted excesses of melanoma among persons holding indoor jobs which may reflect effects of intermittent sunlight exposure. Dubin *et al*[44] have shown that effects of sunlight exposure depend on the tanning ability of individuals. For example, for good tanners, moderate sunlight exposure is protective against melanoma. (In general, Turkish people are good tanners.) Since sedentary jobs are more likely to be indoor jobs than outdoor jobs, the excess of melanoma for sedentary jobs, therefore, may be due to the lack of sufficient sunlight to develop a protective tan, and to the intermittent nature of exposure.

Association of physical activity and prostate cancer has been evaluated previously.[6,12,15,24,27,30] Le Marchand *et al*[27] reported an inverse association between prostate cancer risk and the proportion of time spent in jobs involving only sedentary or light work among men aged 70 years or older. Other investigators have either found a positive association[6,15,24,30] or no association.[12] We found an increasing risk with decreased activity for energy expenditure index. An association between prostate cancer and physical activity may be indirect. Simopoulos[45] has suggested that "energy imbalance is characterized by obesity and sedentary life styles and is associated with increased morbidity and mortality from all causes of cancer, including cancer of the breast, colon and prostate." In addition, several studies[46-50] have found that increased body mass is associated with an increased risk of prostate cancer. A direct role for physical activity also has been proposed by Lee *et al*,[30] who suggested that risk of prostate cancer was affected by physical activity through amelioration of testosterone levels. Studies have associated high testosterone levels with the development of prostate cancer[51-53] and lower levels of testosterone have been found among trained athletes.[54-55] Alternatively, the association between physical inactivity and prostate cancer may be explained by its effects both on body mass and testosterone level.

In our study, the sitting-time index showed an elevated risk of female breast cancer for sedentary jobs without SES adjustment. A protective effect of physical activity on the risk of breast cancer among female subjects has been observed in other studies.[5,26] Associations also have occurred with change in body mass, energy imbalance, obesity, and cholesterol (low-density lipoprotein cholesterol).[19,34,56,57] These results suggest that avoidance of weight gain may reduce the risk

of breast cancer. Some reports, however, suggest that breast cancer risk is associated directly with number of regular ovulatory cycles.[58-60] It has been shown that physical activity may reduce the frequency of ovulatory cycles.[58-62]

For cervical cancer, lower risks were associated with lower levels of occupational physical activity and the magnitude of the risk remained similar after adjustment for SES. An earlier report,[15] however, found an increase in risk (relative risk [RR] = 5.2) with decreased activity levels. We note that this study was based on a total of only 20 cases and, therefore, should be regarded as a preliminary evidence. An inverted risk has been observed among female athletes[26] which was not accounted for by other risk factors (SES, body mass index, and race). It is interesting that we obtained similar risk patterns from our two physical activity indices, despite the fact that distributions of cases ($n = 58$) by activity levels were quite different. We were unable to adjust for other important risk factors for cervical cancer, including number of sexual partners, age of first sexual intercourse,[61-63] oral contraceptive use,[61,64,65] lack of β-carotene,[66] immunosuppression,[67] and pregnancy.[61,66] For a conclusive result, larger studies with information on other confounders are needed.

Cancer of the ovary showed an inverse, but not significant, association with energy expenditure index, while cancer of the uterus showed a decreasing risk with decreased activity. Reduced risk of cancer of the ovary with a borderline significant trend was observed for reduced activity using sitting-time index. These results support the findings of an earlier study[26] which noted that sedentary lifestyle was associated with an RR of 2.5 for cancers of the female reproductive system.

We did not observe excess stomach cancer risk for sedentary jobs as previously reported by Severson *et al*[12] and Brownson *et al.*[24] Our findings for stomach cancer were similar to the results reported by Paffenbarger *et al.*[6] However, we did observe elevated risks of stomach cancer for the medium and low SES group.

We observed no association between physical activity and skin cancer from either index. No relevant report was found in the available literature.

The slightly elevated risk of male breast cancer was based on a small number and disappeared when the risk was adjusted for SES.

Brownson *et al*[24] reported twofold excess risk of testicular cancer among the low physical activity group, while Paffenbarger *et al*[6] observed 20 percent excess risk among college athletes. We did not observe excess risk of testicular cancer after the risk was adjusted for SES.

Similar to the results reported by Severson *et al*[12] and Brownson *et al*,[24] we did not observe an excess risk of bladder cancer for sedentary jobs.

There are several limitations to our study. One was the use of other cancer cases as controls. A potential problem of using a cancer control group is that the apparent association for a given exposure may be due to an inverse association with one of the selected cancer sites.[68,69] However, we excluded from the control group all cancer sites previously showing an association with physical activity to minimize this adverse effect. We did not have information on some confounders for certain cancer sites (*e.g.*, sexual factors for cervical cancer, dietary fat and sun exposure for cancers of the colon and breast) or for nonoccupational physical activity. Assessment of physical activity was limited to the occupational activity. We did not have information on nonoccupational activity. However, routine daily or weekly exercise is not very common in Turkey, especially 10 or 20 years ago. Finally, we had small numbers for some cancer sites such as melanoma and cancers of the male breast, prostate, and cervix. Therefore, the possibility of chance cannot be ruled out for the observed associations between physical activity and these cancer sites.

One of the strengths of the study is that risks were adjusted for smoking and SES in addition to age. Adjustment for SES was particularly important because of its impact on the association between physical activity and the risk of cancers of colon, rectum, larynx, lung, prostate, breast, cervix, ovary, and melanoma. As reported by others,[70] we observed associations between SES and cancers of the colon, rectum, melanoma, prostate, breast, cervix, and ovary. In addition to previously reported associations, we also found a strong inverse association with cancer of the larynx. The disadvantages of using cancer controls may be offset in that if cancer controls are selected appropriately, problems like recall bias and interviewer bias are minimized. In addition, a cancer control group may be useful to examine specificity of exposure.[68,69] Another advantage of this study is that workers in Turkey do not change jobs very often, as is the case in some developed countries.[71,72] This nature of the study helped us to deal with more homogenous patterns of occupational physical activity history than the complex heterogenous ones seen in the developed countries.

This study supports the previously reported association between physical activity and cancer of the colon, and provides additional evidence for the associations among physical activity and malignant melanoma, and cancers of the larynx, prostate, and cervix. It also points out the importance of SES when evaluating physical activity and cancers.

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