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ORIGINAL REPORT

Physical Activity and Survival After Colorectal Cancer Diagnosis

Jeffrey A. Meyerhardt, Edward L. Giovannucci, Michelle D. Holmes, Andrew T. Chan, Jennifer A. Chan, Graham A. Colditz, and Charles S. Fuchs

From the Division of Medical Oncology, Dana-Farber Cancer Institute; Channing Laboratory, Department of Medicine, Brigham and Women's Hospital and Harvard Medical School; Harvard School of Public Health; Department of Medicine, Massachusetts General Hospital, Boston, MA.

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Address reprint requests to Jeffrey A. Meyerhardt, MD, MPH, Dana-Farber Cancer Institute, 44 Binney St, Boston, MA 02115; e-mail: jmeyerhardt@partners.org.

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ABSTRACT

Purpose
Physically active individuals have a lower risk of developing colorectal cancer but the influence of exercise on cancer survival is unknown.

Patients and Methods
By a prospective, observational study of 573 women with stage I to III colorectal cancer, we studied colorectal cancer–specific and overall mortality according to predefined physical activity categories before and after diagnosis and by change in activity after diagnosis. To minimize bias by occult recurrences, we excluded women who died within 6 months of their postdiagnosis physical activity assessment.

Results
Increasing levels of exercise after diagnosis of nonmetastatic colorectal cancer reduced cancer-specific mortality (*P* for trend = .008) and overall mortality (*P* for trend = .003). Compared with women who engaged in less than 3 metabolic equivalent task [MET] -hours per week of physical activity, those engaging in at least 18 MET-hours per week had an adjusted hazard ratio for colorectal cancer–specific mortality of 0.39 (95% CI, 0.18 to 0.82) and an adjusted hazard ratio for overall mortality of 0.43 (95% CI, 0.25 to 0.74). These results remained unchanged even after excluding women who died within 12 and 24 months of activity assessment. Prediagnosis physical activity was not predictive of mortality. Women who increased their activity (when comparing prediagnosis to postdiagnosis values) had a hazard ratio of 0.48 (95% CI, 0.24 to 0.97) for colorectal cancer deaths and a hazard ratio of 0.51 (95% CI, 0.30 to 0.85) for any-cause death, compared with those with no change in activity.

Conclusion
Recreational physical activity after the diagnosis of stages I to III colorectal cancer may reduce the risk of colorectal cancer–specific and overall mortality.

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INTRODUCTION

In both prospective[1-11] and retrospective[12-20] studies, physical activity is associated with a significant likelihood of developing colorectal cancer. The International Agency for Research on Cancer concluded that the evidence supports a causal relation between inactivity and colorectal cancer risk.[21] However, it is largely unknown whether exercise influences survival of patients with established cancer.[22,23]

Cancer patients often inquire about the utility of lifestyle changes beyond standard therapies.[24] Recent data suggest that physically active breast cancer survivors experience a superior survival compared with those who are more sedentary.[25] In a recent study of stage III colon cancer patients participating in an adjuvant chemotherapy trial, increasing postdiagnosis physical activity was associated with significant reductions in cancer recurrence and mortality.[22] In the latter study, because data on activity before diagnosis were not available, the relative influence of prediagnosis and postdiagnosis exercise or change in activity could not be assessed.

We studied the impact of recreational physical activity among women with local and regional colorectal cancer who were participating in a large, prospective cohort study that was initiated before cancer diagnosis (the Nurses' Health Study).

PATIENTS AND METHODS

Study Population

In 1976, the Nurses' Health Study (NHS) cohort was established when 121,700 female registered nurses answered a mailed questionnaire on risk factors for cancer and cardiovascular disease.[26,27] Every 2 years, participants receive follow-up questionnaires to update information on potential risk factors and report new cancer and disease diagnoses. This study was approved by the Human Subjects Committee at Brigham and Women's Hospital.

Measurement of Colon Cancer

On each biennial follow-up questionnaire, participants were asked whether they had had a diagnosis of colorectal cancer during the prior 2 years. When a participant (or next of kin for decedents) reported colorectal cancer, we sought permission to obtain records and pathology reports. Study physicians, blinded to exposure data, reviewed all records related to colorectal cancer and recorded stage, histology, and tumor location. For nonresponders, we searched the National Death Index to discover deaths and ascertain any diagnosis of colorectal cancer that contributed to death or was a secondary diagnosis. We estimate that 96% of the cases of colorectal cancer were identified through these various methods.[28] The individuals in this analysis were NHS participants with stage I to III colorectal cancer diagnosed between 1986 (when physical activity was first assessed) and 2002.

Measurement of Mortality

Women were observed until death or June 2004, whichever came first. Ascertainment of deaths included reporting by the family or postal authorities. In addition, the names of persistent nonresponders were searched in the National Death Index.[29] The cause of death was assigned by physicians blinded to exposures. In the case of a woman who died as a result of colorectal cancer not previously reported, we obtained medical records of the colorectal cancer diagnosis after permission from next of kin. More than 98% of deaths in the NHS have been identified by these methods.[30]

Exclusions

Women were excluded if they presented with metastatic colorectal cancer at time of initial diagnosis or were diagnosed with any other cancer (other than nonmelanoma skin cancer) within 3 years of their colorectal cancer. Moreover, to minimize bias by occult recurrence or other undiagnosed major illnesses, we excluded women who died within 6 months of their postdiagnosis physical activity assessment. There were 573 women eligible for analysis.

Exposure Assessment

We assessed leisure-time physical activity in metabolic equivalent task (MET) -hours per week beginning in 1986, as briefly described.[2,25] Participants reported duration of participation (range, 0 to 11 or more hours per week) in walking (along with usual pace), jogging, running, bicycling, swimming laps, racket sports, other aerobic exercises, lower intensity exercise (yoga, toning, stretching), or other vigorous activities.

Although we only included women with stage I to III cancer, we presumed that those who eventually died as a result of colorectal cancer had metastatic disease before death. To avoid bias due to declining activity immediately before and after diagnosis of metastatic cancer, physical activity was not updated (thereby a single prediagnosis and single postdiagnosis measurement was determined).

Each activity on the questionnaire was assigned a MET score.[31] One MET is the energy expenditure for sitting quietly. MET scores are defined as the ratio of the metabolic rate associated with specific activities divided by the

Table 1. Baseline Characteristics of Patients with Stage I, II, III Colorectal Cancer by Level of Exercise Before and After Diagnosis

Characteristic	Prediagnosis Activity (MET-hours per week)					Postdiagnosis Activity (MET-hours per week)				
	< 3	3-8.9	9-17.9	≥ 18	P*	< 3	3-8.9	9-17.9	≥ 18	P*
No. of patients	142	152	118	161		167	146	97	144	
Median age, years	65	65	63	66	.12	65	65	64	64	.33
Body mass index										
Mean, kg/m^2	27.1	27.4	26.4	25.8	.03	27.4	27.0	26.2	25.3	.14
Change	—	—	—	—		0.3	−0.2	0.8	0.2	.37
Stage of disease, %					.36					.27
I	32	27	34	34		24	35	38	37	
II	38	34	34	39		39	37	35	32	
III	30	39	32	27		37	28	27	31	
Site of disease, %					.48					.33
Colon	81	82	85	76		77	85	78	80	
Rectal	19	18	15	24		23	15	22	20	
Grade of differentiation, %					.17					.007
Well	19	17	12	17		12	20	5	23	
Moderate	59	64	74	64		70	66	69	55	
Poor/undifferentiated	16	13	9	10		15	9	13	11	
Unknown	6	6	5	9		3	5	13	11	
Smoking status, %					.02					.05
Never smoker	41	42	48	45		44	42	42	50	
Past smoker	36	43	41	48		44	46	51	47	
Current smoker	23	15	11	7		12	12	7	3	
Year of diagnosis, %					.006					.47
Prior to 1990	27	23	20	12		16	25	19	21	
1990-1995	29	37	37	34		40	32	36	33	
After 1995	44	40	43	54		44	43	45	46	
Chemotherapy					.26					.82
Reported "no"	12	16	12	21		17	15	14	15	
Reported "yes"	9	11	11	13		8	14	9	11	
Unknown	79	73	77	66		75	71	77	74	

Abbreviation: MET, metabolic equivalent task.
*By χ^2 test, except age, body mass index, and weight change (which were tested with Wilcoxon rank sum).

Table 2. Colorectal Cancer–Specific and Overall Mortality by Level of Postdiagnosis Physical Activity

Postdiagnosis Activity (MET-hours per week; n = 554)	Colorectal Cancer–Specific Mortality						Overall Mortality					
			Unadjusted		Adjusted*				Unadjusted		Adjusted*	
	No. of Events	No. of Patients at Risk	Hazard Ratio	95% CI	Hazard Ratio	95% CI	No. of Events	No. of Patients at Risk	Hazard Ratio	95% CI	Hazard Ratio	95% CI
< 3	29	167	Referent		Referent		47	167	Referent		Referent	
3-7.9	21	146	0.78	0.45 to 1.38	0.92	0.50 to 1.69	37	146	0.83	0.54 to 1.27	0.77	0.48 to 1.23
9-17.9	11	97	0.61	0.31 to 1.23	0.57	0.27 to 1.20	16	97	0.53	0.30 to 0.93	0.50	0.28 to 0.90
≥ 18	11	144	0.41	0.20 to 0.82	0.39	0.18 to 0.82	21	144	0.47	0.28 to 0.78	0.43	0.25 to 0.74
P for trend			.01		.008				.003		.003	

Abbreviation: MET, metabolic equivalent task.
*Adjusted for body mass index, stage of disease (I, II, III), grade of tumor differentiation, colon or rectal primary, age at diagnosis, year of diagnosis, receipt of chemotherapy (yes, no, unknown), time from diagnosis to physical activity measurement, change in body mass index before and after diagnosis, smoking status (current, past, never).

resting metabolic rate. The values from the individual activities were summed for a total MET-hours per week score. Categories of MET-hours per week were predefined as less than 3, 3 to 8.9, 9 to 17.9, 18 or more, to correspond to the equivalent of less than 1, 1 to less than 3, 3 to less than 6, 6 or more hours per week of walking at an average pace, consistent with prior analyses.[32] Our activity questionnaire has been validated previously against activity diaries.[33,34]

For analyses of prediagnosis physical activity, the response from the immediate prior survey was used (median, 6 months before diagnosis). If a response were missing, one previous assessment would be carried forward; otherwise, the patient was not included in those analyses. For postdiagnosis analyses, the first physical activity assessment collected at least 1 year but no more than 4 years after diagnosis (median, 22 months) was used to avoid assessment during the period of active treatment. For change in activity, patients who changed from a higher to lower category before and after diagnosis, respectively, were categorized as decreasing activity, patients who changed from a lower to higher category were categorized as increasing activity, and patients who remained in the same category were categorized as no change.

Covariates

Stage of disease, grade of tumor differentiation, year of diagnosis, and location of tumor were extracted from the medical record. Beginning in 1993, women were asked methods of treatment in a supplemental questionnaire. The time interval between cancer diagnosis and assessment of activity was also adjusted for in these analyses. Body mass index (BMI) and smoking status (current, past, or never) were also taken from the biennial questionnaire at the time of the respective physical activity assessment.

Statistical Analyses

Cox proportional hazards models were used to calculate hazard ratios (HRs) of death or death as a result of colorectal cancer, adjusted for other risk factors for cancer survival. In the main analysis, death as a result of colorectal cancer was the primary end point and deaths as a result of other causes were censored. In secondary analyses, death as a result of any cause was the end point. The primary exposure of interest was physical activity after the diagnosis of colorectal cancer. In addition, we examined prediagnosis activity and change in physical activity. For the analyses of postdiagnosis physical activity and change in activity, participants were observed from the date of return of postdiagnosis physical activity assessment to either death or June 2004. In the analyses of physical activity before diagnosis, participants were observed from the date of diagnosis of colorectal cancer to either death or June 2004. The two-tailed *P* value for the linear trend test across categories was calculated by using the median value of each category as a continuous variable, consistent with prior studies.[2,25] Tests of interactions between physical activity categories

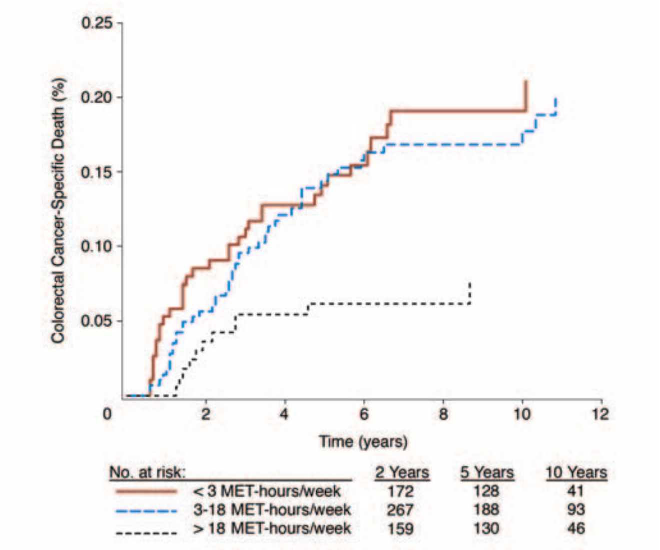

Fig 1. Cumulative incidence curve of colorectal cancer–specific deaths by level of postdiagnosis physical activity. MET, metabolic equivalent task.

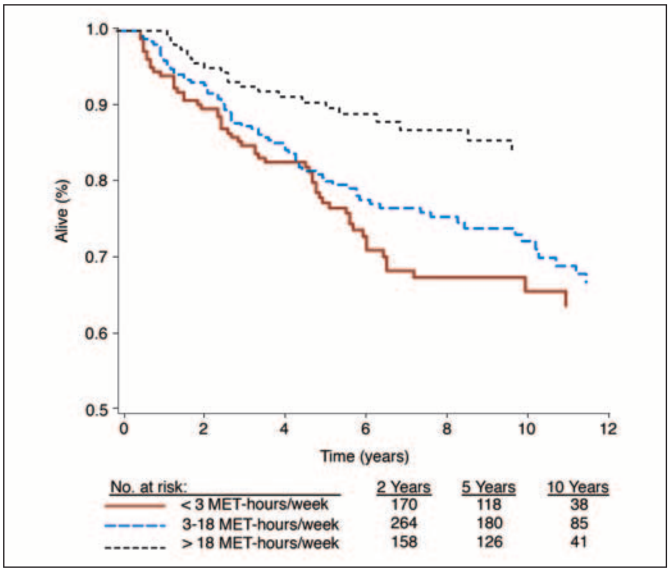

Fig 2. Kaplan and Meier curve of overall survival by level of postdiagnosis physical activity. MET, metabolic equivalent task.

and potential effect modifiers were assessed by entering in the model the cross product of the median of each physical activity category with the dichotomized covariate. All analyses used SAS version 8.0 (SAS Institute Inc, Cary, NC).

RESULTS

Baseline Characteristics by Physical Activity Category

Among the 573 eligible participants with stage I, II, or III colorectal cancer, there were 132 deaths, of which 80 were classified as colorectal cancer–specific deaths. The median time of follow-up from date of diagnosis of women who are alive was 9.6 years (with 95% observed for 5 or more years). Baseline characteristics of the 573 patients are shown according to categories of both prediagnosis and postdiagnosis physical activity (Table 1). In general, women who were more active had a lower BMI and were less likely to have smoked cigarettes.

Physical Activity After Diagnosis

We assessed the influence of physical activity after the diagnosis of colorectal cancer on patient survival (Table 2). Higher postdiagnosis physical activity was associated with a significant reduction in the risk of colorectal cancer–specific and overall mortality, even after adjusting for other predictors of recurrence. Compared with patients who reported less than 3 total MET-hours per week of activity, those reporting 18 or more MET-hours per week had an adjusted HR for cancer-specific mortality of 0.39 (95% CI, 0.18 to 0.82; *P* for trend = .008). Similarly, the adjusted HR for overall mortality was 0.43 (95% CI, 0.25 to 0.74; *P* for trend = .003).

Given that lower levels of physical activity among patients at risk for cancer recurrence could reflect occult cancer recurrence or impending death, we excluded patients who developed cancer recurrence or died within 6 months of completing the physical activity assessment in our primary analyses (n = 8). To address this issue further, we repeated our analyses with a restriction of 12 months. Although statistical power was somewhat diminished, women in the highest category had an HR of 0.54 (95% CI, 0.25 to 1.19) for colorectal cancer–specific mortality (*P* for trend = .08) and an HR of 0.51 (95% CI, 0.29 to 0.91) for overall mortality (*P* for trend = .02), compared with the least active women. If we extend this restriction period further to 2 years, the relationship continued to be evident, with an HR of 0.36 (95% CI, 0.12 to 1.13) for colorectal cancer–specific mortality (*P* for trend = .05) and an HR of 0.39 (95% CI, 0.20 to 0.78) for overall mortality (*P* for trend = .01).

For the analysis of 5-year survival, activity levels were collapsed into three categories (< 3, 3 to 17.9, and ≥ 18 MET-hours per week) based on the results described above (Figs 1 and 2). Of note, follow-up in this analysis begins at the time of completion of the questionnaire that assessed physical activity to reduce bias rather than the date of diagnosis of colorectal cancer, as is typically derived for studies for adjuvant chemotherapy. Nonetheless, the proportion of patients with colorectal cancer–specific deaths at 5 years (Fig 1) was 14.1% for patients who engaged in less than 3 MET-hours per week, 14.4% for patients who engaged in 3 to 17.9 MET-hours per week, and 6.2% for patients who engaged in 18 or more MET-hours per week (*P* log-rank = .004). There was also a statistically significant difference in overall survival across physical activity tertile (*P* = .02, Fig 2).

We examined the influence of postdiagnosis physical activity across strata of other predictors of cancer recurrence and mortality (Table 3). The inverse relation between postdiagnosis physical activity and cancer-specific mortality remained largely unchanged across strata of BMI, age, pathologic stage, site of disease, or year of diagnosis.

Table 3. Multivariate-Adjusted Stratified Analyses of Colorectal Cancer–Specific Mortality by Postdiagnosis Activity

		Postdiagnosis Activity (MET-hours per week)								
			3-8.9		9-17.9		≥ 18			
Characteristic	No. of Patients	< 3	Hazard Ratio	95% CI	Hazard Ratio	95% CI	Hazard Ratio	95% CI	*P* for Trend	*P* Interaction
Body mass index, kg/m^2										.08
≤ 25	233	Referent	0.88	0.29 to 2.72	1.05	0.30 to 3.70	0.12	0.02 to 0.76	.02	
> 25	292	Referent	0.74	0.34 to 1.64	0.40	0.15 to 1.11	0.45	0.19 to 1.10	.08	
Age, years										.96
≤ 65	269	Referent	0.80	0.33 to 1.93	0.72	0.28 to 1.84	0.56	0.22 to 1.45	.23	
> 65	256	Referent	0.89	0.38 to 2.10	0.43	0.12 to 1.55	0.15	0.04 to 0.64	.005	
Stage										.84
I/II	360	Referent	0.83	0.34 to 2.05	0.63	0.19 to 2.03	0.35	0.11 to 1.17	.08	
III	165	Referent	0.81	0.34 to 1.93	0.68	0.26 to 1.82	0.37	0.14 to 1.00	.05	
Site of disease										.33
Colon	421	Referent	1.18	0.57 to 2.41	1.08	0.48 to 2.43	0.49	0.19 to 1.30	.11	
Rectal	104	Referent	0.54	0.14 to 2.09	—		0.28	0.08 to 0.94	.05	
Year of diagnosis										.43
Before 1995	286	Referent	0.74	0.35 to 1.57	0.73	0.31 to 1.72	0.45	0.17 to 1.15	.11	
After 1995	239	Referent	0.92	0.33 to 2.53	0.31	0.06 to 1.49	0.30	0.08 to 1.17	.06	

NOTE. Adjusted for body mass index, stage of disease (I, II, III), grade of tumor differentiation, colon or rectal primary, age at diagnosis, year of diagnosis, receipt of chemotherapy (yes, no, unknown), time from diagnosis to physical activity measurement, change in body mass index, smoking status (current, past, never).
Abbreviation: MET, metabolic equivalent task.

Physical Activity Before Diagnosis

In contrast to postdiagnosis physical activity, physical activity before diagnosis (Table 4) was not significantly associated with either cancer-specific or overall mortality. When we adjusted for prediagnosis physical activity as well as other predictors of cancer survival, increasing postdiagnosis physical activity was still associated with a significant reduction in both colorectal cancer–specific mortality (*P* for trend = .02) as well as overall mortality (*P* for trend = .002).

Change in Physical Activity

For participants with a prediagnosis and postdiagnosis activity measurement, we calculated change in physical activity based on the difference in exercise categories at those two time points (Fig 3). Compared with women who did not materially change their activity level (n = 203), women who increased their activity (n = 144) had an adjusted HR of 0.48 (95% CI, 0.24 to 0.97) for colorectal cancer–specific mortality and an adjusted HR of 0.51 (95% CI, 0.30 to 0.85) for overall mortality. In contrast, women who decreased their activity level (n = 176) experienced a modest, though nonsignificant, increase in both cancer-specific (HR, 1.32; 95% CI, 0.74 to 2.34) and overall mortality (HR, 1.23; 95% CI, 0.79 to 1.91).

To better characterize this relationship, we subdivided the categories of steady level of activity and increased activity. For patients with no change in activity, we divided participants into those engaging in less than 9 MET-hours per week (152 of 523 participants) and greater than 9 MET-hours per week (51 of 523 participants). For women who increased their activity levels, we defined two populations, those who started with less than 9 MET-hours per week and increased at least one category (102 of 523 participants) and those who started with at least 9 MET-hours per week and increased activity (42 of 523 participants). Compared with relatively sedentary patients with no change in activity, patients who increased their activity (irregardless of prediagnosis) and patients who were consistently active (at least 9 MET-hours per week) had improvements in colorectal cancer–specific mortality and overall mortality (Table 5).

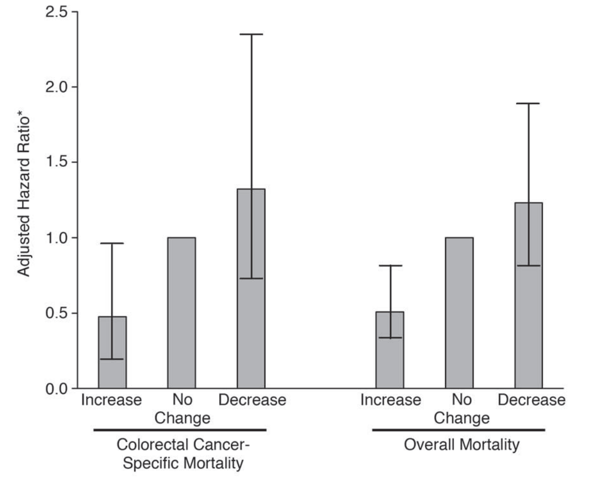

Fig 3. Impact of change of physical activity before and after colorectal cancer diagnosis. *Compared with no change. Adjusted for body mass index, stage of disease (I, II, III), grade of tumor differentiation, colon or rectal primary, age at diagnosis, year of diagnosis, receipt of chemotherapy (yes, no, unknown), time from diagnosis to physical activity measurement, change in body mass index, smoking status (current, past, never).

DISCUSSION

In our analyses, women who were physically active after the diagnosis of nonmetastatic colorectal cancer experienced a significantly decreased risk of colorectal cancer–specific death as well as death from any cause. Interestingly, level of activity before diagnosis did not influence cancer-specific or overall survival. Colorectal cancer patients who increased their activity from their levels before diagnosis had an approximately 50% reduction in both colorectal cancer–specific and all-cause mortality.

Physical activity has been shown consistently to reduce colon cancer incidence.[1-20] Although the mechanism is unclear, the association with sedentary lifestyle and hyperinsulinemia is a potential etiology.[35-37] Insulin and the insulinlike growth factor family have been associated with enhanced tumor growth and antiapoptosis,[35] and colon cancer risk is elevated in individuals with higher circulating levels of insulin or C-peptide (a marker of insulin secretion) and insulinlike growth factor-1.[38-43] Colon cancer recurrences are believed to be growth of micrometastases. Thus, an environment that allows such microscopic tumors to proliferate could be detrimental. Whether insulinlike factors or other mechanisms potentially linked to physical activity would affect this environment is unknown.

Table 4. Colorectal Cancer–Specific and Overall Mortality by Level of Physical Activity Prior to Diagnosis

Prediagnosis Activity (MET-hours per week; n = 573)	Colorectal Cancer–Specific Mortality: No. of Events	No. of Patients at Risk	Unadjusted Hazard Ratio	Unadjusted 95% CI	Adjusted* Hazard Ratio	Adjusted* 95% CI	Overall Mortality: No. of Events	No. of Patients at Risk	Unadjusted Hazard Ratio	Unadjusted 95% CI	Adjusted* Hazard Ratio	Adjusted* 95% CI
< 3	22	142	Referent		Referent		36	142	Referent		Referent	
3-8.9	22	152	0.92	0.51 to 1.65	0.83	0.45 to 1.53	34	152	0.87	0.54 to 1.38	0.85	0.52 to 1.37
9-17.9	19	118	1.02	0.55 to 1.88	1.05	0.56 to 1.99	31	118	1.02	0.63 to 1.64	1.14	0.69 to 1.87
≥ 18	17	161	0.70	0.37 to 1.31	0.86	0.44 to 1.67	31	161	0.82	0.50 to 1.32	0.95	0.57 to 1.59
P for trend			.26		.81				.50		.92	

Abbreviation: MET, metabolic equivalent task.
*Adjusted for body mass index, stage of disease (I, II, III), grade of tumor differentiation, colon or rectal primary, age at diagnosis, year of diagnosis, receipt of chemotherapy (yes, no, unknown), time from diagnosis to physical activity measurement, change in body mass index, smoking status (current, past, never).

Table 5. Subset Analyses of the Impact of Stable and Increasing Activity on Colorectal Cancer Specific–Mortality and Overall Mortality

Activity Level (MET-hours per week)	No. of Patients	Colorectal Cancer–Specific Mortality: Adjusted Hazard Ratio	95% CI	Overall Mortality: Adjusted Hazard Ratio	95% CI
Stable activity < 9	152	Referent		Referent	
Stable activity ≥ 9	51	0.33	0.11 to 0.97	0.27	0.09 to 0.80
Increase activity					
Prediagnosis activity < 9	102	0.26	0.10 to 0.66	0.36	0.19 to 0.67
Prediagnosis activity ≥ 9	42	0.35	0.11 to 1.13	0.62	0.28 to 1.34

Abbreviation: MET, metabolic equivalent tasks.
*Adjusted for body mass index, stage of disease (I, II, III), grade of tumor differentiation, colon or rectal primary, age at diagnosis, year of diagnosis, receipt of chemotherapy (yes, no, unknown), time from diagnosis to physical activity measurement, change in body mass index, smoking status (current, past, never).

In a separate cohort of men and women with stage III colon cancer, we reported a similar reduction in disease-free survival among patients physically active after diagnosis.[22] The NHS provide provides several complementary advantages. First, given that patients who are more physical active after cancer diagnosis may have been active before diagnosis, we considered the possibility that physically active individuals who do develop colon cancer simply acquire tumors that are biologically less aggressive. However, physical activity levels before diagnosis were not predictive of cancer survival. Second, the NHS cohort provided a unique opportunity to explore the relationship of change in activity before and after diagnosis. It should be noted that greater than 50% of women changed levels of physical activity appreciably after diagnosis. Although a decrease in activity was not significantly associated with survival, increases in activity did seem to confer a significantly improved survival. The magnitude of benefit of increasing activity seemed similar in women who were both relatively inactive and more active before diagnosis. These analyses also demonstrate that women who were at a relatively higher level of activity before diagnosis should at least maintain such activity, but do not necessarily need to increase beyond that level. Nonetheless, because we do not know the reasons why these women increased their activity levels, these findings need to be confirmed.

Beyond cause of mortality, data on cancer recurrences were not available in this cohort. Nonetheless, given that median survival for metastatic colorectal cancer was approximately 10 to 12 months during much of the time period of this study,[44] colorectal cancer–specific mortality should be a reasonable surrogate for cancer-specific outcomes. Our cohort was restricted to women; it is possible that these findings might not apply to male patients with colorectal cancer. However, we did not observe a sex interaction in our prior study of postdiagnosis activity.[22]

In this cohort, data on the treatment are limited. Two thirds of the women had stage I or II disease, in which surgery alone generally would be standard of care. Furthermore, although there are differences in the likelihood of use of adjuvant chemotherapy based on factors such as socioeconomic class, the fairly homogenous nature of this cohort (professional nurses) would likely increase the probability of at least standard therapy.[45,46] Moreover, as shown in Table 1, chemotherapy use (based on the available data) did not differ according to postdiagnosis physical activity levels. Comorbidities and access to health care may also confound these findings. Given the population studied (professional nurses), we would expect the latter to be relatively diminished. Although comorbidities have been shown to affect mortality in colorectal cancer survivors,[47-49] such diseases are less likely to affect disease recurrence and thereby colorectal cancer–specific mortality.

We cannot completely exclude the possibility that lower levels of physical activity may be reflective of other occult predictors for poor prognosis. However, we did not observe any significant associations between physical activity and other predictors of cancer outcome. Our findings remained unchanged after adjusting for potential risk factors for colorectal cancer mortality. Moreover, we found a consistent benefit for physical activity among patients with either stage I/II or stage III disease. Furthermore, we considered the possibility that sick patients (with cancer recurrences and limited survival) will exercise less. To minimize the bias by occult cancer recurrence, we excluded recurrences or deaths within 6 months of the activity assessment in the primary analysis and continued to observe a positive impact of exercise even when extending this restriction to 12 and 24 months. Finally, we would expect few patients to have undetected recurrences over extended periods of time, given the relatively brief natural history of recurrent colon cancer.

Patients who underwent treatment for colorectal cancer may be considered limited in their ability to exercise. However, Arndt et al[50] reported that 1 year after surgery of the primary tumor, patients with colorectal cancer reported their physical functioning and global quality of life nearly identical to those of a noncancer population. Furthermore, the distribution of levels of exercise in our study does not vary significantly by stage and is similar to that in other reports from the NHS in women without cancer.[2]

Our results suggest that physical activity after a colorectal cancer diagnosis may lower the risk of death from that disease. This benefit was seen regardless of age, BMI, stage, or site of disease. Along with our prior findings,[22] these data suggest that, in addition to surgery and chemotherapy, increasing physical activity may confer additional benefit to patients with colorectal cancer.

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The authors indicated no potential conflicts of interest.

Author Contributions

Conception and design: Jeffrey A. Meyerhardt, Edward L. Giovannucci, Michelle D. Holmes, Charles S. Fuchs
Financial support: Jeffrey A. Meyerhardt, Edward L. Giovannucci, Graham A. Colditz, Charles S. Fuchs
Administrative support: Jeffrey A. Meyerhardt
Provision of study materials or patients: Edward L. Giovannucci, Graham A. Colditz
Collection and assembly of data: Edward L. Giovannucci, Graham A. Colditz, Charles S. Fuchs
Data analysis and interpretation: Jeffrey A. Meyerhardt, Michelle D. Holmes, Andrew T. Chan, Jennifer A. Chan, Graham A. Colditz, Charles S. Fuchs
Manuscript writing: Jeffrey A. Meyerhardt, Charles S. Fuchs
Final approval of manuscript: Jeffrey A. Meyerhardt, Edward L. Giovannucci, Michelle D. Holmes, Andrew T. Chan, Jennifer A. Chan, Graham A. Colditz, Charles S. Fuchs