Association between Daytime Activity, Fatigue, Sleep, Anxiety, Depression, and Symptom Burden in Advanced Cancer Patients: A Preliminary Report

Sriram Yennurajalingam, MD, MS,^{1,*} Supakarn Tayjasanant, MD,^{1,2,*} Dave Balachandran, MD,⁴ Nikhil S. Padhye, PhD,⁵ Janet L. Williams, MPH, CCRP,¹ Diane D. Liu, MS,³ Susan Frisbee-Hume, RN, MS, OCN,¹ and Eduardo Bruera, MD¹

Abstract

Background: There is limited research in advanced cancer patients (ACP) regarding association between objectively measured daytime activity and sleep (as measured by actigraphy), patient characteristics, and cancer symptoms (fatigue, sleep, anxiety, depression, cachexia, and symptom distress scores [SDSs]).

Objectives: Our aim of the study was to determine the association between mean daytime activity (MDTA) and the following items: fatigue (FACIT-F), SDSs (Edmonton Symptom Assessment Scale [ESAS]), sleep quality (Pittsburg Sleep Quality Index [PSQI]), objective sleep variables (OSV) (sleep onset, sleep efficacy, wake after sleep onset, total sleep time), anxiety and depression (Hospital Anxiety and Depression Scale [HADS]), body composition scores, and overall survival (OS). We also examined the association between sleep [PSQI and OSV scores] and FACIT-F, HADS, and ESAS.

Methods: Secondary analysis of a recent clinical trial of cancer-related fatigue in advanced cancer (NCT00424099). Association between MDTA and OSV (measured by actigraphy) during the first week of the study and patient characteristics, symptoms (FACIT-F, ESAS, HADS, and PSQI), and OS were analyzed.

Results: Seventy-nine eligible patients were evaluable. The median age was 57 years. Median MDTA was 248.43 counts/minute. Multivariate analysis shows that low MDTA was significantly associated with age, gender, Functional Assessment of Cancer Therapy (FACT)-Functional Well-Being (FWB), ESAS dyspnea, HADS-anxiety, and total sleep time. MDTA was not associated with FACIT-F ($p=0.997$) and OS ($p=0.18$). Sleep quality (PSQI) was significantly associated with FACIT-F, HADS, ESAS anxiety, and depression, but none of these variables was associated with OSV.

Conclusion: In ACP, lower MDTA was significantly associated with age, gender, FACT-FWB, ESAS dyspnea, HADS-anxiety, and total sleep time. Both sleep quality and cancer-related fatigue scores were strongly associated with depression and anxiety. More research is needed.

Introduction

ADVANCED CANCER PATIENTS (ACP) present with high frequency of physical and psychosocial symptoms such as fatigue, sleep disturbance, anxiety, depression, and cachexia.^{1–5} However, these symptoms are underdiagnosed and untreated in

ACP and significantly impact patients' quality of life (QOL).^{6–13} Prior studies suggest a significant association between fatigue, sleep disturbances (SD), and low physical activity.^{14–19} However, there are limited studies in ACP using objective measures such as actigraphy (accelerometers), which have been increasingly used with good feasibility to objectively measure the

¹Department of Palliative Care and Rehabilitation Medicine, Unit 1414, The University of Texas MD Anderson Cancer Center, Houston, Texas.

²Siriraj Palliative Care Center, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand.

³Department of Biostatistics, The University of Texas MD Anderson Cancer Center, Houston, Texas.

⁴Department of Pulmonary Medicine, The University of Texas MD Anderson Cancer Center, Houston, Texas.

⁵Research Center for Nursing Research, University of Texas Health School of Nursing, Houston, Texas.

*Both authors have contributed equally to this article.

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association between fatigue, physical activity, and sleep especially in cancer survivors.^{20–22} There are also very limited published studies in patients with advanced cancer to describe the association between objectively measured physical activity and subjective symptoms.

In a preliminary cross-sectional study, Lowe et al.²³ investigated the association between physical activity using actigraphy and QOL in 31 ACP receiving whole-brain radiation therapy for brain metastasis. They found that sedentary behavior was significantly associated with better physical functioning assessed by late life function and disability instrument but worse psychosocial functioning. Dahele et al.²⁴ in a case-controlled study of 20 gastrointestinal cancer patients receiving palliative chemotherapy found that low physical activity as measured by actigraphy was not associated with QOL scores (European Organization of Research and Treatment of Cancer-QLQ 30) and FACIT-F. Berger et al.²⁵ examined 14 early-stage breast cancer patients after receiving adjuvant chemotherapy using wrist actigraphy and found that cancer-related fatigue (CRF) was significantly correlated with lower activity, greater symptom distress, and low physical/social health status.

Therefore, the associations between the subjective perception of both fatigue and SD with objective measures have not been adequately investigated in ACP.^{26–31} The purpose of this secondary analysis was to determine such an association in a group of patients who underwent multiple validated subjective assessments and actigraphy.

We hypothesized that more active patients had better physical and psychological symptom scores, the objective sleep scores correlated with subjective sleep, fatigue, anxiety, and depression scores, and that subjective sleep correlated with fatigue, anxiety, and depression scores.

The specific aims of this study were as follows:

- To determine the association between mean daytime activity (MDTA) as measured using actigraphy and fatigue as assessed by Functional Assessment of Chronic Illness Therapy-Fatigue³² (FACIT-F), sleep quality [Pittsburgh Sleep Quality Index (PSQI)], objective sleep variables (OSV) (actigraphy), anxiety and depression [Hospital Anxiety and Depression Scale (HADS)], cancer symptoms and SDSs [Edmonton Symptom Assessment Scale (ESAS)], body composition markers (body mass index [BMI], serum albumin (SA) levels), and overall survival (OS).
- To examine the factors predictive of poor daytime activity in ACP.
- To examine the association between sleep quality (PSQI), fatigue (FACIT-F), anxiety, depression, and SDSs (HADS, ESAS) and also the association between OSV [sleep onset, sleep efficacy, wake after sleep onset (WASO), total sleep time] (actigraphy) and sleep quality (PSQI), fatigue (FACIT-F), anxiety, and depression (HADS, ESAS).

Materials and Methods

Study design

This study was a secondary analysis of a recently published randomized placebo controlled trial—effects of Methylphenidate with or without nursing telephone intervention for cancer-related fatigue, NCT00424099.³³

The Institutional Review Board of the MD Anderson Cancer Center and the Committee for the University of Texas Health Science Center at Houston approved this protocol.

Patient eligibility

As previously described,³³ patients with advanced cancer and fatigue (defined as ≥ 4 on a 0 to 10 scale) and a normal score ($\geq 24/30$) on the mini-mental state examination were recruited from the outpatient palliative care clinic, pain clinic, and outpatient oncology clinics.

Actigraphy data analysis

We analyzed actigraphy data collected from this clinical trial. In this study, actigraphy was offered as an elective procedure and also depending on the availability of Acti-watches. Actigraphy data were obtained using the Acti-watch2^{34,35} (Philips Respironics; software: Actiware 6.02).

We examined MDTA, which was calculated using total activity counts divided by total active time in minutes of Tuesday, Wednesday, and Thursday, during the first week of the study. We specifically chose working days to better reflect patient activity, unaffected by weekend variability. OSV, including sleep onset latency, WASO, total sleep time, and sleep efficiency, were also collected from the same day. OSV were recorded automatically by the Acti-watches. Sleep interval is part of the rest interval. Rest interval is time in bed, and then, sleep interval begins when, according to the scoring algorithm, sleep onset was detected. Sleep efficiency is the sleep time ([total sleep time—onset latency—WASO] divided by total sleep time). Patients without data on these days were excluded.

Assessments

We also reviewed patients' demographic information (age, gender, ethnicity, cancer diagnoses), time since cancer diagnosis, baseline QOL, and symptoms, including Functional Assessment of Cancer Therapy-General (FACT-G), Functional Assessment of Chronic Illness Therapy-Fatigue (FACIT-F),³² ESAS,³⁶ HADS,³⁷ Pittsburgh Sleep Quality Index (PSQI), BMI, SA (within three weeks before or after assessment date), % weight change three and six months (weight change from three and six months before assessment date), and OS.

The FACT-G is a 27-item compilation of general questions divided into four primary QOL domains: Physical Well-Being (PWB), Social/Family Well-Being (SWB), Emotional Well-Being (EWB), and Functional Assessment of Cancer Therapy-General functional well being (FWB). FACT-G has been found to have excellent test-retest reliability (correlation coefficient=0.92), internal consistency ($\alpha=0.89$) and construct validity.³⁸ FACIT-F subscale is a 13-item FACIT-fatigue subscale added to the FACT-G.³⁸ This scale has been shown to have strong internal consistency ($\alpha=0.93–0.95$) with a sensitivity of 0.92 and specificity of 0.69.³²

The Edmonton Symptom Assessment System. This tool was designed by our group to assist in the assessment of 10 symptoms common in cancer patients over the prior 24 hours: pain, fatigue, nausea, depression, anxiety, drowsiness, shortness of breath, appetite, sleep, and feelings of well-

FIG. 1. Study flow chart. *Most of the patients who did not have the actigraphy data were because in that study, actigraphy was only conducted as an elective and depending on available accelerometers. Some of the accelerometers were never returned by the patients and a few accelerometers malfunctioned.

being. The instruments and techniques are both valid and reliable in the assessment of the intensity of symptoms in cancer populations. ESAS SDS was defined as a sum of ESAS item mentioned earlier except sleep item.³⁶

Hospital Anxiety and Depression Scale. HADS is a 14-item questionnaire, which has a good internal consistency ($\alpha=0.77-0.93$),³⁹ and retest reliability (correlation coefficient >0.8)³⁹ has been validated in a number of clinical situations and is widely used to assess medically ill patients.³⁷

Pittsburgh Sleep Quality Index. PSQI is an effective instrument for determining the sleep quality and patterns with good internal homogeneity ($\alpha=0.83$), test-retest reliability (correlation coefficient $=0.85$), and validity. Numerous studies using the PSQI have confirmed its high level of validity and reliability.⁴⁰

Statistical analysis

Descriptive statistics (medians and interquartile range (IQR), frequencies, and percentages) were used to summarize the patients' characteristics, actigraphy scores, QOL, and symptoms. The MDTA levels were compared between male and female by the Wilcoxon rank-sum test. The chi-squared test or Fisher's exact test was applied to compare distribution of gender, race, and cancer diagnosis, and the Wilcoxon rank-sum test was applied to compare age and baseline symptoms between patients with and without eligible actigraphy. We determined the association between any two continuous variables, including MDTA levels, OSV (sleep onset, sleep efficacy, WASO, total sleep time, OSV), FACIT-F, FACT-G, ESAS, HADS, PSQI, BMI, and SA, using Spearman correlation coefficients.

Multivariate linear regression analysis was performed to determine the factors predictive of MDTA. Specifically, stepwise model selection was performed to select among the variables that are significantly associated with MDTA or trending toward association with MDTA ($p \leq 0.15$). For the multivariate model analysis, we first performed logarithmic transformation (base 2) on MDTA and so the distribution is more normal. Kaplan-Meier survival analysis was used to estimate the OS time, and the log-rank test was used to determine the association between MDTA, PSQI, OSV (sleep

onset, sleep efficacy, WASO, and total sleep time), and OS. Spearman correlation coefficients were used to analyze the correlation between sleep quality (PSQI), fatigue (FACIT-F), anxiety, and depression (HADS, ESAS); correlation between OSV and sleep quality (PSQI), fatigue (FACIT-F), anxiety, and depression (HADS, ESAS).

Results

A total of 190 patients participated in the previous study³³ (Fig. 1). Of these 190 patients, 88 patients had actigraphy data. Reason for the lack of actigraphy data was that actigraphy was only administered as an elective procedure and was based on the availability of accelerometers. Some of the actiwatchers were never returned by the patients (who were

TABLE 1. PATIENT CHARACTERISTICS (N=79)

	N (%)
Gender	
Female	47 (59.5)
Male	32 (40.5)
Race	
White non-Hispanic	58 (73.4)
Hispanic	15 (19.0)
Black non-Hispanic	6 (7.6)
Cancer	
Gastrointestinal	17 (21.5)
Lung	17 (21.5)
Breast	12 (15.2)
Melanoma	11 (13.9)
Genitourinary	10 (12.7)
Hematologic	3 (3.8)
Others	9 (11.4)
Marital status	
Married	54 (68.4)
Divorced	9 (11.4)
Others	16 (20.2)
Education	
2-8th grade	9 (11.4)
High school	21 (26.6)
College	33 (41.8)
Postgraduate	13 (16.4)
Missing	3 (3.8)

TABLE 2. BASELINE RESULTS AND CORRELATIONS WITH MEAN DAYTIME ACTIVITY

	N	Median (IQR)	Correlation with MDTA	
			r	p
MDTA (counts/minute)	79	248.43 (175.76, 309.53)		
Age	79	57.47 (50.02, 65.89)	-0.379	<0.001
BMI (Kg/m ²)	72	26.86 (22.99, 29.98)	0.182	0.126
% Weight change 3 m (%)	59	-0.43 (-2.97, 2.03)	0.236	0.072
% Weight change 6 m (%)	50	-1.58 (-5.75, 0.96)	0.228	0.111
Serum albumin (mg/dL)	69	3.80 (3.40, 4.20)	0.328	0.006
Time since diagnosis (months)	61	34.30 (6.62, 78.3)	-0.004	0.976
FACIT-F	77	94.00 (77.00, 109.00)	0.029	0.805
FACT-G	78	69.50 (62.00, 81.00)	0.085	0.458
FACT-PWB	79	16.00 (12.00, 20.00)	0.042	0.716
FACT-SWB	79	23.00 (21.00, 26.00)	-0.031	0.789
FACT-EWB	78	17.00 (14.00, 20.00)	-0.090	0.433
FACT-FWB	78	15.00 (10.00, 20.00)	0.248	0.028
FACIT-Fatigue Subscale	78	22.00 (15.00, 29.00)	<0.001	0.997
Edmonton Symptom Assessment Scale				
Pain	78	3.00 (0.00, 5.00)	0.214	0.060
Fatigue	78	6.00 (5.00, 7.00)	-0.138	0.227
Nausea	78	0.00 (0.00, 2.00)	-0.150	0.191
Depression	78	1.00 (0.00, 4.00)	0.042	0.715
Anxiety	78	1.00 (0.00, 4.00)	0.185	0.104
Drowsiness	78	3.00 (1.00, 7.00)	-0.044	0.705
Shortness of breath	78	1.00 (0.00, 4.00)	-0.300	0.008
Appetite	78	3.00 (1.00, 5.00)	0.016	0.891
Sleep	78	3.00 (2.00, 6.00)	-0.050	0.664
Feeling of well-being	78	4.00 (2.00, 5.00)	-0.022	0.851
SDS	79	32.00 (20.00, 41.00)	-0.037	0.750
Hospital Anxiety and Depression Scale				
HADS-anxiety	79	6.00 (3.00, 10.00)	0.262	0.019
HADS-depression	78	7.00 (5.00, 9.00)	-0.103	0.372
PSQI	73	10.00 (6.00, 13.00)	-0.011	0.928
Actigraphy sleep variables				
Sleep onset latency	79	12.17 (6.33, 21.67)	-0.193	0.088
Sleep efficiency	79	77.75 (66.16, 85.31)	-0.056	0.625
Wake after sleep onset	79	76.76 (45.67, 181.06)	-0.049	0.670
Total sleep time (minutes)	79	423.50 (356.50, 505.05)	-0.323	0.004

BMI, body mass index; ESAS, Edmonton Symptom Assessment Scale; EWB, emotional well-being; FACIT-F, Functional Assessment of Chronic Illness Therapy-Fatigue; FACT-G, Functional Assessment of Cancer Therapy-General; FFWB, Functional Assessment of Cancer Therapy-General functional well being subscale; HADS, Hospital Anxiety and Depression scale; IQR, interquartile range; MDTA, mean daytime activity; PSQI, Pittsburgh Sleep Quality Index; PWB, physical well-being; SDS, symptom distress score; SWB, social/family well-being. Bold indicates $p < .05$.

lost to follow-up) and a few actiwatchers malfunctioned, and so, we were unable to retrieve the data. Nine patients were excluded due to the lack of actigraphic data on Tuesday, Wednesday, or Thursday of the first week of the study due device malfunction or patient compliance issues. Finally, we found 79 patients with actigraphy data available for analysis.

Patient demographics and diagnoses are shown in Table 1. The median age was 57 years. Sixty percent ($N=47$) were women, 73% ($N=58$) were white, and the most common cancer type was gastrointestinal and lung (22%, $N=17$ for both).

The median (IQR) body weight was 77.1 Kg (64.6, 88.9), BMI was 26.86 (22.99, 29.98), and SA was 3.80 gm/dL (3.40, 4.20). The median (IQR) of MDTA was 248.43 counts/minute (175.75, 309.53). Univariately, lower MDTA was significantly correlated with older age ($p < 0.001$), lower SA ($p = 0.006$), worse FACT-FWB ($p = 0.028$), worse ESAS shortness of breath ($p = 0.008$), lower HADS-anxiety

($p = 0.019$), longer total sleep time ($p = 0.004$), and borderline with male gender (263.65 in female vs. 218.85 in male, $p = 0.06$). However, there was no significant association between MDTA and FACIT-F. The median values, IQR, and correlation between MDTA and different clinical variables are summarized in Table 2.

Table 3 shows demographics, diagnoses, and baseline ESAS symptoms of patients with and without eligible actigraphy (who were excluded from the study). There were no significant differences between both groups, except that more male patients had eligible actigraphy than the female patients (51.6% vs. 36.7%, $p = 0.05$).

The multivariate linear regression analysis in Table 4 shows that lower MDTA was significantly associated with older age ($p = 0.0002$), male gender ($p = 0.0144$), worse FACT-FWB ($p = 0.0005$), worse ESAS shortness of breath ($p = 0.0026$), lower HADS-anxiety ($p = 0.0011$), and longer total sleep time ($p < 0.0001$).

TABLE 3. DEMOGRAPHICS AND ESAS SYMPTOMS OF PATIENTS WITH AND WITHOUT ELIGIBLE ACTIGRAPHY

Covariate	All patients (N=190), N (%)		With actigraphy (N=79), N (%)		Without actigraphy (N=111), N (%)		p ^a
Diagnosis							
GI	41	(21.6)	17	(41.5)	24	(58.5)	0.95
Lung	39	(20.5)	17	(43.6)	22	(56.4)	
Breast	32	(16.8)	12	(37.5)	20	(62.5)	
GU	27	(14.2)	10	(37)	17	(63)	
Melanoma	25	(13.2)	11	(44)	14	(56)	
Hematologic	9	(4.7)	3	(33.3)	6	(66.7)	
Other	17	(8.9)	9	(52.9)	8	(47.1)	
Gender							
Female	128	(67.4)	47	(36.7)	81	(63.3)	0.05
Male	62	(32.6)	32	(51.6)	30	(48.4)	
Race							
White non-Hispanic	136	(71.6)	58	(42.6)	78	(57.4)	0.6
Hispanic	33	(17.4)	15	(45.5)	18	(54.5)	
Black non-Hispanic	19	(10)	6	(31.6)	13	(68.4)	
Asian or Pacific Island	2	(1.1)	0	(0)	2	(100)	
	N	Median (IQR)	N	Median (IQR)			
Age	79	57.32 (50.06, 65.93)	111	58.83 (49.78, 67.14)			p ^b 0.55
ESAS							
Pain	78	3 (0, 5)	110	3 (1, 5)			0.98
Fatigue	78	6 (5, 7)	111	6 (5, 8)			0.49
Nausea	78	0 (0, 2)	111	0 (0, 3)			0.63
Depression	78	1 (0, 4)	111	1 (0, 4)			0.67
Anxiety	78	1 (0, 4)	111	2 (0, 5)			0.38
Drowsiness	78	3 (1, 7)	109	4 (1, 7)			0.74
Shortness of breath	78	1 (0, 4)	111	1 (0, 4)			0.43
Appetite	78	3 (1, 5)	111	4 (2, 6)			0.08
Sleep	78	3 (2, 6)	108	4 (2, 6.5)			0.37
Feeling of well-being	78	4 (2, 5)	111	4 (2, 5)			0.27
SDS	78	28.5 (18, 36)	111	28 (22, 38)			0.35

^aChi-squared or Fisher's exact test.^bWilcoxon rank-sum test.

We also found no significant association between MDTA and OS using 250 counts/minute to dichotomize the baseline MDTA measures, although the group with higher MDTA appears to have a longer OS time (19.4 months vs. 14.3 months, $p=0.18$). We found no significant association between PSQI or OSV with OS.

Table 5 shows correlation between PSQI and other symptoms. We found significant association between PSQI, FACIT-

F, ESAS depression, ESAS anxiety, HADS-depression, and HADS-anxiety.

However, there was no significant association between OSV and PSQI, ESAS sleep, fatigue (FACIT-F), anxiety, and depression (HADS) (Table 6).

Discussion

Our study is one of the first studies in ACP to evaluate the effects of objectively measured daytime physical activity and sleep using actigraphy and the association with patient characteristics, including BMI and SA, patient reported outcomes that impact QOL such as fatigue, sleep, anxiety, and depression. The results of this study suggest that low MDTA as measured by actigraphy was associated with older age, lower SA, worse FACT-FWB, worse ESAS shortness of breath, lower HADS-anxiety, and longer total sleep time. However, there was no association between MDTA and CRF. These finding suggest that effective management of these factors would result in significant improvement in the MDTA. Further studies are needed.

While it could be expected that a lower level of daytime activity is related to increased age, worse FWB, worse dyspnea, longer sleep time, and low SA (as a measure of

TABLE 4. MULTIVARIATE ANALYSIS OF THE ASSOCIATION BETWEEN MEAN DAYTIME ACTIVITY (LOG₂(MDTA)) AND CLINICAL VARIABLES

	Parameter estimate	Standard error	p
Age	-0.023	0.006	0.0002
Gender (male vs. female)	-0.302	0.120	0.0144
FACT-FWB	0.036	0.010	0.0005
Shortness of breath	-0.073	0.023	0.0026
HADS-anxiety	0.051	0.015	0.0011
Total sleep time (minutes)	-0.002	0.0004	<0.0001

 $R^2=0.58$.Bold indicates $p < .05$.

TABLE 5. CORRELATION COEFFICIENTS BETWEEN PSQI AND OTHER SYMPTOMS

	<i>FACIT-F</i>	<i>ESAS depression</i>	<i>ESAS anxiety</i>	<i>HADS-D</i>	<i>HADS-A</i>
PSQI	−0.376 ^a	0.263 ^a	0.342 ^b	0.270 ^a	0.369 ^b
FACIT-F	—	−0.274 ^a	−0.419 ^b	−0.752 ^b	−0.403 ^b
ESAS-depression	—	—	0.673 ^b	0.319 ^b	0.540 ^b
ESAS-anxiety	—	—	—	0.287 ^a	0.656 ^b
HADS-depression	—	—	—	—	0.429 ^b

^a $p < 0.05$, ^b $p < 0.01$.

cachexia) consistent with previous studies,⁴¹ the reason for the positive association between daytime activity and anxiety is not clear. Hagelin et al.⁴² in a recent study on fatigue toward end of life found decrease in anxiety due to fatigue in terminally ill patients. They postulated that this lack of anxiety due to fatigue could be as a result of change in the values or priorities and as a means of adaptation to the situation (response shift).^{43,44} A similar adaptation may occur and result in decreased anxiety despite worsening activity. However, Lowe et al.²³ found a negative association between activity and psychological functioning. Our populations are significantly different, since we studied ACP with significant level of fatigue as an inclusion criterion. More research is necessary to better characterize the potentially complex associations of decreased activity and mood in ACP and whether significant improvement of fatigue and sleep due to exercise is mediated by changes in mood.

OSV were not associated with subjective symptoms as assessed by PSQI, ESAS items, including sleep, HADS, and FACIT-F (Table 5). This lack of association between sleep measured objectively and subjectively was consistent with other previous studies.^{6–8,45–51} A possible explanation for this finding is that there is a difference between current sleep and usual sleep before their diagnosis of cancer. Patients might still be sleeping reasonably well but that might be worse than their expectation. In addition, this lack of consistency may be due to the changes in perception of sleep over time due to adaptation. Therefore, patients with objectively poor sleep may not actually perceive it to be worse. The difference in longitudinal comparison might be more sensitive than the cross-sectional design of this study. Liu et al.⁷ found some evidence for this lack of association in longitudinal comparison of cancer patients undergoing chemotherapy. However, more studies are needed with larger cohorts and longitudinal follow-up to determine the disturbance in sleep over time in a given person.

Our preliminary findings of a significant association between patient-reported sleep in terms of PSQI, fatigue (FACIT-F), anxiety and depression (both measured by HADS

and ESAS) suggest that patient-reported sleep disturbance and fatigue are more associated with emotional distress than a reflection of an objectively measured sleep. Other studies also reported these associations.^{6–12} Both fatigue and sleep disturbance are frequent findings among patients with anxiety and depression. It is likely that patients with mood disturbance have a higher awareness of sleep disturbance in a similar way as they have a higher awareness and reporting of fatigue and other symptoms.^{9–12} It is therefore possible that patients reporting sleep disturbance may have had enough objective sleep but wake up perceiving poor rest and fatigue in the morning because of their depression and anxiety. Our group had also found consistently more severe fatigue in the morning in ACP.^{33,52,53} The inability to perceive objective sleep as actual sleep may also be attributed to so-called “sleep state misperception,” a form of primary insomnia, which is common in patients with symptoms of depression and anxiety.^{54–56} Longitudinal studies would be required to determine if treatment of depressive and anxiety-related symptoms would improve subjective sleep disturbance in patients with advanced cancer.^{53–56}

Our findings suggest that both in the case of patient-reported fatigue and patient-reported sleep disturbance, the association with mood may impact the perception and expression of the symptom. Therefore, future studies involving interventions to alleviate patient-reported fatigue or sleep may also benefit from determining these variables objectively, using devices such as actigraphy.

The strength of this study is the objectively measured daytime activity and sleep through the use of actigraphy with good quality of subjective symptoms data. However, there are some limitations. Because of our study's cross-sectional design, we could not define the cause–effect relationship. Another potential limitation is that the data collected were secondary analysis from a previously conducted clinical trial in which actigraphy was only offered as an elective procedure. We could not obtain data on those who declined or whose adherence was poor. In addition, another limitation of this study is the fact that all patients had clinically important

TABLE 6. CORRELATIONS BETWEEN PATIENT-REPORTED SLEEP DISTURBANCE, FATIGUE, ANXIETY, DEPRESSION, AND ACTIGRAPHY SLEEP VARIABLES

	<i>Onset latency</i>		<i>Sleep efficiency</i>		<i>Wake after sleep onset</i>		<i>Total sleep time</i>	
	r	p	r	P	r	p	r	p
PSQI	0.043	0.719	−0.110	0.355	0.114	0.335	0.047	0.690
ESAS sleep	−0.012	0.919	−0.088	0.445	0.138	0.229	−0.064	0.579
FACIT-F	0.099	0.390	0.054	0.639	−0.088	0.449	−0.069	0.552
HADS-depression	−0.039	0.735	−0.059	0.609	0.038	0.739	0.078	0.496
HADS-anxiety	−0.046	0.686	0.049	0.666	−0.098	0.392	−0.016	0.887

levels of fatigue (one inclusion criterion of the main RCT was a score of 4 or greater on a 0 to 10 fatigue scale). This may decrease the variability in fatigue scores, which may explain why no relationship was observed with physical activity. The data availability and limited variability may also limit the generalization of the findings.

Conclusion

In ACP, low daytime activity measured by actigraphy was significantly associated with age, gender, FACT-FWB, ESAS dyspnea, HADS-anxiety, and total sleep time. Sleep measured objectively by actigraphy was not associated with patient-reported sleep disturbance. Patient-reported fatigue and sleep disturbance were significantly associated with anxiety and depression. These findings suggest that subjective reports of fatigue and sleep are more likely associated with mood problems than pure deconditioning or decreased sleep time. More research is needed.

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Author Disclosure Statement

No competing financial interests exist.

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Address correspondence to:

Eduardo Bruera, MD

*Department of Palliative Care
and Rehabilitation Medicine*

*The University of Texas MD Anderson Cancer Center
Unit 1414*

*1515 Holcombe Boulevard
Houston, TX 77030*

E-mail: ebruera@mdanderson.org