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Physical activity level and quality of life in long term lung cancer survivors

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Abstract

Purpose—Lung cancer is associated with a multitude of challenges, and lung cancer survivors report significantly lower quality of life (QOL) than other cancer survivors.

Methods—This study aimed to examine the relationship between physical activity level and QOL in a large sample of long term lung cancer survivors ($N = 1937$). Average age at diagnosis was 65 years, 92% were Caucasian, and 51% male. Surveys were completed at lung cancer diagnosis and then average 4.2 years post-diagnosis.

Results—Most survivors reported having a sedentary lifestyle at both timepoints. However, 256 survivors reported a change in physical activity level from diagnosis to follow-up. Decreased physical activity ($n = 140$) was associated with decreased overall, mental, physical, emotional, social, and spiritual QOL (all $ps < .001$) and decreased symptom control as seen in reported pain, dry coughing, coughing with phlegm, shortness of breath, and level of fatigue (all $ps < .05$). In contrast, increased physical activity ($n = 116$) was associated with improved QOL (all $ps < .05$), and improved symptom control as seen in frequency and severity of pain ($p < .01$). For all participants, those engaging in regular physical activity (30 min or more per day, at least five days per week) reported significantly higher QOL scores (all $ps < .001$), and better symptom control than more sedentary survivors.

Conclusions—Results indicate a significant association between change in physical activity and QOL and symptom control for long term lung cancer survivors, and research exploring interventions designed to improve activity level for lung cancer survivors is further warranted.

Keywords

Long term lung cancer survivors; Physical activity; Exercise; Quality of life; Symptom control

1. Introduction

According to the National Cancer Institute (NCI), more than 200,000 new cases of lung cancer were estimated in 2011. Treatment for lung cancer continues to improve, however, and the number of lung cancer survivors is rapidly increasing. Unfortunately, lung cancer survivors report significantly lower QOL than survivors of other types of cancer [1–3]. QOL has been defined as a multidimensional construct incorporating mental, physical, emotional, social, and spiritual well-being [4]. Research examining the QOL of *long term* lung cancer survivors (i.e., living 3 years or more following diagnosis) is still at an early stage [1], and little is currently known about how QOL might change or be impacted for these survivors. The current study sought to examine the potential association of physical activity level on QOL and symptom control in long term lung cancer survivors.

A range of health behaviors can impact the QOL of cancer survivors. For example, cigarette smoking, second hand smoking exposure, alcohol use, and obesity, have been associated with decreased QOL in lung cancer survivors [5]. Physical activity has been associated with a number of physical and psychological health benefits in the general population [6,7], and over the past decade research has also increasingly demonstrated that there are numerous physical and mental benefits of physical activity for cancer survivors [8–11]. The American College of Sports Medicine recently examined evidence of the impact of physical activity in cancer survivors, and concluded that physical activity is safe for cancer patients, both during and after cancer treatment, and may lead to improved physical functioning, decreased physical fatigue, and improved QOL in a number of cancer survivor groups [12], including breast cancer [13–21], prostate cancer [22–24] and hematopoietic malignancies [25–28].

Lung cancer patients often experience comorbid medical conditions such as cardiovascular disease, chronic obstructive pulmonary disease, hypertension, and other malignancies [29], and most patients also frequently experience impairing symptoms such as pain, fatigue, dyspnea, and decreased QOL [30]. Preliminary physical activity level research with early-stage lung cancer survivors has shown benefits in mood, fatigue, and dyspnea from physical activity [31], and a relationship between symptom burden, physical fitness, and QOL has been suggested [32,33], indicating that physical activity may have important impact also for lung cancer survivors.

How physical activity level impacts the QOL of *long term* lung cancer survivors is however not well understood. A recent review concluded that exercise may potentially be an important part of “multidisciplinary management” along the course of disease for lung cancer patients [34]. More specifically, one study retrospectively examined engagement in physical activity across the cancer trajectory of 175 patients completing surgical treatment for early stage non-small lung cancer. The authors found survivors who met physical activity guidelines reported improved QOL compared with sedentary survivors [31]. Our research team recently completed a study that examined the relationship between motivational readiness for physical activity and QOL in 272 long term lung cancer survivors [35]. Regular physical activity (i.e., at least 30 min or more per day, at least five days per week) was associated with better QOL across mental, physical, emotional, social, and spiritual well-being domains, and also greater symptom control (i.e., pain, fatigue, shortness of breath, and coughing) [35].

To our knowledge, no study to date has examined the potential association of change in physical activity level with change in QOL in long term lung cancer survivors. The current study therefore aimed to examine whether change in physical activity level from diagnosis to follow-up would be associated with change in QOL in a large sample of long term lung cancer survivors. Specifically, it was hypothesized that an increase in physical activity level

would be associated with improvements in QOL and symptom control. In contrast, it was hypothesized that a decrease in physical activity level from diagnosis to follow-up would be associated with decreases in QOL and symptom control.

2. Methods

2.1. Procedure overview

2.1.1. Participants—Participants in the study were enrolled in the Epidemiology and Genetics of Lung Cancer Research Program at Mayo Clinic, in Rochester, MN [36]. All patients diagnosed with lung cancer at the Mayo Clinic since January 1st 1997 have been offered participation in a prospective follow-up study. Participation rate of eligible lung cancer patients [36,37] in the study has been over 90%. Details related to ongoing patient recruitment, baseline data retrieval, and patient follow-up have been previously reported [36,37]. Briefly, all participants complete baseline surveys related to their health around time of diagnosis, and are subsequently mailed similar surveys on an annual basis. Trained study personnel review patients' medical records upon enrollment and during follow-up period, abstracting information related to demographics, previous or concurrent illnesses, tobacco usage and exposure, tumor staging, nutritional habits, and cancer therapies. The Revised Tumor, Node, Metastasis (TNM) Staging System of non-small cell lung cancer is utilized [38]. Enrollment in the study does not influence clinical decision-making in any way, and all cancer treatment decisions are made by each patient's individual health care providers.

2.2. Measures

2.2.1. Smoking status—Participants who reported smoking any cigarette in the past 30 days were classified as “current smokers.” Participants who had not smoked any cigarettes in the past 30 days were classified as “former smokers,” and those who reported smoking less than 100 cigarettes in their lifetime were classified as “never smokers” [35,39].

2.2.2. Physical activity level

Stage of change for physical activity level: A four-item measure related to current level of physical activity and intention of future physical activity was utilized to assess activity level [35,39–42]. Participants in the study were classified according to readiness for physical activity level; (1) *precontemplation*, no current structured physical activity, and no intention to increase in the next six months, (2) *contemplation*, not currently physically active, but plan to start in the next six months, (3) *preparation*, some physical activity, but not meeting recommended level, (4) *action*, currently physically active, and (5) *maintenance*, physically active for at least six months [13,40–44]. The stage of change for physical activity level has been utilized in breast cancer patients [45] and lung cancer patients [35], and previous research has shown that the measure can be successfully completed by study participants when using mailed surveys [35,43–46].

2.2.3. Quality of life and symptom control

Linear Analog Self-assessment (LASA): The LASA is a self-report measure containing a series of individual items gauging level of functioning on 10-point scales [47]. All items were positively valenced so that higher numbers represent better outcomes (10 = best possible QOL). Six QOL items ask participants to rate their QOL from 0 (as bad as it can be) to 10 (as good as it can be) on: (1) mental (intellectual) well-being, (2) physical well-being, (3) emotional well-being, (4) level of social activity, (5) spiritual well-being, and (6) overall quality of life.

Six symptom control items ask participants to rate symptoms from 0 (as bad as it can be) to 10 (as good as it can be) on: (1) frequency of pain, (2) severity of pain, (3) dry coughing, (4) coughing with phlegm, (5) shortness of breath, and (6) level of fatigue. All items were positively valenced so that higher numbers represent better outcomes (10 = no pain). The LASA has been validated for use in cancer patients with Cronbach's alpha ranging from .83 to .88, and the LASA items are correlated to Eastern Cooperative Oncology Group (ECOG) performance score [48], Mini Mental State Exam (MMSE) Score [49], Profile of Mood States (POMS) [50] and Functional Assessment of Cancer Therapy-Brain (FACT-Br) [51,52]. Normative data for the overall QOL LASA items range from an average of 4.4 for medical students to 8.0 for healthy individuals with a standard deviation of two points on the scale [52,53]. The LASA has been utilized in newly diagnosed high grade glioma patients [52,54], lung cancer patients [35] and patients with advanced stage cancer [35–38,55]. Clinically meaningful differences between groups have been defined as half the standard deviation (1 point on the 0–10 point scale) [56].

2.3. Statistical analyses

Summary measures included means and standard deviations. Analyses controlled for cancer stage at diagnosis as well as current smoking status. Differences between groups were tested with two-sided Kruskal–Wallis tests with a .05 statistical significance level. Addressing potential false positive findings due to multiple comparisons ($n = 24$), Bonferroni corrections [57] were employed at significance level $p = .002$.

3. Results

Participants ($N = 1937$) completed questionnaires for motivational readiness for physical activity, QOL, and symptom control on at least two time points. Surveys at follow-up were completed an average of 4.2 years (standard deviation, $SD = 2.9$ years) from lung cancer diagnosis, and maximum time from first to last observation was 12 years. Average age was 65 ($SD = 10.15$) years old at the time of lung cancer diagnosis, and 70 ($SD = 10.25$) years at the time of follow-up. Of the total sample, 714 were less than 3 years from diagnosis, 426 were 3–5 years from diagnosis, and 797 patients were more than 5 years since diagnosis. Lung cancer classification was either small cell lung cancer (6%), or non-small cell lung cancer stage I (49%), II (9%), III (21%), or stage IV (14%). Most participants were Caucasian (92%), male (51%), and married (79%). The majority of participants were former smokers (56.4%). See Table 1 for demographics and clinical characteristics.

3.1. Physical activity level, QOL, and symptom control

The majority of survivors reported having a sedentary lifestyle (precontemplation, contemplation, and preparation) at diagnosis as well as at follow-up. Of the 1937 participants, 256 (13%) participants nevertheless reported change in their physical activity level from first to last observation. See Table 1 for demographics and clinical characteristics also for this subgroup. Of those that changed their physical activity level, 50 were less than 3 years from diagnosis, 82 were 3–5 years from diagnosis, and 124 patients were more than 5 years from diagnosis. Change in physical activity level from baseline to follow-up was reported as either; (1) decreased activity (i.e., active at baseline and non-active at follow-up: $n = 140$), or (2) increased activity (i.e., non-active at baseline and active at follow-up: $n = 116$). Table 2 shows mean QOL scores at baseline and follow-up for both groups, including mean change score and standard deviation.

As predicted and presented in Table 2, patients reporting decreased physical activity level from baseline to follow-up reported a significant decrease in mental ($p < .001$), physical ($p < .001$), emotional ($p < .001$), social ($p < .001$), and spiritual ($p < .001$) well-being, as well

as in overall QOL ($p < .001$). Patients reporting increased physical activity from baseline to follow-up, in contrast, reported increase in their mental ($p = .005$), physical ($p = .003$), emotional ($p = .02$), social ($p < .001$), and spiritual ($p = .02$) well-being, as well as in overall QOL ($p < .001$). Interestingly these two groups essentially switched positions in terms of QOL and symptom control status (see Fig. 1) from diagnosis to follow-up.

It was also hypothesized that change in physical activity level would be associated with change in symptom control. Supporting this premise, patients reporting decreased physical activity level from baseline to follow-up reported increased symptom burden (i.e., decreased symptom control) in the form of frequency of pain ($p = .03$), severity of pain ($p = .002$), frequency of dry coughing ($p = .03$), coughing with phlegm ($p < .001$), shortness of breath ($p = .003$), and level of fatigue ($p < .001$). Increased physical activity from baseline to follow-up was associated with increased symptom control (i.e., decreased symptom burden) in the form of reduced frequency ($p = .005$) and severity ($p = .006$) of pain, but not with frequency of dry coughing, coughing with phlegm, shortness of breath, or level of fatigue. See Table 2 for details.

Bonferroni corrections ($p = .002$) did effect on the significant relationship between change in physical activity level and change in overall QOL, particularly for patients with decreasing activity level, but added caution regarding the relationship between change in physical activity level and change in symptom control (Table 2).

3.2. Motivational readiness for physical activity, QOL, and symptom control

The current study also sought to examine the relationship between current stage of change for physical activity level, QOL and symptom control. Participants in the entire sample were classified as either in the maintenance stage for physical activity ($n = 688$, 35.52%), action stage ($n = 77$, 3.98%), preparation stage ($n = 230$, 11.87%), contemplation stage ($n = 503$, 25.97%), or the precontemplation stage ($n = 439$, 22.66%) for physical activity. Regular physical activity was associated with better QOL across the stages of motivational readiness. Table 3 shows mean QOL scores by each stage of change in physical activity level. As stages of change in physical activity level increased, QOL scores in the form of mental, physical, emotional, social, spiritual well being, and overall QOL increased (all p -values $< .0001$). Increasing stages of physical activity level were also associated with better mean symptom control (Table 3) in the form of frequency of pain, severity of pain, frequency of dry coughing, coughing with phlegm, shortness of breath, and level of fatigue; all with p -values $< .0001$.

4. Discussion

Many cancer survivors experience declines in QOL and impairing symptom burden. The benefits of physical activity for the general population have been well established, and the current study adds to the growing literature pointing to a link between physical activity and quality of life for cancer survivor populations with significant symptom burden. In this project, long term lung cancer survivors who reported increased physical activity level also described improvements in their QOL. In contrast, the long term lung cancer survivors who decreased their physical activity level reported a decline in their QOL. Results were consistent across all five domains of QOL as well as overall QOL. Increases in physical activity level were also associated with improved symptom control for these long term lung cancer survivors, and conversely decreased physical activity was associated with decreased symptom control related to frequency and severity of pain.

A previous study from our group found a cross-sectional association between level of physical activity, QOL and symptom control in lung cancer survivors [35]. The current

study replicates these findings, but with a much larger sample ($N = 1937$). It also evaluated changes across time, showing that long term lung cancer survivors who are physically active on a regular basis report better QOL, both overall and across all five domains of QOL, compared with more sedentary survivors. Similar to the previous report, without exception, as stage of change for physical activity level increased, so did QOL scores. Physically active lung-cancer survivors also reported having better symptom control compared with more sedentary survivors, and reported having lower frequency and severity of pain, lower frequency of dry coughing and coughing with phlegm, less shortness of breath, and also lower level of fatigue. The pattern of consistency across stages was impressive, as increased physical activity was consistently associated with increased QOL and increased level of reported symptom control.

Research focusing on older cancer patients is somewhat limited at this point. The average age for participants in this study was 65, and with a large portion of patients being 65 years or older, results suggest that significant associations between physical activity, symptom control and QOL can also be found in older cancer patients. Considering the current aging population in our society, further research examining QOL in older cancer survivors is important.

The nature of this study does not allow for conclusions about causality as survivors were not randomized to a physical activity intervention. It remains plausible that perhaps an increase in lung cancer symptoms could reduce a survivor's health status, leading him or her to stop exercising, possibly experience a decline in QOL secondary to declining health, and also to experience more symptoms. However, the association between physical activity level and QOL is striking in this study, both for survivors who changed their activity level and for the large cross-sectional sample. Previous research has clearly demonstrated that most long term lung cancer survivors experience a decline in health status over time. Considering the often complicated and burdensome trajectory for lung cancer survivors, it may be less likely that a long term lung cancer survivor somehow began to experience improvements in their health, and that this unaccounted improvement in health status leads to more physical activity, improved QOL, and improved symptom control. Our study did control for cancer stage at diagnosis, as well as current smoking status, and it is possible that engaging in a physically active lifestyle could improve QOL and symptom control for long term lung cancer survivors. Future studies could closely monitor and report survivors ongoing health status to help clarify this issue.

5. Limitations

As mentioned, all analyses in this study controlled for cancer stage at diagnosis as well as current smoking status, which strengthens the findings. However, there are study limitations. First, as noted, the causal nature of the relationship between physical activity level, QOL, and symptom control cannot be clearly established without a randomized intervention or close monitoring of the survivors ongoing health status. Second, participants were primarily Caucasians, and these results may potentially not apply to more diverse samples. Future research should seek to include a more diverse sample when further examining these associations. Third, we used a mixed sample of lung cancer disease and stages. However, we did find these results remained the same when SCLC was excluded from the sample; therefore the SCLC patients were included in this report. Finally, only self-report measures of physical activity level were utilized in the study, and future investigations should include direct measurement of physical activity level.

6. Conclusion

The benefits of regular physical activity on physical and psychological well-being have been well established in the general population, and the current study provides further support for a strong association between physical activity, QOL, and symptom control in long term lung cancer survivors. Changes in physical activity level from diagnosis to follow-up were associated with changes in QOL and symptom control for long term lung cancer survivors in the current study, and a cross-sectional analysis also found physical activity level to be strongly associated with QOL and symptom control. Randomized controlled studies are required in order to establish clear causality. However, the current results do indicate that physical activity may have significant QOL and symptom control benefits for long term lung cancer survivors, and research exploring tailored interventions designed to improve the physical activity level of long term lung cancer survivors is warranted.

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Fig. 1.
Association of change in physical activity and quality of life.

Table 1

Demographics and clinical characteristics of 1937 lung cancer survivors.

	Total sample N = 1937	Total change in activity level N = 256	Active to non-active N = 140	Non-active to active N = 116
Age at lung cancer diagnosis (mean)	65.3 years	65.1 years	65.8 years	65.1 years
(±SD)	(±10.53, range 18–93)	(±10.47, range 21–89)	(±10.10, range 18–83)	(±10.47, range 21–89)
Age at follow-up	70.0 years	70.4 years	71.4 years	70.4 years
(±SD)	(±10.65, range 22–98)	(±10.25, range 27–91)	(±10.01, range 27–91)	(±10.25, range 27–91)
Gender(%)				
Female	49%	47.7%	45.7%	50%
Male	51%	52.3%	54.3%	50%
Racial group (%)				
Caucasian	92.5%	92.6%	92.9%	92.2%
Hispanic	1.3%	0.8%	1.4%	0%
Alaskan/Indian	5.2%	6.3%	5.7%	6.9%
Black	0.4%	0%	0%	0%
Asian	0.5%	0.4%	0%	0.9%
Unknown	0.2%	0%	0%	0%
Marital status (%)				
Single	4.1%	3.8%	5.8%	1.1%
Married	78.6%	76.8%	79.2%	74.7%
Divorced/widowed	17.3%	19%	15%	24.2%
Cigarette smoking status at follow-up (%)				
Never	19.3%	18.8%	17.9%	19.8%
Former	56.4%	55.5%	60%	50%
Current	22.7%	25.7%	22.1%	30.2%
Missing	1.6%	0%	0%	0%
Pack years (mean)	46.8 years	47.6 years	47.3 years	48.1 years
(±SD)	(±30.72, range 0–208)	(±29.27, range 0.5–168)	(±27.26, range 2.0–138)	(±31.78, range 0.5–168)
Histology (%)				
SCLC	6.2%	5.1%	6.4%	3.4%
NSCLC	93.8%	94.9%	93.6%	96.6%
Stage at diagnosis				

	Total sample <i>N</i> = 1937	Total change in activity level <i>N</i> = 256	Active to non-active <i>N</i> = 140	Non-active to active <i>N</i> = 116
SCLC	6.2%	5.1%	6.4%	3.5%
Stage I	49%	48.2%	48.6%	47.8%
Stage II	9.3%	11.4%	10.7%	12.2%
Stage III	21%	24.7%	22.1%	27.8%
Stage IV	14.4%	10.6%	12.1%	8.7%
Treatment				
Chemotherapy	47.4%	43.5%	45.3%	41.4%
Radiation therapy	29.3%	28.6%	31.7%	25%
Other lung treatment	20%	0.8%	0%	1.7%
Surgery	71.5%	78.8%	77%	81%

SCLC, small cell lung cancer; NSCLC, non-small cell lung cancer.

Table 2
Association of physical activity level change (stage of change) and QOL(LASA) – baseline to follow-up.

	Active at baseline (N = 140) 54.69%		Non-active at follow-up (N = 140) 54.69%		Change		Active to non-active		Non-active at baseline (N = 116) 45.31%		Active at follow-up (N = 116) 45.31%		Change		Non-active to active		Decreased vs. increased activity	
	Mean (SD)		Mean (SD)		Mean (SD)	p	Mean (SD)		Mean (SD)		Mean (SD)		Mean (SD)	p	Mean (SD)	p		p
QOL domain																		
Mental well-being	8.38 (1.52)		7.73 (1.96)		-0.65 (1.73)	<.001			7.58 (2.09)		8.11 (1.73)		0.52(1.95)	.005			<.0001	
Physical well-being	7.35 (1.75)		6.14 (2.12)		-1.22 (1.98)	<.001			6.59 (1.91)		7.22 (1.78)		0.62(2.20)	.003			<.0001	
Emotional well-being	8.07 (1.70)		7.46 (2.00)		-0.61 (1.78)	<.001			7.37 (2.04)		7.86 (1.90)		0.47 (2.20)	.02			<.0001	
Level of social activity	7.79 (1.77)		6.27 (2.54)		-1.53 (2.28)	<.001			6.64 (2.12)		7.48 (1.86)		0.82(2.51)	<.001			<.0001	
Spiritual well-being	8.59 (1.53)		7.90 (1.96)		-0.70 (1.85)	<.001			7.88 (1.99)		8.31 (1.83)		0.50(2.24)	.02			<.0001	
Overall QOL	7.85 (1.56)		6.89 (2.11)		-0.99 (2.02)	<.001			7.02 (1.88)		7.74 (1.76)		0.71 (2.03)	<.001			<.0001	
Symptom control																		
Frequency of pain	6.77 (2.74)		6.18 (2.90)		-0.64 (3.43)	.03			6.02 (2.77)		6.78 (2.90)		0.80(3.03)	.005			0.001	
Severity of pain	7.39 (2.17)		6.74 (2.38)		-0.66 (2.48)	.002			6.42 (2.61)		7.09 (2.70)		0.66(2.57)	.006			<.001	
Frequency of dry cough	7.42 (2.45)		6.90 (2.71)		-0.52 (2.85)	.03			7.01 (2.61)		7.05 (2.72)		0.04 (3.01)	.88			.17	
Coughing with phlegm	7.76 (2.48)		6.51 (3.01)		-1.26 (2.62)	<.001			7.48 (2.75)		7.52 (2.70)		0.09 (2.95)	.75			.003	
Shortness of breath	5.84 (2.72)		5.15 (2.73)		-0.69 (2.73)	.003			5.59 (2.68)		5.76 (2.63)		0.16(2.73)	.54			.03	
Level of fatigue	5.77 (2.34)		4.70 (2.31)		-1.06 (2.25)	<.001			4.99 (2.20)		5.37 (2.24)		0.38 (2.60)	.12			<.0001	

Table 3

Stage of change for physical activity level and QOL (LASA) among 1937 lung cancer survivors.

QOL domain	Stage of change at follow-up					
	Precontemplation (N = 439) 22.66%	Contemplation (N = 503) 25.97%	Preparation (N = 230) 11.87%	Action (N = 77) 3.98%	Maintenance (N = 688) 35.52%	Total (N = 1937) 100%
QOL domain						
Mental well-being	6.9	7.5	8.1	7.8	8.3	7.7
Physical well-being	5.3	6.1	7.0	7.1	7.5	6.6
Emotional well-being	6.6	7.2	7.8	7.6	8.1	7.5
Level of social activity	5.2	6.2	7.4	7.5	7.8	6.7
Spiritual well-being	7.2	7.7	8.1	8.5	8.5	8.0
Overall QOL	5.9	6.7	7.5	7.5	7.9	7.1
Symptom control item						
Frequency of pain	5.7	6.2	6.8	6.8	6.8	6.4
Severity of pain	6.0	6.6	7.2	7.3	7.3	6.8
Frequency of dry coughing	6.5	7.0	7.3	7.0	7.4	7.1
Coughing with phlegm	6.3	6.9	7.2	7.2	7.6	7.1
Shortness of breath	4.5	5.1	5.6	5.6	6.3	5.5
Level of fatigue	3.9	4.6	5.3	5.4	5.8	5.0

All endpoints are on a scale from 0 to 10 with 10 being the best possible score.