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Associations of objectively assessed physical activity and sedentary time with health-related quality of life among lung cancer survivors: A quantile regression approach

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ABSTRACT

Objectives: No studies have examined objectively assessed physical activity, sedentary time, and patient-reported outcomes among lung cancer survivors. The objective of this study was to determine associations of objectively assessed moderate-to-vigorous intensity physical activity (MVPA) and sedentary time with health-related quality of life (HRQoL) and fatigue among lung cancer survivors.

Materials and method: Lung cancer survivors in Southern Alberta (N = 540) were invited to complete a mailed survey that assessed HRQoL [Functional Assessment of Cancer Therapy-Lung (FACT-L)], physical and functional well-being [Trial Outcome Index (TOI)], and fatigue [Fatigue Scale (FS)]. Physical activity and sedentary time data was collected using an Actigraph® GT3X+ accelerometer that was worn on the hip for seven consecutive days. Quantile regression was used to examine associations of HRQoL and fatigue with physical activity and sedentary time at the 25th, 50th, and 75th HRQoL and fatigue percentiles.

Results: A total of 127 lung cancer survivors participated for a 24% response rate (Mean age = 71 years; Mean time since diagnosis = 75 months). Total MVPA minutes was positively associated with fewer fatigue symptoms at the 25th percentile ($\beta = 0.16$, $p = 0.046$). Total sedentary time was inversely associated with HRQoL at the 75th percentile ($\beta = -0.07$, $p = 0.014$) and inversely associated with fatigue symptoms at the 50th percentile ($\beta = -0.04$, $p = 0.009$). Total sedentary time was also inversely associated with physical and functional well-being scores at the 25th ($\beta = -0.07$, $p = 0.045$), 50th ($\beta = -0.07$, $p = 0.004$) and 75th ($\beta = -0.04$, $p = 0.035$) percentiles.

Conclusion: Across the HRQoL, fatigue, and physical and functional well-being distributions, sedentary time was inversely associated with HRQoL, fatigue, and physical and functional well-being in lung cancer survivors. Small associations were observed between MVPA and fatigue, but no associations emerged with HRQoL or physical and functional well-being.

1. Introduction

Lung cancer is the leading cause of cancer deaths [1]. Most lung cancer survivors are diagnosed with early stage disease, for which primary treatment is surgical resection. Other treatments include chemotherapy and radiation, and both therapies are associated with numerous side effects [2]. The combination of treatment side effects and multiple comorbidities are associated with a high symptom burden (e.g., fatigue, dyspnea, insomnia, nausea, pain, depression) that has a major impact on one's health-related quality of life (HRQoL) [3,4]. After curative intent treatment for lung cancer (with often includes surgical lung resection), survivors often experience reduced physical function including poorer aerobic capacity and muscular strength [5].

Recent systematic reviews have suggested that exercise training may potentially improve exercise capacity/lung function and muscular strength [6,7], and patient reported outcomes (PROs) including HRQoL and fatigue [8–10]. However these studies have relied on self-reported estimates of physical activity, which may have a substantial impact on

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observed levels of physical activity [11] given self-reported assessment of activity may be prone to recall error and over-reporting [12]. Objective daily activity behaviour measures have been implemented in the lung cancer context [13]. However, many of these studies focused on circadian function and organization [14–16] rather than physical activity, and how activity is accumulated throughout the day.

Whilst studies have examined objectively assessed step counts and/or time spent sitting [17–19], to date no studies have examined the full spectrum of physical activity (i.e., light, moderate, and vigorous intensity) and sedentary behaviour, using objective accelerometer measures among lung cancer survivors. In general, cancer survivors spend upwards of 70% of their day in sedentary behaviour, defined as any waking behaviour characterized by an energy expenditure ≤1.5 metabolic equivalents, while in a sitting, reclining or lying posture [20]. Sedentary behaviour has adverse health consequences that are distinct from the negative effects of physical inactivity (not achieving physical activity public health guidelines) [21]. Studies examining sedentary time among lung cancer survivors hve been descriptive. Cavalheri et al. [5] reported survivors with lung resections spent on average 49% of their total day engaged in sedentary behaviours accrued in at least 30-min bouts, while Maddocks et al. reported survivors spent almost 20 h per day sitting or lying down [19]. Among lung cancer survivors, associations between sedentary behaviour and HRQoL and fatigue are unknown.

Accelerometers provide objective, precise, and reliable measurement of movement patterns throughout the day. No studies to date have simultaneously studied associations of objectively assessed physical activity and sedentary behaviour with PROs including HRQoL and fatigue outcomes among lung cancer survivors. The objectives of this study were to a) describe daily physical activity (i.e., light, moderate, and vigorous) and sedentary time patterns, and b) determine associations of objectively assessed physical activity and sedentary time with HRQoL, fatigue, and physical and functional well-being among lung cancer survivors.

2. Material and methods

2.1. Participants

The study was approved by the Health Research Ethics Board of Alberta and the Athabasca University Research Ethics Board. All lung cancer survivors were recruited from the Glans-Look Lung Cancer Database at the University of Calgary. The Glans-Look Database includes comprehensive data (e.g., demographics, diagnosis, treatments received) on all adult non-small cell lung cancer (NSCLC) patients diagnosed from January 1, 1999 to December 31, 2014 in Southern Alberta. Eligibility criteria included (a) previous clinical and/or pathological diagnosis of NSCLC confirmed by chart review, (b) not currently receiving treatment for lung cancer or any other cancer, (c) community dweller, and (d) ability to read and write English.

2.2. Data collection

Eligible survivors were mailed a study information package followed by a reminder phone call. Consented individuals were mailed a study package including an Actigraph® GT3X+ accelerometer (Actigraph, LLC, Pensacola, Florida), along with accelerometer instructions, an accelerometer diary to record wear time, and a health survey. At the end of the seven-day monitoring period, participants returned all aforementioned materials in a padded postage paid priority envelope that was provided.

2.3. Measures

Demographic and clinical information such as age, sex, diagnosis date, stage, histology, and treatment received (e.g., surgery, chemotherapy, radiation therapy) were obtained from the Glans-Look Database. Information not available from the database, including sociodemographic and lifestyle factors were collected by self-report. To assess body mass index, participants indicated their height and weight at the time of completing the survey. Medical comorbidities were assessed via self-report and consisted of asking participants if a medical professional had ever told them they have one of the following: high blood pressure, high blood cholesterol, diabetes, stroke, angina, heart attack, and other (open-ended). Treatment and disease stage were extracted from the lung cancer database. Demographic characteristics were assessed to control for potentially confounding covariates including sociodemographic (e.g., marital status, education) and lifestyle factors (e.g., smoking).

Physical activity and sedentary time were assessed using the ActiGraph® GT3X+ accelerometer, an instrument that records acceleration using a tri-axial accelerometer. The accelerometer was worn on an elasticized band around the waist during waking hours, except while bathing or swimming. For accelerometer data processing, commonly accepted activity count cutoffs were used to categorize sedentary time (< 100 counts/minute) from light intensity activity (100–1951 counts/minute) and MVPA (≥1952) from counts/minute) [22,23]. Data was processed in 60-s epochs. Non-wear time was defined as intervals of at least 60 consecutive minutes of zero counts, with allowance for up to two minutes of observations of less than 50 counts per minute within the non-wear interval [23]. Participants were asked to record, in a daily log, the time they put on and took off the monitor each day. These recordings were used to confirm wearing start and end times, as well as non-wear time. To be included in the analyses, participants needed to provide at least four valid days of accelerometer wear time. A valid day was defined as having at least 600 min (10 h) of wear time and no excessive counts (> 20,000 counts per minute).

HRQoL was assessed by the Functional Assessment of Cancer Therapy-Lung (FACT-Lung) questionnaire [24] which is composed of 34 items: physical well-being (7 items), social and family well-being (7 items), emotional well-being (6 items), functional well-being (7 items), and lung cancer-specific symptoms (LCS) (7 items). Participants were asked to indicate how true each statement is for them over the last seven days, on a five-point scale from 0 (not at all) to 4 (very much) where higher scores indicate better HRQoL. From the FACT-Lung, the Trial Outcome Index-Lung (TOI) is also generated. The TOI comprises the sum of the physical and functional well-being scales in addition to lung cancer-specific symptoms subscale and provides an indication of *physical and functional well-being*.

Fatigue was assessed with the 13-item Fatigue Scale (FS) [25]. Each item was measured on a 4-point scale from 0 (very much fatigued) to 4 (not at all fatigued) with higher scores indicating less fatigue.

2.4. Statistical analysis

Descriptive statistics were used to examine the demographic and clinical characteristics of the sample, as well as objective physical activity and sedentary behaviour estimates. MVPA accumulated in at least 10-min bouts (more synonymous with a physical activity session), and sedentary time accumulated in at least 30-min bouts were also examined. Quantile regression was used to examine associations of HRQoL, fatigue, and physical and functional well-being (i.e., TOI) (dependent variables) with MVPA, light-intensity physical activity, and sedentary time (independent variables) at the 25th, 50th, and 75th percentiles of the dependent variables. Quantile regression coefficients are interpreted similarly to those of linear regression coefficients except that a quantile regression coefficient indicates the change in the value at the modeled percentile, and not the mean, of the dependent variable [26]. This analysis allows comparison of non-normally distributed PROs across physical activity and sedentary time levels. As the population is not segmented into smaller samples sizes as it is in linear regression, increased power is gained to better detect any differences. All models