Comparison of Objectively and Subjectively Measured Sedentary Behavior in Men with Prostate Cancer and a History of Androgen-Deprivation Therapy Use

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Abstract

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Background: Men with prostate cancer commonly receive Androgen Deprivation Therapy (ADT) treatment at some point during treatment. Though efficacious, ADT has significant side effects, including increased risk of cardiovascular disease (CVD) and diabetes. Emerging evidence indicates that reducing sedentary behavior (SB) may reduce the risk of diabetes and CVD. Given the co-morbidities, increased age, and side-effects of treatment among men with prostate cancer, reducing SB may offer a feasible means of reducing side effects associated with ADT.

Methods: Eighteen men with prostate cancer and a history of ADT use completed a single-item sedentary time survey question. Participants were then fitted with accelerometers and objective SB was measured over seven days. Objective and self-reported measures of SB were then compared using Pearson correlation and Bland

Altman Plots. Qualitative perceptions of SB were collected through semi-structured exit interviews at follow-up.

Results: On average participants underreported SB (5.9 hours/day, ±3.1) compared to objectively measured SB (9.6 hours/day, 2.5). Pearson correlation between objective and self-reported SB was .22 ($p = 0.4$). Bland-Altman plots indicated that participants underreported SB by 3.5 hours compared to objective measures. When discussing SB, participants commonly cited barriers to decreasing SB, facilitators for increasing SB, and perceptions of current SB.

Conclusion: This pilot data suggest that men with prostate cancer and a history of ADT use have high levels of SB, but are largely unaware of their actual SB. While they are overwhelming interested in reducing their sedentary time, health reasons, lack of awareness, and enjoyment of sedentary activities present significant barriers to reducing sedentarism.

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Introduction:

Prostate cancer is the most common cancer among men in the USA, with an estimated 220,800 cases diagnosed in 2015.[1, 2] As a result of advances in disease detection and multimodal treatment, the 5-year survival rate for prostate cancer is high at 98.8%.[1] As such, more men with prostate cancer are living longer, making the long-term side effects of treatment an important consideration when treating this disease. Up to 50% of men with prostate cancer receive Androgen Deprivation Therapy (ADT) at some point during the course of their disease management.[3] ADT works by suppressing the hypothalamic-pituitary-gonadal axis to reduce androgen (testosterone and dihydrotestosterone) production to castration levels (i.e. chemical castration).[4] Diminished androgen levels reduce prostate cancer cell growth and disease progression.[5] In randomized trials, ADT is shown to improve survival rates in locally advanced prostate cancer.[5,6] Though efficacious, ADT has significant side effects. These include weight gain, reduced lean body mass, diminished physical performance, fatigue, increased risk of cardiovascular disease (CVD) and diabetes, and diminished quality of life.[5, 7, 8]

Physical activity (PA) has been found to reduce the side effects of ADT and the risk of prostate cancer progression and mortality.[9-14] Currently, it is recommended that cancer survivors engage in 150 minutes of exercise per week and strength training for 2 days per week.[15] However, PA recommendations may not be feasible for all prostate cancer patients, specifically those with a

history of ADT. A systematic review of PA interventions in prostate cancer survivors found that only 49.1% of participants met current physical activity recommendations.[16] Among men with prostate cancer undergoing ADT, only 45% met current PA recommendations.[17] Co-morbidities, increased age, and side-effects of hormone therapy are commonly cited reasons for reduced PA among this population.[18] Though potentially beneficial, these findings suggest that PA interventions may not be feasible or appropriate for all men with prostate cancer and a history of ADT use.

Reducing sedentary behavior (SB) may offer an alternate intervention for treating and preventing side effects associated with ADT. Sedentary behavior is defined as any waking activity performed in a seated or reclined position that expends less than 1.5 metabolic energy equivalents.[19] Recent epidemiological studies have found that SB, independent of PA, is associated with increased adverse health risks such as diabetes and CVD.[20-24] These findings suggests that targeting SB alone may have beneficial health outcomes, especially among populations where PA interventions are less feasible.

Emerging evidence from animal models suggests that SB may alter metabolic processes differently than PA. Lipoprotein lipase (LPL), the rate-limiting enzyme in the catabolism of triglyceride-rich lipoproteins, plays a central in the regulation of plasma HDL cholesterol and triglyceride concentrations.[25] Results from animal studies suggest that reductions in skeletal muscle contraction may reduce LPL activity and initiate metabolic changes that alter plasma lipid profiles and the regulation of inflammation and atherosclerotic signaling.[19, 26-28] As such, reducing SB may offer an alternative means of reducing the risk of weight gain, CVD and diabetes among men with prostate cancer and a history of ADT use.

Based on longitudinal studies of objectively measured SB, prostate cancer survivors spend on average 9.9 hours per day engaged in SB.[30] High levels of SB among this population may reflect not only physical limitations due to side effects of treatment and diagnosis, but limitations related to aging. The latter is supported by evidence from studies of objectively measured SB among non-cancer men of similar age. Martin et al. found that men over 70 years old spent an average 10.3 hours engaged in SB each day.[45] Cawthorn et al. found that community dwelling men greater than 65 years old spent on average 13.8 hour per day engaged in SB.[46] Differences between cohorts may reflect greater motivation to incorporate healthier behaviors after a cancer diagnosis and suggest that prostate cancer survivors might more open to SB interventions, especially where PA interventions have failed.

To date, literature on SB and prostate cancer with and without ADT use is limited. In a literature search, only four studies were identified that examined SB in men with prostate cancer. A cross-sectional study of objectively measured SB by Lynch et al. found that prostate cancer survivors spent approximately 69% of their day, an average of 9.9 hours, engaged in SB.[30] A prospective cohort study of prostate cancer survivors by Phillips et al. found no statistically significant association between self-reported SB and quality of life.[29] A cross-sectional study by Rogers et al. found no statistically significant difference in self-reported SB between men with and without a history of prostate cancer.[31] In a qualitative study of men with prostate cancer and ADT use, Trinh et al. found that participants were only mildly aware of their daily sedentary time and believed that inactivity and its consequences were synonymous with SB.[32] As such, they tended to focus on increasing PA, as compared to reducing sedentary time.[32]

While these findings are illustrative, the use of self-reported measures of SB in all but one study (Lynch et al.) significantly limit these findings. At present, no studies have compared self-

reported SB to objective SB in men with prostate cancer to determine the validity of self-reported measures of SB among this population. The present mixed methods study aimed to compare self-reported SB to objectively measured SB in men with a history of ADT use in order to examine how accurately men perceive daily sedentary time. Additionally, the present study aimed to qualitatively examine views on SB among this population. Such research expands upon previous literature and aims to describe perceptions that may guide the methodology of future studies of SB in men with prostate cancer and a history of ADT.

Methods:

The present study took place between 2014-2015. Participants were recruited from Group Health Cooperative, a medium-size health system in Seattle, WA and were part of a larger study investigating objective measurement of physical activity and sedentary behavior in men with prostate cancer (N = 30). For the current analysis, only the subset of men with a history of ADT use were included (N = 18). Human subjects approval was obtained from the Group Health Research Institute.

Procedures

Electronic medical records were obtained from Group Health Cooperative and extracted to develop a sampling frame. The sampling frame included: men > 40 years, a SEER code for prostate cancer (excluding distant and metastasized disease), and receipt of primary care at Group Health in or near Seattle. History of ADT treatment was ascertained from medical record procedural codes indicating an injection of at least one ADT medication within two years prior to August 1, 2014 or bilateral orchiectomy any time prior to January 1, 2005. Participants with a death date prior to extraction, codes for palliative care, and ICD-9 codes diagnosing serious mental health or substance abuse were excluded.

Eligible individuals from the sampling frame were sent a letter and invited to participate in the study. Interested individuals were instructed to leave a message on a study voicemail and were then contacted by a study team member. During this phone call, participants gave oral informed consent and answered a series of additional eligibility questions. Individuals were excluded from the study if they denied having prostate cancer, were unable to stand or walk one block, or were unable to speak English.

From November 2014-May 2015 research team members conducted in-person assessments at the main care clinic of Group Health. In-person assessments were done in private rooms with written informed consent given at onset of the visit. During the visit participants completed a survey, had height and weight measurements taken, and were fitted with an ActivPAL device. Participants were instructed on proper device wear and care and asked to wear devices for 7 days and keep a wear time log for each device.

After the 7-day wear period, participants returned the devices by mail in a pre-addressed, stamped envelope. Data was extracted from devices and analyzed to generate a feedback report graphically illustrating participant's average sitting, standing, and steps. Two weeks after mailing feedback reports, study team members contacted participants by phone, obtained oral informed consent and conducted semi-structured exit interviews. Audio recordings were sent to an independent transcription company. A study team member reviewed final transcripts and any identifiers were masked. Participants who completed the study received compensation of $10 and a Fitbit device.

Survey:

Subjective SB was assessed via a single-item question within the survey administered at in-person visit. The single-item SB question, derived from the International Physical Activity

Questionnaire (IPAQ),[48] asked participants to report average sitting time on a usual day during the past seven days. Estimated SB was provided in hours and minutes for both weekdays and weekends.

Semi-structured Exit Interviews

Exit interviews lasted approximately 30-45 minutes. Questions were semi-structured and designed to elicit open-ended discussion about PA and SB and maintain consistency between interviewers. Questions targeted study topics of interest such as willingness to decrease SB or increase PA, thoughts on objective measures from feedback chart, and preferences for a program targeting SB and PA. Sample questions include: "are you interested in reducing your sedentary behavior?" and "what would make it challenging to reduce your sedentary behavior?" Exit-interviews were conducted by trained masters students and postdoctoral fellows, audio-recorded and transcribed.

Device – Objective SB:

Participants wore ActivPAL3^{TM}, Glasgow, Scotland, an accurate and validated[34] accelerometer-device used to objectively measure sitting and standing time. ActivPAL3 was selected as the preferred device for measuring SB as it is a more accurate tool for measuring SB compared to waist-worn devices.[49] Depending on participant's needs, ActivPAL3^{TM} was worn either adhered to the thigh with a mild adhesive (ActivPAL stickie) for easy removal during sleeping or bathing or adhered to the thigh with tegaderm dressing for continual wear. Proprietary ActivPAL software was used to extract ActivPAL3^{TM} data from devices. Wear time log data was used to parse sleep data from wake-time data. Wake-time data included hours spent sitting, standing, stepping, and in transition between sitting and standing.

Statistical Analysis

Device data was included if participants had a minimum of 10 hours/day of wear as reported in participant's wear log and if total wear days was three or more. Weekday and weekend sedentary hours from the single-item SB question were summed and divided by the number of corresponding days in order to determine mean sedentary time. All completed surveys were included and objective and self-reported SB were analyzed using Stata version 12.1 (StataCorp, College Station, TX). Descriptive statistics were then used to analyze continuous and categorical survey variables. Pearson's correlation (r) and Bland-Altman plots were used to robustly analyze correlation and agreement between objective and self-reported SB measures (significance was set at $P < 0.05$).[36] Bland-Altman plots were derived by plotting the difference between objective SB (A) and subjective SB (B) measures (i.e. A-B) versus the mean of both SB measures (i.e. A+B/2). Average underreporting of SB was determined by taking the average difference between objective SB (A) and subjective SB (B) measures (i.e. A-B).

Qualitative Data Analysis

A four-member coding team employed inductive thematic coding to analyze qualitative themes from exit interviews. The coding team followed general principles of thematic analysis posited by Braun and Clarke.[37] In the first phase, team members reviewed four transcripts and created an initial codebook with definitions. Credibility of the initial codebook was determined by reconciling codes among the team. During the second phase of analysis, teams of two researchers independently coded remaining transcripts and reconciled codes with one another. The codebook was collaboratively updated throughout the coding process. Coded transcripts were then entered into Atlas.ti version 7.0 to assist with identification of themes related to SB.

Results

Objective and Subjective Sedentary Behavior

Participant characteristics are summarized in Table 1. A total of 15 participants were included in the analysis. One participant dropped out and two were excluded from analysis due to insufficient survey or device data. Men were predominantly white (93.3%), with a mean age of 77.4 (±7.5) and mean BMI of 27.4 (±3.1). The majority of participants (67.7%) had a college degree or higher. Nearly half of the participants (53.3%) reported two or more health conditions (diabetes, heart disease, high blood pressure, high cholesterol, or arthritis) and 20% of participants reported a fall in the past six months.

Self-reported SB and objective SB data are described in Table 2. On average, participants wore ActivPAL devices for six days (±0.6), for an average of 14.3 hours/day (±1.5). On average participants were found to underreport SB (5.9 hours/day, ±3.1) compared to ActivPAL measured SB (9.6 hours/day, 2.5). The remainder of ActivPAL-measured behavior was spent standing (3.4 hours/day, ±1.7), followed by stepping (1.2 hours/day, ±0.5), which amounted to an average of 4560.3 (±2318.8) steps/day.

Correlation between self-reported and objective SB are described in Table 3 and Figures 1 and 2. Analysis of the Bland-Altman plot indicated disagreement between subjective and objective measures of SB with a high degree of bias. All but two points on the Bland-Altman plot were greater than zero on the y-axis, indicating a tendency towards underreporting subjective SB. This is supported by Bland-Altman analysis of the mean difference between objective SB and subjective SB, which found participants underreported SB by 3.5 hours compared to the ActivPAL measure. Overall, analysis of the Bland-Altman plot showed minimal linear relationship

between subjective and objective measures of SB, as indicated by linear regression with slope of -0.3. This was supported by analysis of the Pearson correlation with r = 0.22 (p = 0.4).

Table 1: Characteristics of Participants

Categorical Variables (n, %)	
N	15
Race	
White	14 (93.3)
Non-Hispanic Black	1 (6.7)
Retired	15 (100.0)
Married	13 (86.7)
Education	
Some College or less	5 (33.3)
College degree or more	10 (67.7)
Health Characteristics	
Diabetes	2 (13.3)
Heart Disease	3 (20.0)
High blood pressure	6 (40.0)
High cholesterol	6 (40.0)
Arthritis	5 (33.3)
2+ conditions	8 (53.3)
Current smoker	0 (0.0)
Continuous Variables (Mean, SD)	
Age	77.4 (7.5)
BMI	27.4 (3.1)

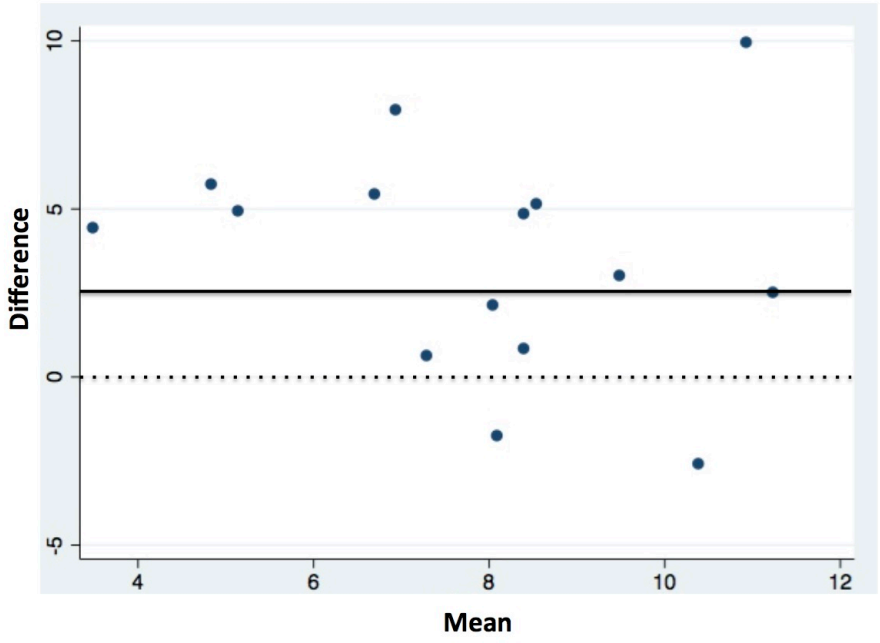
Table 2: Self-reported and Objectively Measured Sedentary Behavior

Continuous Variables (mean hours/day, SD)		
Activity	**ActivPAL SB**	**Self-reported SB**
Waking hours of wear	14.2 (1.5)	--
Days of wear	6 (0.6)	
Sitting	9.6 (2.5)	5.9 (3.1)
Standing	3.4 (1.7)	--
Stepping	1.2 (0.5)	--
Steps/day	4560.3 (2318.8)	--

Table 3: Bland-Altman – Agreement between Objective SB and Subjective SB

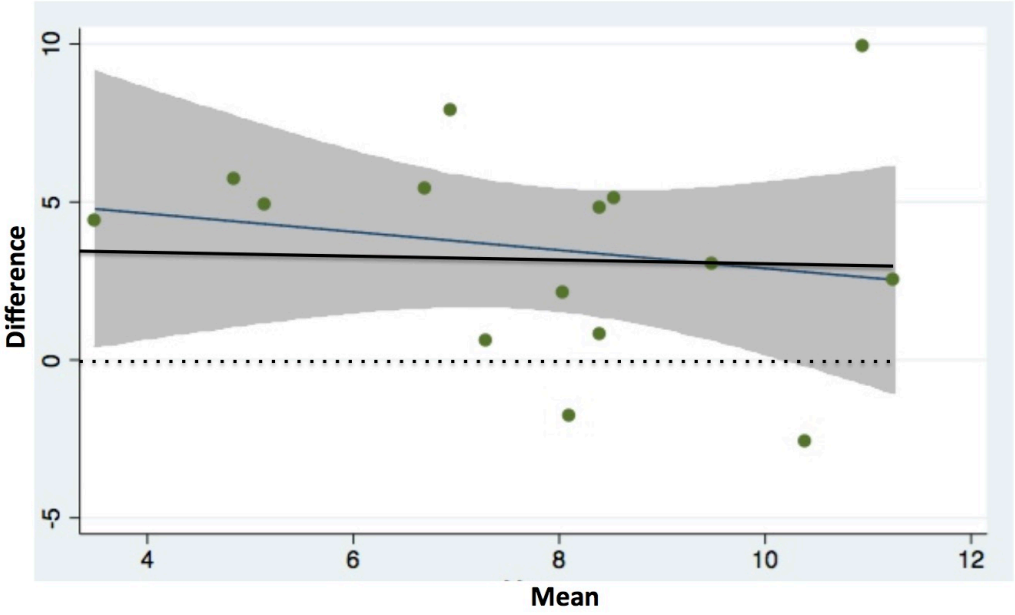
Objective (A)	Subjective (B)	Mean (A+B/2)	Difference (A-B)
9.1	11.7	10.4	-2.6
7.2	9	8.1	-1.8
9.4	4	6.7	5.4
7.6	2.7	5.15	4.9
7.6	7	7.3	0.6
7.7	2	4.9	5.7
11	8	9.5	3.0
11.1	6	8.6	5.1
5.7	1.3	3.5	4.4
10.8	6	8.4	4.8
12.5	10	11.3	2.5
10.9	3	6.95	7.9
8.8	8	8.4	0.8
15.9	6	11.0	9.9
9.1	7	8.1	2.1
Mean			3.5

Figure 1: Bland-Altman Plot - Difference vs. Mean



Bland-Altman plot comparing objective SB to self-reported SB measures. Solid line represents mean difference (3.5 hours).

Figure 2: Bland-Altman Plot – Difference vs. Mean (with confidence intervals & linear regression)



Bland-Altman plot comparing objective to subjective SB measures. Solid black line represents mean difference (3.5 hours). Linear regression y = -0.3x + 5.79

Exit Interviews

In coding exit interviews, three predominant themes emerged: barriers to decreasing SB, facilitators for increasing SB, and perceptions of current SB. Results from the qualitative analysis are described in Table 4.

Barriers to decreasing Sedentary Behavior

Participants commonly described barriers that prevented them from decreasing time spent sedentary. These included health issues, enjoyment of sedentary activities, and the need to rest by engaging in sedentary activities. Health-related barriers were not exclusively prostate cancer-related, but included chronic disease (e.g. arthritis) and aging-related pain. For example, participants 14 and 5 reported:

Participant 14*: Based on the treatment, [SB] may vary…every two or three months. You may switch treatments and your whole physical abilities have changed…Sometimes when I feel good I'm very enthusiastic about activity. When you're not, you're quite sedentary.*

Participant 5*: I was not particularly surprised by how much time I spend sitting down. I'm 69 years old, and so I've got osteoarthritis in my knees…for me, standing and walking can be uncomfortable.*

Participants commonly mentioned sedentary activities as being pleasurable and distracting. As such, personal valuation of sedentary activities was seen as a barrier to reducing SB. Pleasurable sedentary activities included watching television, using the computer, reading, and playing games. For example:

Participant 4: *I spend probably too much time on the computer because I enjoy my computer. Yeah, I do.*

Facilitators for Decreasing Sedentary Behavior

While the majority of participants described barriers to decreasing SB, a number of participants discussed what motivated them to reduce SB and reasons they were trying to reduce SB. Such participants commonly expressed that being aware of their sedentary time motivated them to take breaks from sitting or incorporate light PA into their daily lives (e.g. walking, stretching). For example, participant 7 reported:

Participant 7: *…I just have to try to be more conscious to get up from the television. That's the thing that probably causes most sitting and maybe a little bit on the computer. I don't sit all day with that.*

Additionally, participants described health as a motivation for reducing SB (e.g. decreased stiffness). For example, participants 15 and 2 reported:

> ***Participant 15:*** *I can't sit for a long time. I get up and then my hip is…tightened up and it's painful to walk until I take a few steps and walk it out. Then once I start moving around it…goes away a little bit…Sitting down for a long time, it's just painful.*

> ***Participant 2:*** *I take breaks. I get tired of sitting, and I get up and move around…*

Perceptions of Sedentary Behavior

Participants commonly discussed perceptions of SB. Many explained that they were unaware of their daily sedentary time and were surprised by results from the feedback report. For example, participant 12 reported:

> ***Participant 12:*** *I was just kind of alarmed that I was standing – or sitting so much during the day.*

However, newfound awareness of sedentary time did not universally motivate participants to reduce SB. For example:

> ***Participant 4:*** *I notice I did more sitting than I thought I did…But I'm not going to change it because I have to sit. They took a pound and three-quarters out of my left thigh, muscle and tumor.*

Participants who perceived their sedentary time as low commonly described normal daily activities that involved a high degree of sitting (i.e. running errands by car, watching television). For example, participants 1 and 3 reported:

Participant 1: *I'm not very sedentary – well, I'm retired, so I guess I am sedentary. But when I don't have pain and I'm not limited by the energy that I have from my treatment, I'm quite active. You know, walks every day, go to the gym, all those things.*

Participants 3*: Oh, a usual week, I'm gone all the time. I'm always out running around here, there and everywhere. I've spend very little time sitting or doing nothing, you know, except when I'm at the computer working, but most I'm going.*

Table 4: Exit Interviews - Perceptions of SB by Theme and Subtheme

Theme	Subtheme	Participants Quoted	Quote
Barriers to decreasing SB	Health	**1, 4, 5, 8, 14**	**1:** My situation is if I did not have pain, I would be active enough…when I don't have pain and I'm not limited by the energy that I have from my treatment, I'm quite active. You know, walks every day, go to the gym, all those things. **5**: I was not particularly surprised by how much time I spend sitting down. I'm 69 years old, and so I've got osteoarthritis in my knees…for me, standing and walking can be uncomfortable…I can't say that I ever asked or tried to find out what sitting and standing hours are good for me. **14**: Based on the treatment, you feel – it may vary based on every two or three months. You may switch treatments and your whole physical abilities have changed…Sometimes when I feel good I'm very enthusiastic about activity. When you're not, you're quite sedentary.
Barriers to decreasing SB	Value SB Activities	**3, 4, 16, 10, 15**	**10:** I like puzzles. I put puzzles together to occupy my time. It really takes my mind off of everything and I concentrate on putting puzzles together.

			4: Oh yeah. That's part of my sedentary time. I spend probably too much time on the computer because I enjoy my computer. Yeah, I do.
Barriers to decreasing SB	Physical activity	**11**	**11:** "When I get up in the morning I get these exercises. After my exercises I feel great. But, it's during the day if I sit down to watch TV, I fall asleep."
Facilitators for Decreasing SB	Health	**2, 15**	**15:** "I try to get up. Every time there's a commercial on, I just get up…because I get so stiff…[Breaks are] a few minutes just to maybe run to the bathroom or go to the kitchen. [I use] my watch [to take a break] about [every] half hour probably."
Facilitators for Decreasing SB	Awareness of SB	**7, 13, 15**	**7**: …I just have to try to be more conscious to get up from the television. That's the thing that probably causes most sitting and maybe a little bit on the computer. I don't sit all day with that. **15:** Well, I'd have to think about that a little more frequent when I'm sitting and reading or watching television…
Perception about current SB	Perceived SB as low prior to study	**4, 12, 13, 14**	**13**: I was kind of surprised that the amount of sitting time I was doing might take at least eight hours a lot of the time and you can't spend your whole day standing up...Since I've retired and I haven't done that since early 2012, that's gotten me into a longer sitting time. So, that measurement was kind of an eye opener for me. **14:** …I was pretty much overwhelmed by the inactivity part of it...You look at it and say, well, I didn't do anything this week and kind of let it pass at that.
Perception about current SB	Currently perceive SB as low	**1, 3, 7**	**1:** I'm not very sedentary – well, I'm retired, so I guess I am sedentary. But when I don't have pain and I'm not limited by the energy that I have from my treatment, I'm quite active. You know, walks every day, go to the gym, all those things. **3**: Oh, a usual week, I'm gone all the time. I'm always out running around here, there and everywhere. I've spend very little time sitting or doing nothing, you know, except when I'm at the computer working, but most I'm going.

Discussion

Results indicate that participants spent a significant amount of their day sedentary and consistently underreported SB. High amounts of SB may be due to impaired health (age and cancer-related), lack of awareness, or a high value placed on sedentary activities. High bias found from the Bland Altman Plots indicated that the two methods for measuring SB systematically produced different results, with little to no correlation. Low Pearson's correlation coefficient supported these findings, indicating there was no linear relationship between objective and subjective measurements. Overall, disagreement between self-reported and objectively measured SB indicated poor validity of the single-item SB question as compared to the objective measure of SB.

Differences in perceptions of SB versus actual SB may be due to lack of awareness, misconceptions about active versus sedentary activities or social desirability bias. Overall, high levels of SB suggest that SB is a target worthy of intervention among this population. However, subjective methods for measuring SB should be used and interpreted cautiously due to poor validity and potential for exposure misclassification among men using ADT.

Though sedentary time among this population was high, it was consistent with objectively measured sedentary time in men with prostate cancer (no ADT use) and men 70-85 years old within the general population. Lynch et al. found that men with a history of prostate cancer (mean age 75.4) spent 69% of their day sedentary, comparable to our findings of 67.5% among men with prostate cancer and a history of ADT use.[30] Studies of sedentary time by Evenson et al. and Matthews et al. found that men over 70 years spent 8.8-9.4 hours and 9.52 hours per day sedentary, respectively.[38, 39] These results are consistent with our findings in which participants spent 9.6 hours per day sedentary. These findings together suggest that a history of prostate

cancer and ADT use may not be the lone force responsible for high levels of sedentarism among men over 70 years old. This is supported by our findings, whereby participants commonly mentioned non-cancer-related health issues as contributors to high SB and half of all participants had two or more chronic conditions. Considering that the median age at diagnosis for prostate cancer is 66 years[40], it is plausible that poor general health (cancer-related or not) and physical limitations related to aging may collectively contribute to increased sedentary time among this population. Further investigation into the underlying reasons for high SB may help researchers tailor SB interventions to accommodate the needs and limitations of this population.

In comparing accelerometer measures of SB to a self-reported single-item SB question, our findings suggest that men with prostate cancer and a history of ADT use commonly underreport sedentary time. In fact, there was high bias and low correlation between perceived SB and objective SB. Based on qualitative data, it is likely that many men are simply not cognizant of time spent sedentary or are not aware that common activities (i.e. running errands) are largely comprised of sedentary activities. These findings are consistent with similar studies comparing ActivPAL measures of SB to a single-item question about SB. Chastin et al. found that adults (mean age 41) tended to underestimate sedentary time by 2.2-4.6 hours/day.[41] Aguilar-Farías et al. found that older adults (mean age 74.5) underreported sedentary by approximately 3 hours/day.[42] Results from the present study, in which participants unreported sedentary time by 3.5 hours, are consistent with these findings.

Studies comparing ActivPAL measures of SB to more sophisticated subjective measures of SB, such as domain-specific or interval-based have found better agreement between objective and subjective measures of SB. When comparing ActivPAL SB to 24 hour-recall using a complex

series of subjective SB questions, called MARCA, Aguilar-Farías et al. found moderate correlation and low mean bias.[42] Hart et al. found no significant difference between more complex "BAR" SB questions versus ActivPAL-measured sedentary time.[43] However, results from the Hart et al. study should be compared cautiously due to significant differences in the populations studied (mean age 29.1). Findings from the Aguilar-Farías et al. study, in which the age of participants is more reflective of the present study, suggest that sophisticated, subjective tools (MARCA) may offer a more valid, cost-effective measure of SB and reduce the risk of exposure misclassification associated with a single-item SB question in older populations of men.

Initially this studied aimed to include analysis of domain-specific questions about sedentary time. However, the large extent of non-responses to domain-specific questions led us to exclude this data from analysis. Studies of domain-specific questions in older populations may offer insight into the difficulties of self-reporting SB in older adults. A study by van Uffelen et al. found that older adults were commonly confused by questions referring to "leisure time activities" and "sitting activities" and that participants had trouble determining where to place sedentary activities that were not explicitly described in domain-specific questions (e.g. eating) or that were only done occasionally (e.g. going to the theater).[44] Furthermore, van Uffelen et al. found that participants had difficulty recalling SB because it was fragmented throughout the day or inconsistent between days.[44] Results from this study may elucidate why participants frequently did not answer our domain-specific question, "how long did you usually spend in other leisure pursuits while sitting down". Additionally, it is consistent with our qualitative findings that participants were frequently unaware of their SB and had not considered it prior to the study. As such, further research into the validity of domain-specific or interval-based SB tools in this population could improve the results of future studies of SB in this population.

Though the present study should be evaluated in the context of several limitations. As a formative study, the sample size was small, with predominantly white participants recruited through convenience sampling. These issues limited us to descriptive analysis and prevented us from drawing associations or causal relationships between variables. Though objective SB was measured over an average 6 days and subjective SB was measured over 7 days, analysis of data was not standardized to the same time period. It is possible that this may have impacted the overall results. However, as the difference between measurements was nominal, the likelihood of results significantly differing was low. Additionally, missing domain-specific SB data limited the breadth of our comparative analysis. Finally, discordance between self-reported and objectively SB may have been affected by our measurement tools. ActivPAL does not differentiate between sitting and reclined positions, however the single-item SB question referred only to sitting, not sleeping/napping habits.

Despite these limitations, this is the first study to compare objective and subjective measures of SB among this population. Employment of mixed methodology lends greater robustness to the quantitative results; offering insight into why subjective perceptions of SB may have varied considerably from objective measures. Additionally, use of ActivPAL to measure SB further strengthens the findings of this study, as ActivPAL is considered the gold standard for measuring SB.

Overall this study, illustrated that men with prostate cancer and a history of ADT consistently underestimated their SB and frequently expressed that they were surprised by the amount of time they spent sedentary. While participants were overwhelming interested in reducing their sedentary time, health reasons, lack of awareness, and enjoyment of sedentary activities presented significant barriers to reducing sedentarism. Considering that cancer survivors

frequently do not meet PA recommendations and that the majority of participants in this study were interested in reducing their sedentary time, interventions focused on reducing SB may be an efficacious way to reduce health risks associated with ADT use. Furthermore, conversations about physical activity and health that include a discussion about sedentary time may increase awareness about individual sedentary time. Overall, this approach may prove to be more feasible than PA interventions, especially in a population that is older and in poorer physical health than other populations.

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