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Sitting Time, But Not Level Of Physical Activity, Is Associated With Depression In Methadone-Maintained Smokers

Michael D. Stein, M.D.[a,b], **Celeste M. Caviness, M.A.**[a], **Bradley J. Anderson, PhD**[a], and **Ana Abrantes, PhD**[a,b]

[a]General Medicine Research Unit, Butler Hospital, Providence, RI, 02906

[b]Warren Alpert Medical School of Brown University, Providence, RI, 02912

Abstract

Problem—Sedentary behavior has been linked to many physical and mental health disorders including heightened risk for depression. Methadone-maintained individuals are at increased risk for depression and have been shown to be physically active at lower rates than the general population.

Method—We assessed the relationship between sitting time, physical activity, and depression in a group of 315 methadone-maintained smokers.

Results—Mean participant age was 39.9 years of age, 49.5% were male, and 79.4% were non-Hispanic White. The mean time reported sitting each day was 320.4 minutes and the mean CES-D depression score was 12.0. After controlling for background characteristics, physical function, and physical activity, depression was significantly and positively related to sitting time.

Conclusion—Interventions to decrease time spent sitting and increase physical activity could have important benefits for the mental health of methadone-maintained individuals. This population is often underserved and suffers disproportionately from limited physical and mental health functioning, making them an ideal population for low-cost interventions to reduce sitting time and/or increase physical activity to improve well-being.

Keywords

Methadone; exercise; sedentary; depression

Introduction

Levels of physical activity and sedentary behaviors are conceptually distinct and not always associated empirically (Biddle, Gorely, Marshall, Murdey, & Cameron, 2004; Ekelund, et al., 2006). Physical activity has many important health benefits, including decreased risk of chronic disease and premature mortality (W. J. Brown, Burton, & Rowan, 2007; Haskell, et al., 2007; Kruk, 2007; Sieverdes, et al., 2012; Warburton, Nicol, & Bredin, 2006).

Corresponding Author: Michael D. Stein, M.D., Professor of Medicine & Community Health, General Medicine Research Unit, Butler Hospital, 345 Blackstone Blvd., Providence, RI 02906, Telephone: 1-(401) 455-6646, FAX: 1-(401) 455-6618, Michael_Stein@brown.edu.

Conversely, the absence of physical activity increases risk of cardiovascular disease, hypertension, diabetes mellitus, obesity, osteoporosis, colon cancer, and psychiatric disorders (Blair, LaMonte, & Nichaman, 2004; Haskell, et al., 2007; Sieverdes, et al., 2012). Sedentary behaviors, defined here as activities that require little energy expenditure and are done while either sitting or lying down (Sedentary Behaviour Research, 2012), are related to health, morbidity, and mortality, independent of the level of moderate-to-vigorous physical activity (Ford & Caspersen, 2012; Rhodes, Mark, & Temmel, 2012; Tremblay, Colley, Saunders, Healy, & Owen, 2010).

We have recently found that only 38% of methadone maintenance treatment (MMT) patients met American Heart Association weekly exercise recommendations, and nearly 25% reported no physical activity (Caviness, Bird, Anderson, Abrantes, & Stein, 2012). Methadone, administered daily through outpatient clinics, is a synthetic opiate used in the replacement therapy for opioid dependence. Methadone maintenance treatment has been shown to be an effective treatment for reducing illicit drug use, drug craving, withdrawal symptoms and retaining individuals in treatment (Mattick, Breen, Kimber, & Davoli, 2009), thereby reducing negative social consequences (such as drug seeking, crime, risky behavior; Center for Substance Abuse Treatment, 2005). In keeping with their low levels of physical activity, methadone patients are at increased risk for diabetes mellitus, hypertension, coronary artery disease, chronic pain, sleep complaints, and other health related co-morbidities (Cullen, O'Brien, O'Carroll, O'Kelly, & Bury, 2009; Fareed, Casarella, Amar, Vayalapalli, & Drexler, 2009; Mertens, Lu, Parthasarathy, Moore, & Weisner, 2003; Sharkey, et al., 2011; Stein, et al., 2004). In addition, nearly 90% of MMT participants smoke cigarettes, heightening their cardiovascular risk (Best, et al., 1998; Clarke, Stein, McGarry, & Gogineni, 2001; Demarie, et al., 2011; Teichtahl, et al., 2004). Methadone maintenance patients perceive their health to be worse than the general population (Millson, et al., 2004).

Compared with the general population, psychiatric comorbidity, specifically anxiety and depression, also occurs at higher rates in drug dependent individuals (Kandel, Huang, & Davies, 2001). Among opioid-dependent individuals, clinical studies suggest that about half report lifetime depression (Brienza, et al., 2000), and nearly one-third have depressed mood at treatment intake (Rounsaville, Weissman, Kleber, & Wilber, 1982).

The relationship between levels of physical activity and depression has been well-documented in cross-sectional studies as well as exercise intervention studies (Teychenne, Ball, & Salmon, 2008). But the relationship between sedentary behaviors and mental health functioning remains understudied. In a recent systematic review, Teychenne, Ball, & Salmon, (2010b) reported a positive association between sedentary behaviors and risk for depression in all 7 observational studies reviewed. In a large population-based study (the SUN Cohort Study, n=10,381) conducted in Spain, investigators found that ≥42 hours/week of television viewing was associated significantly with an increased likelihood of being diagnosed with a mental disorder such as depression or anxiety (Sanchez-Villegas, et al., 2008). In another multi-site, naturalistic cohort study conducted in the Netherlands, after controlling for general level of physical activity, time spent using a computer was predictive of a diagnosis of Major Depressive Disorder, while time watching television was predictive of an anxiety disorder (de Wit, van Straten, Lamers, Cuijpers, & Penninx, 2011). In the United States, accelerometer data from the National Health and Nutrition Examination Survey (NHANES) revealed that among overweight/obese adults, higher levels of sedentary behaviors was associated with increased risk for depression (Vallance, et al., 2011). Particularly concerning is recent data obtained from the Cardiovascular Health Study (CHS) conducted with Americans aged 65 above where after adjusting for multiple heart disease risk factors (such as age, race, gender, BMI, cholesterol, blood pressure, and diabetes), a

sedentary lifestyle alone accounted for 25% mortality risk among those who were depressed (Win, et al., 2011).

The purpose of this study was to assess whether sedentary behavior, specifically time spent sitting, is associated with depressive symptoms in MMT patients. We hypothesize that depression will be related to time spent sitting, above and beyond what can be explained by physical health limitations and general physical activity level. Empirical support for this hypothesis will give added impetus to creating interventions to reduce sitting time in this population.

Methods

Participants

Study recruitment took place at nine methadone maintenance treatment (MMT) sites throughout Southern New England. Participants were screened for a smoking cessation intervention trial. Study eligibility included: currently a smoker (≥10 cigarettes per day); enrollment in methadone treatment for at least four weeks; no current (less than two weeks ago) use of pharmacotherapy for smoking cessation; absence of bipolar disorder, schizophrenia, or suicidal ideation; non-pregnant; no recent seizures, psoriasis, dialysis, recent heart problems (study medication contraindications), and the ability to complete the study interviews in English. The study protocol was approved by the Butler Hospital Institutional Review Board.

Between December 2008 and May 2011, 760 individuals were screened for the study. Of those, 246 were ineligible. The most common reasons for study ineligibility were self-reported history of bipolar disorder (n=138) or exclusionary medications (n=63). A total of 514 individuals were eligible for the study, and one hundred ninety three did not attend the initial appointment to enroll; 321 enrolled in the protocol. After written, informed consent, an additional 6 were excluded, most often for not completing the baseline visit. The final sample consisted of 315 participants. All participants completed a 45-minute baseline interview assessment. Baseline data were used in the current analysis.

Baseline Measures

Physical activity—Participants were asked to recall their physical activity levels for the previous 7-days using the Short Version of the International Physical Activity Questionnaire (IPAQ), a valid and reliable measure (Craig, et al., 2003). Participants received broad definitions of “vigorous” and “moderate” exercise to help self-report accuracy. For each type of physical activity, participants were asked to recall on how many days they performed at least 10 minutes of the specific physical activity type and to report the average number of hours and minutes they engaged in those activities. Participants were defined as meeting minimum recommended guidelines for moderate activity if they reported a minimum of 30 minutes of moderate exercise on at least 5 days per week, or if they reported vigorous exercise for a minimum of 20 minutes on 3 or more days / week. This is consistent with the defined “moderate” activity level scoring for the IPAQ. Participants were also asked how much time they spent sitting on a typical day; this was coded as average minutes sitting per day. Physical activity was used as a categorical, instead of continuous variable due to the nature of participants’ response patterns. When compared to accelerometer data, the IPAQ has shown fair to moderate agreement, however, when the IPAQ is scored categorically, four fifths of individuals’ physical activity levels were similarly classified on both the IPAQ and objective accelerometer data (Craig, et al., 2003). Time spent sitting from the IPAQ has been used as an index of sedentary behaviors and found to be associated with varied health-risk biomarkers (Celis-Morales, et al., 2012).

Depression—Participants were asked to answer the 10 item Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977). Participants rated how often they had experienced each mood related event on a scale from Rarely (0) to Most Days (3). Possible scores ranged from 0–30, with higher scores indicative of more severe depression. Scores above ten are considered positive screens for depression (Zhang, et al., 2012). The CES-D has been used extensively across a wide variety of populations and is a valid and reliable measure (Irwin, Artin, & Oxman, 1999; Knight, Williams, McGee, & Olaman, 1997; Radloff, 1977; Thombs, Hudson, Schieir, Taillefer, & Baron, 2008).

Health Related Quality of Life—Participants completed the 12-item Short-Form Health Survey (SF-12; Ware, Kosinski, & Keller, 1996). The SF-12 has good reliability and validity (Ware, et al., 1996), and this remains true across diverse populations (Larson, 2002; Larson, Schlundt, Patel, Beard, & Hargreaves, 2008). Function scores were generated for the physical health component and used in the analysis.

Baseline Characteristics: Assessed demographic characteristics included age, race/ethnicity, gender, years of education, and employment status.

Analytical Methods

We present descriptive statistics to summarize the characteristics of the study cohort. Zero-order correlations are presented to briefly summarize the bivariate associations between CES-D scores, demographic characteristics, SF-12 physical function scores, and time spent sitting. Ordinary Least Squares (OLS) regression was used to estimate the adjusted associations between predictor variables and CES-D. All continuous variables were standardized to 0 mean and unit variance prior to analysis; coefficients for continuous predictors were fully standardized and those for categorical predictors were y-standardized. Tests of significance and 95% confidence interval estimates were based on the Huber-White variance estimators that are robust to heteroskedasticity. To determine if the effect of time spent sitting on CES-D scores was conditional on activity level we extended the regression model to include the first-order time sitting by activity level interaction. Prior to multivariate analysis, we evaluated the linearity of the association between time spent sitting and CES-D depression scores by using the nlcheck (Jann, 2008) procedure which runs under Stata (StataCorp, 2010). This procedure conveniently bins continuous predictor variables into k discrete categories, creates k-1 dummy variables, and compares the fit of the more complex model with k-1 dummy indicators to the more parsimonious linear prediction model. A significant F-test indicates the more complex model fits the data better than the linear prediction model. To assess the assumption of linearity, we compared the fit of the linear model to models treating time spent sitting as 3-, 5-, and 7-discrete categories.

Results

Participants averaged 39.9 (± 9.6) years of age, 156 (49.5%) were male, 250 (79.4%) were non-Hispanic Caucasian, 8 (2.5%) were African-American, 38 (12.1%) were Hispanic, and 19 (6.1%) were of other ethnic or racial origins (Table 1). Indicator variable contrasting non-Hispanic Caucasians to all racial and ethnic minorities was used in all subsequent analyses. Mean educational attainment was 11.8 (± 2.1) years and 68 (21.7%) were employed either partor full-time. Mean SF-12 physical function and CES-D scores were 44.5 (± 11.3) and 12.0 (± 6.3), respectively; 121 (38.4%) met minimum recommended guidelines for moderate or vigorous exercise. The mean time reported sitting each day was 320.4 (± 257.3) minutes. The distribution of time spent sitting day was positively skewed; the median, 25th, and 75th percentiles were 240, 120, and 420 minutes per day, respectively. Mean minutes spent

sitting per day was significantly (t_{313} = 2.90, p = .004) higher (353.3, ± 280.5) among those who did not meet minimum exercise guidelines than among those who did (267.7, ± 205.4).

Zero-order correlations are presented in Table 2. Non-Hispanic Caucasians had significantly (r = −.11, p < .05) lower CES-D scores than ethnic or racial minorities. CES-D scores were inversely associated with educational attainment (r = −.21, p < .01), with being employed part-or full-time (r = −.19, p < .01), and with SF-12 physical function scores (r = −.30, p < .01), and positively associated with time spent sitting per day (r = .21, p < .01). CES-D scores were not associated significantly with meeting recommended minimum exercise guidelines. We also note that persons who were employed full- or part-time reported significantly fewer minutes of sitting per day (r = −.24, p < .01) and that minutes sitting per day was inversely associated with SF-12 physical function scores (r = −.17, p < .01). To determine if the effect of time spent sitting was conditional on activity level we extended the model by including the first order interaction term; the effect of time spent sitting did not differ significantly by level of activity (b = −.13, t = −1.07, p = .287).

Controlling for background characteristics, physical function as measured by the SF-12, and reporting moderate or vigorous exercise, CES-D depression scores were significantly and positively associated with time spent sitting (b = .16, 95%CI .05; .27, p < .01) (Table 3). The adjusted association between CES-D scores and time spent sitting was approximately linear; models evaluating 3-category (F2,304 = 1.02, p = .364), 5-category (F4,302 = 1.80, p = .128), and 7-category (F6,300 = 1.57, p = .155) discrete indicators of time spent sitting did not fit the observed data significantly better than the linear model. Adjusting for all other covariates in the prediction model (Table 3), CES-D was inversely associated with educational attainment (b = −.18, 95%CI −.28; −.07, p < .01) and with SF-12 physical function scores (b = −.23, 95%CI −.35; − .12).

Discussion

In this population of methadone-maintained smokers, time spent sitting was significantly and positively associated with our measure of depression after controlling for physical functioning, physical activity level, and other health related factors. This finding is consistent with previous studies which have linked sedentary behavior, such as sitting time, to depression (Geulayov, Goral, Muhsen, Lipsitz, & Gross, 2010; Proper, Picavet, Bemelmans, Verschuren, & Wendel-Vos, 2012; Sund, Larsson, & Wichstrom, 2011; Teychenne, Ball, & Salmon, 2010a; Teychenne, et al., 2010b; Vallance, et al., 2011). High levels of sitting time have been associated with the development of depression in adolescent boys (Sund, et al., 2011), and poorer mental health in Dutch adults (de Wit, et al., 2011; Proper, et al., 2012). Additionally among women living in disadvantaged neighborhoods in Australia, those spending the most time per week sitting at a computer or in front of a television had the highest risk of depression (Teychenne, et al., 2010a).

The direction of causality between depression and sedentary behavior cannot be determined by our data. Another limitation of the current study is the lack of specific information regarding the activities persons were engaged in while sitting. It may be that time spent sitting while watching television has different effects on mood than time spent sitting while engaged in conversation with friends or colleagues. Perhaps time spent sitting is a marker not only for low levels of physical activity, but also for low levels of engagement in things that challenge and stimulate one’s mind. With fewer than a quarter of study participants employed, depressive symptoms were not unexpected. But the inverse relationship of depression to employment is of special interest here. Employed persons may not only experience greater “mental activity” than the unemployed, but part or full-time employed study participants also reported significantly fewer minutes of sitting per day, suggesting

that the widening of employment opportunities might serve as a potent form of activation for this population.

Several additional limitations should be noted. First, this study recruited methadone maintained individuals for a smoking cessation trial. While 80–90% of those in MMT smoke cigarettes (Nahvi, Richter, Li, Modali, & Arnsten, 2006; Richter, Gibson, Ahluwalia, & Schmelzle, 2001), these results may not generalize to those who do not smoke, receive an alternative form of opioid treatment, or to those with other substance use disorders. Smoking may make it more difficult for some individuals to engage in physical activity, which may have impacted the results. Second, our physical activity data were collected by self-report, potentially introducing recall error and bias. There is some evidence that physical activity is overestimated when using the IPAQ (Lee, Macfarlane, Lam, & Stewart, 2011), and it is possible that people underestimate time spent sitting. Finally, our study sample may not generalize to other MMT populations outside of Southern New England with different gender, racial, and ethnic profiles.

Interventions to reduce sedentary behaviors and those to increase physical activity are conceptually distinct (Owen, et al., 2011), However, we note that while the first-order interaction between time spent sitting and physical activity was not significant statistically, directionally the association between time spent sitting and depression was stronger among those not meeting recommended criteria for moderate exercise than among those with higher activity levels. Our study was not explicitly designed to test this hypothesis and may lack sufficient power to detect potentially important interactions at conventionally accepted Type I error rates. This may be a fruitful line of investigation for future research. In the current study, depression was also significantly associated with decreased physical functioning. It is possible that interventions to decrease sedentary behavior, and increase physical activity could address not only depression, but also improve physical function. Physical activity reduces the risk of cardiovascular problems (W. J. Brown, et al., 2007; Kruk, 2007; Warburton, et al., 2006), cancers (W. J. Brown, et al., 2007; Kruk, 2007; Warburton, et al., 2006), and diabetes (W. J. Brown, et al., 2007; Kruk, 2007) and has also been shown to improve sleep (Passos, et al., 2011; Reid, et al., 2010), all medical problems highly prevalent in this population (Cullen, et al., 2009; Fareed, et al., 2009; Mertens, et al., 2003; Sharkey, et al., 2011; Stein, et al., 2004). Additionally, preliminary exercise interventions have shown promise in addressing drug and alcohol misuse (R. A. Brown, et al., 2009; R. A. Brown, et al., 2010; Buchowski, et al., 2011; Weinstock, Barry, & Petry, 2008), which is of special import to the population studied here. Finally, in a web-based study designed to encourage physically inactive individuals to engage in physical activity, the treatment group showed significant improvements in depression symptoms compared with controls (Irvine, et al., 2011), and New Zealand general practitioners believe that prescribing exercise is an important way to manage depression in their patients (Patel, Schofield, Kolt, & Keogh, 2011). Further research is needed to determine if the effect of being sedentary is purely due to the lack of physical activity or if the effect is specific to the types of activities in which people are engaged while sitting.

Interventions to encourage the minimization of sedentary behavior and an increase in physical activity could be brief, delivered by a medical provider or substance abuse counselor following a motivational interviewing or 5A’s framework (Fiore, Jaen, & Baker, 2008). Alternatively, methadone clinic physicians could write exercise “prescriptions” for their patients (Patel, et al., 2011) and their progress could be tracked monthly at counseling appointments. Additionally, interventions would also need to address strategies and methods to decrease sedentary behaviors as well as increase physical activity as both may be necessary to improve functioning. These interventions could include behaviors as simple as

getting up during commercial breaks while watching television, or going for a walk while talking on the telephone instead of sitting down (Owen, et al., 2011).

We believe these results add to the important and growing body of literature linking sedentary behavior, such as sitting time, with adverse physical and mental health outcomes. With nearly 300,000 individuals enrolled in MMT programs at any given time in the United States (Substance Abuse and Mental Health Services Administration, 2011), MMT treatment provides a unique opportunity to intervene in an underserved and vulnerable population with highly prevalent physical and mental problems. Routine counseling and doctor visits are part of standard methadone maintenance care, and interventions to reduce sitting time and/or increase physical activity could be a cost-effective and impactful way to improve the health and well-being of this population.

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- Cross-sectional sample of 315 methadone maintained cigarette smokers
- Assessed the relationship between sitting time, physical activity, and depression.
- After accounting for demographics, physical function, and activity level, depression was significantly and positively related to sitting time.
- Further research on physical activity interventions and interventions to reduce sitting time to improve well-being in methadone patients is warranted.

Table 1

Background Characteristics (n = 315).

	Mean (± SD) or n (%)
Years Age	39.9 (± 9.6)
Gender (Male)	156 (49.5%)
Race/Ethnicity	
Non-Hispanic Caucasian	250 (79.4%)
African-American	8 (2.5%)
Hispanic	38 (12.1%)
Other Ethnic Minority	19 (6.0%)
Education Attainment (Years)	11.8 (± 2.1)
Employed (Yes)	68 (21.7%)
PCS (SF-12 Physical Functioning)	44.5 (± 11.3)
CES-D (Depression)	12.0 (± 6.3)
Moderate or Vigorous Exercise (Yes)	121 (38.4%)
Minutes Sitting /Day	320.4 (± 257.3)

Table 2

Zero-Order Correlations (n = 315).

	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. CES-D	1.00								
2. Years Age	.10	1.00							
3. Male Gender	−.06	−.03	1.00						
4. Non-Hispanic Caucasian	−.11*	−.06	.03	1.00					
5. Years Education	−.21**	.12*	.05	.11*	1.00				
6. Employed (Yes)	−.19**	−.16**	.18**	.10	.11*	1.00			
7. SF-12 Physical Function	−.30**	−.27**	.04	.11	.12*	.22**	1.00		
8. Moderate+ Exercise (Yes)	−.04	−.05	.08	.05	.08	.17**	.18**	1.00	
9. Minutes Sitting / Day	.21**	.06	−.07	.03	−.02	−.24**	−.17**	−.16**	1.00

* p < .05,

** p < .01

Table 3

Linear Regression Model Estimating the Adjusted Effect of Time Sitting /Day on CESD Depression (n = 315).

Predictor	CESD b[a] (95% CI)[b]
Years Age	.03 (−.07; .14)
Gender	−05 (−.25; .16)
Ethnicity (Caucasian)	−16 (−.44; .12)
Educational Attainment	−18** (−.28; −07)
Employed (Yes)	−18 (−.43; .07)
SF-12 Physical Function	−23** (−.35; −12)
Moderate+ Activity (Yes)	.13 (−.08; .34)
Minutes Sitting / Day	.16** (.05; .27)
Intercept	.14
Model Fit	R^2 = .168 $F_{8,305}$ = 9.91, p < .001

* p < .05;

** p < .01

[a] Coefficients for continuous predictors are fully standardized, coefficients for categorical predictors are y-standardized.

[b] Confidence interval estimates and tests of significance are based on robust (Huber-White) variance estimators