



Physical activity and sleep: Day-to-day associations among individuals with and without bipolar disorder



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ABSTRACT

Objective: To evaluate the relative role of psychopathology in the relationship between physical activity and sleep, the present study investigated the day-to-day relationship between physical activity and sleep in individuals without a psychiatric disorder and individuals with bipolar disorder using a longitudinal, naturalistic design.

Method: Participants in two groups—a healthy group with no psychiatric illness ($N = 36$) and an inter-episode bipolar disorder group ($N = 32$)—were studied over a two-month period. Physical health was assessed by the SF-36. Daily subjective and objective measures of physical activity and sleep were collected. A total of 6670 physical activity measurements and 6548 sleep measurements were logged.

Results: The bipolar disorder group exhibited poorer physical health on the SF-36 and more sleep disturbance relative to the healthy group. No group differences were found in physical activity, nor in models examining the relationship between physical activity and sleep. Hierarchical linear models indicated that for every standard deviation increase in sleep disturbance (i.e., increased total wake time), there was a three percent decrease in subsequent day physical activity, in both the healthy and bipolar groups. Increased physical activity was associated with improved sleep for participants who reported greater average sleep disturbance.

Conclusions: The results for all participants in the study suggest that reduced physical activity and sleep difficulties may be mutually maintaining processes, particularly for individuals who suffer from poor sleep. Findings also raise the potential importance of targeting physical activity and sleep concurrently in interventions aimed at improving physical and mental health.

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Evidence is accruing for the importance of both physical activity and adequate sleep for physical and mental health. Low levels of physical activity have been linked to a wide range of medical problems (Anzuini, Bastistella, & Izzotti, 2011; Ekelund et al., 2012). Similarly, poor sleep is a risk factor for medical illness and mortality (Mallon, Broman, & Hetta, 2002). There is some evidence for a bidirectional relationship between low levels of physical activity and poor sleep. For example, correlational studies indicate that individuals who sleep less than 8 h per day are more sedentary (Garaulet et al., 2011). In addition, exercise confers benefits for

sleep among healthy individuals (Driver & Taylor, 2000) and can be used as an effective treatment for chronic insomnia (Reid et al., 2010). Prescribed structured exercise improves reported sleep quality, increases total sleep time, reduces pre-sleep anxiety and improves reported quality of life and general mood (Passos et al., 2011). However, there is a dearth of studies on the effects of exercise in a naturalistic setting as opposed to the effects of prescribed or supervised exercise. Moreover, very little research has examined day-to-day associations of these health behaviors even though accumulating evidence suggests that physical activity and sleep are highly variable behaviors within people (e.g., Knutson, Rathouz, Yan, Liu, & Lauderdale, 2007; Maher et al., 2013). Additionally, most of the research on physical activity and sleep has examined cross-sectional or between-person associations. This leaves the question of whether there are unmeasured within-person

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associations that may be helpful in informing strategies to promote health or quality of life in the general population as well as populations who are particularly vulnerable to low physical activity and poor sleep. Hence, the goal of the current study was to prospectively investigate the proposed day-to-day bidirectional relationship between physical activity and sleep in both healthy individuals and individuals for whom both physical activity and sleep are characteristically disturbed; namely, individuals with bipolar disorder.

1. Physical health in bipolar disorder

Like other psychiatric disorders such as major depression and schizophrenia (Harris & Barraclough, 1998), bipolar disorder is a severe and chronic psychiatric illness that is associated with high rates of medical morbidity and premature mortality (Kupfer, 2005; Thompson, Kupfer, Fagiolini, Scott, & Frank, 2006). Medical costs are 2.5 times higher among individuals with bipolar disorder relative to the general population. One influential model by Wolkowitz, Epel, Reus, and Mellon (2010) proposes that the biological stress associated with having a psychiatric illness may result in “accelerated aging” at a cellular level. This cellular damage renders the individual more vulnerable to diseases associated with aging, such as cardiovascular and cerebrovascular diseases. The model suggests that understanding the mechanisms involved in cell damage may one day lead to a re-conceptualization of psychiatric illness as a “whole body disease rather than just a mental illness” (p. 327, Wolkowitz et al., 2010). Both physical activity (Cherkas et al., 2008) and sleep (Prather et al., 2011) have been implicated in cellular aging among individuals without a psychiatric disorder. Thus, understanding the conditions that constitute high risk for poor physical health in individuals with bipolar disorder could contribute to an increased understanding of mechanisms associated with accelerated aging.

2. Physical activity, sleep and bipolar disorder

Recent surveys indicate that individuals with bipolar disorder lead predominantly sedentary lives (Chuang, Mansell, & Patten, 2008), similar to many other severe mental illnesses (Davidson et al., 2001). Additionally, relative to healthy individuals, individuals with bipolar disorder exhibit lower physical activity levels during the day as measured by actigraphy (Harvey, Schmidt, Scarna, Semler, & Goodwin, 2005; Salvatore et al., 2008). Individuals with bipolar disorder have poorer exercise habits relative to healthy individuals, such as infrequent walking and infrequent strength exercises (Kilbourne et al., 2007). However, there have been some notable exceptions to this line of evidence with one study finding no differences in self-reported physical activity levels between individuals with bipolar disorder and the general population (Cairney, Veldhuizen, Faulkner, Schaffer, & Rodriguez, 2009).

Bipolar disorder is also associated with pervasive sleep difficulties, particularly insomnia and hypersomnia, even during periods of clinical remission (for reviews see Harvey, 2008; Kaplan & Harvey, 2009). Furthermore, there is evidence that rates of obesity and hypertension are greater in individuals with bipolar disorder and insomnia compared to good sleeping individuals with bipolar disorder (Soehner & Harvey, 2012). This study also found that as the severity of insomnia symptoms increases, so does the risk of obesity, hypertension and diabetes. This is an important area of investigation given that changes in physical activity and sleep are important diagnostic features in bipolar disorder (American Psychiatric Association, 2000) and are also associated with poor health outcomes (Roshanaei-Moghaddam & Katon, 2009). Hence, bipolar disorder is an ideal population for studying the potential

bidirectional relationship between physical activity and sleep. To our knowledge, no research to date has focused on a naturalistic observation of the day-to-day relationship between physical activity and sleep in either healthy individuals or individuals with bipolar disorder. The evidence to date suggests that bipolar disorder is associated with poorer health outcomes relative to healthy individuals, leading us to hypothesize that the relationship between physical activity and sleep will also be different. However, there is minimal research investigating whether the relationship between physical activity and sleep are different in bipolar disorder.

3. The current study

As the evidence above outlines, there is likely a connection between physical activity and sleep that exists in all people. To understand the full continuum of this relationship, we examine both healthy adults and adults diagnosed with bipolar disorder, for whom this connection may be particularly strong. We also examine each individual's daily physical activity and sleep in order to better understand within-person associations. Using a longitudinal, naturalistic design, healthy participants (no psychiatric illness) and an inter-episode bipolar disorder group, were studied daily over a two-month period using subjective and objective measures of physical activity and sleep. The study had three aims. First, we sought to investigate overall physical health functioning and physical activity levels in a group diagnosed with bipolar disorder relative to the healthy group. The hypothesis tested was that the bipolar group would exhibit poorer physical health and engage in less physical activity, measured both subjectively and objectively, relative to the healthy group (Kilbourne et al., 2007; Salvatore et al., 2008). Second, we examined the relationship between physical activity and sleep in all participants. For this aim, we hypothesized that sleep disturbance would be associated with less engagement in subsequent day physical activity, as measured by both self-report and actigraphy (Garaulet et al., 2011). We also examined the flip side of this relationship; namely, that increased physical activity during the day would be associated with less subsequent sleep disturbance (Driver & Taylor, 2000). The third aim was to determine if the relationship between physical activity and sleep disturbance is differentially impacted in the bipolar disorder group relative to the healthy group. For this aim, we tested the hypothesis that the bipolar group would experience a more pronounced relationship between physical activity and sleep relative to the healthy group (Soehner & Harvey, 2012).

4. Method

4.1. Participants

As part of a larger study, we recruited 32 adults (ages 18–64) diagnosed with bipolar I disorder who were currently inter-episode and 36 healthy adults with no history of psychiatric or sleep disorders. The two groups were recruited to match by age and gender. Two publications report findings from this study (Eidelman, Gershon, Kaplan, McGlinchey, & Harvey, 2012; Gershon et al., 2012). This paper focuses uniquely on physical activity and its relation to sleep.

Participants were recruited through internet advertisements and flyers distributed in the community. A telephone interview was completed to screen for eligibility. Individuals who were considered likely to be eligible were invited for a baseline visit.

Individuals in the bipolar group were eligible to participate if they (a) met DSM-IV criteria for a diagnosis of bipolar I disorder (American Psychiatric Association, 2000) based on the SCID; (b) did not meet criteria for a diagnosis of substance or alcohol abuse or

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