

University of Louisville

ThinkIR: The University of Louisville's Institutional Repository

Electronic Theses and Dissertations

8-2013

Behavioral rhythm, sleep, and mood disturbances in newly admitted nursing home residents.

Irene M. Kostiwa
University of Louisville

Follow this and additional works at: <https://ir.library.louisville.edu/etd>

Recommended Citation

Kostiwa, Irene M., "Behavioral rhythm, sleep, and mood disturbances in newly admitted nursing home residents." (2013). *Electronic Theses and Dissertations*. Paper 773.
<https://doi.org/10.18297/etd/773>

This Doctoral Dissertation is brought to you for free and open access by ThinkIR: The University of Louisville's Institutional Repository. It has been accepted for inclusion in Electronic Theses and Dissertations by an authorized administrator of ThinkIR: The University of Louisville's Institutional Repository. This title appears here courtesy of the author, who has retained all other copyrights. For more information, please contact thinkir@louisville.edu.

BEHAVIORAL RHYTHM, SLEEP, AND MOOD DISTURBANCES
IN NEWLY ADMITTED NURSING HOME RESIDENTS

By

Irene M. Kostiwa

M.A., University of Louisville, 2007

B.A., Northern Illinois University, 2005

B.S., Southern Illinois University, 2002

A Dissertation

Submitted to the Faculty of the
College of Arts and Sciences of the University of Louisville
In Partial Fulfillment of the Requirement
for the Degree of

Doctor of Philosophy

Department of Psychological and Brain Sciences
University of Louisville
Louisville, KY

August 2013

Copyright 2013 by Irene Kostiwa

All rights reserved

BEHAVIORAL RHYTHM, SLEEP, AND MOOD DISTURBANCES
IN NEWLY ADMITTED NURSING HOME RESIDENTS

By

Irene M. Kostiwa
M.A., University of Louisville, 2007
B.A., Northern Illinois University, 2005
B.S., Southern Illinois University, 2002

A Dissertation Approved on
June 24, 2013

By the following Dissertation Committee:

Suzanne Meeks, Dissertation Director

Benjamin Mast

Sandra Sephton

Barbara Stetson

Ryan Wetzler

DEDICATION

This dissertation is dedicated
to my grandmother Marina who taught me to be strong and independent,
to my mother Leola who taught me to be sincere and dedicated,
to my husband Wade for his love and support, and
to my children Maggy and Anneliese for sharing abundant joy and wonder.

ACKNOWLEDGEMENTS

I would like to express profound gratitude to my mentor, Dr. Suzanne Meeks. I will be forever grateful for your patience and support as I worked toward becoming a clinician, researcher, and mother. You instilled confidence in me to achieve and succeed in all of these roles simultaneously. I also would like to thank my dissertation committee for your guidance. Thank you Dr. Barbara Stetson for sparking my interest in health psychology, Dr. Benjamin Mast for helping me see the beauty in statistical analyses, Dr. Ryan Wetzler for inspiring my passion for the study of sleep, and Dr. Sandra Sephton for encouraging me to expand my understanding of circadian rhythms and sleep. This project would not have come to fruition without the help of outstanding research assistants. Thank you, Patrick Smith, for your time and commitment. There is no one I would trust more with completion of this or any project. Thank you, Brian Ludwin, for your collaboration, assistance with data collection and your medical expertise. And, a final thank you to my husband, children, and friends for being so patient and accepting of me throughout this long process.

ABSTRACT

BEHAVIORAL RHYTHM, SLEEP, AND MOOD DISTURBANCES IN NEWLY ADMITTED NURSING HOME RESIDENTS

Irene M. Kostiwa

June 24, 2013

Older adults entering a nursing home face many physical and psychosocial challenges, all at a point in life when their bodies may be least equipped to handle such adversity. Data for the present study were collected for 186 incoming residents from 6 nursing homes over the course of 1 year. Fifty-six participants were interviewed at the earliest possible time point following admission and rest-activity data were collected via actigraphy for 1 week, after which participants were interviewed a second time.

Newly admitted residents in this sample were functionally dependent, highly medicated, and diagnosed with many conditions associated with sleep and/or mood disturbances. Sleep disorders appear to be underreported or underdiagnosed on the Minimum Data Set (MDS) which documented only 5.9% of patients with sleep-related diagnoses. A large number of residents, 63%, reported sleep disturbances consistent with clinical sleep pathology. The MDS indicated that 7.4% were prescribed hypnotics but this figure is deceiving in regard to medication use for sleep. Medication administration records showed 35% used sleep-related medications, and 39% of patients reported using medications to sleep.

Consistent with other studies, these nursing home residents received inadequate bright light exposure with an average of 11 minutes at or above 1000 lux per day and none above 2000 lux. Approximately 35% were diagnosed with depression on the MDS. Self-reports showed approximately 29% with mild and 32% with moderate to moderately severe depression.

A primary aim of this study was to identify sleep timing changes during the transition to the nursing home because adjustment to this type of change can be difficult for older adults. The average change in sleep timing fell between 1 and 2 hours, with a range from 0 to 6½ hours. As expected, participants preferred morning activity which is consistent with other studies of older adults and may reflect an age-related advance of the endogenous circadian rhythm. On average, all chronotypes experienced advances in sleep timing which is consistent with our hypothesis that the early morning routine typical of nursing homes would require residents to modify their sleep routines. Greater evening preference predicted a larger advance in sleep timing.

Sleep phase changes are an important concern, particularly in light of the widespread rest-activity rhythm disturbances found in this setting and this study confirmed that rest-activity rhythms are disturbed in incoming nursing home residents. Another aim was to investigate the role of social rhythms, or the frequency and regularity of a daily routine, during this transition. A unique pattern of relationships was found among rest-activity rhythms, social rhythms, sleep and mood in the presence of certain types of sleep timing changes. This was not identified or explained based on the hypothesized model proposed in this study. Future studies should further evaluate these

relationships based on a more nuanced model that accounts for the type (bed- versus wake-time) and direction (advance versus delay) of sleep timing change.

TABLE OF CONTENTS

	PAGE
DEDICATION	iii
ACKNOWLEDGEMENTS	iv
ABSTRACT	v
LIST OF TABLES	x
LIST OF FIGURES	xii
INTRODUCTION	1
LITERATURE REVIEW	5
Extent of the problem.....	5
Circadian rhythms and aging	11
Chronotype and aging	17
Aging and homeostatic sleep drive	18
Circadian rhythms and sleep.....	19
Circadian rhythms and mood.....	21
Sleep and aging.....	22
Sleep and mood.....	23
Institutionalization and the nursing home setting	25
Social Zeitgeber Theory.....	35
Summary and statement of the problem	40
HYPOTHESES	41

METHODS	44
Study Design.....	44
Recruitment.....	44
Measures	46
Procedures.....	57
RESULTS	59
Sample characteristics.....	59
Performance on outcome measures	72
Associations between primary variables and other related factors.....	76
Analyses of Main Hypotheses	82
Secondary analyses	92
DISCUSSION	95
Summary of findings.....	95
Study aims and hypotheses	97
Implications.....	108
Strengths and limitations.....	109
Future directions	113
REFERENCES	115
APPENDIX.....	137
CURRICULUM VITAE.....	147

LIST OF TABLES

TABLE	PAGE
1. Definitions of sleep variables from Actiware software.	54
2. Demographic characteristics of overall sample	61
3. Demographic characteristics and comparisons among sample subsets	62
4. Reasons cited in chart for nursing home placement	63
5. Neurological disease and stroke in study sample	65
6. Need for staff assistance with mobility and ambulation.	66-67
7. Need for staff assistance in activities of daily living	67
8. Percent of sample endorsing pain and related effects on sleep and activities	68
9. Psychiatric diagnoses designated on the MDS.	69
10. Frequency and percentage of hypnotic and antidepressant use.	70
11. Insomnia measured by the Insomnia Severity Index (ISI).....	73
12. Sleep disturbance measured by the Pittsburgh Sleep Quality Index (PSQI).	73
13. Participant performance on PSQI subscales at T1 and T2.....	74
14. Depression measured by the Patient Health Questionnaire (PHQ-9).	75-76
15. Correlations among hypothesized outcome variables.....	78
16. Correlations among hypothesized predictor variables	79
17. Correlations among predictor and outcome variables	80
18. Correlations among objective and subjective sleep measures	81

19. Summary of regression analyses for primary analyses.	83
20. Sleep timing changes in participants with delays and those with advances	84
21. Wake time changes in different chronotype groups.	88
22. Bed-time changes in different chronotype groups.	89
23. Comparisons of morning versus neutral types on outcome measures.	91
24. Associations between social rhythms and mood in sleep-timing subgroups	93
25. Comparisons of IS and IV to published data	98

LIST OF FIGURES

FIGURE	PAGE
1. Hypothesized relationships between variables of interest.	43
2. Illustration of method used for setting bed- and wake-times.....	49-50
3. Calculation of interdaily stability.....	51
4. Calculation of intradaily variability	52
5. Study flow	60
6. Summary of significant correlations related to hypothesized model.....	77
7. Chronotypes based on MEQ categories.....	86
8. Linear regression between chronotype and bed and wake time changes.....	87
9. Amount of change in wake time based on chronotype	89
10. Amount of change in bed time based on chronotype.....	90
11. Patterns of relationships between outcome variables based on sleep timing change subgroups	94

INTRODUCTION

In the United States, nearly half of adults who turn 65 in 2010 will spend some time in a nursing home (Congressional Budget Office, 2004). The capacity to adjust to the nursing home environment may affect whether and how quickly an individual is able to return to independent living. Poor adjustment can lead to functional decline, recurrent hospitalizations, and increased burden on family, nursing home staff, and the healthcare system. For those who remain in long-term care, factors associated with adjustment are important to maintenance or improvement of health, function, and quality of life.

Disturbances in behavioral circadian rhythms¹, sleep and mood are common in the nursing home. In a study of the broad nursing home population, 97% of residents were found to have disturbed rest-activity rhythms (Martin et al., 2006). Disturbed sleep is readily seen as residents are observed napping during the day and awake at night. Data suggest that rates of major depressive disorder found in the nursing home are nearly double those found in the community. An overarching goal of the present investigation is to shed light on predictors and relationships between behavioral rhythms, sleep, and mood early in the transition into the nursing home setting.

¹ Behavioral circadian rhythms or behavioral rhythms will be used in reference to both rest-activity rhythms and social rhythms. Rest-activity rhythms can serve as an indicator of central circadian function although it is not always a precise indicator of endogenous circadian rhythm. See page 9 for details regarding the relationship between rest-activity and circadian rhythms. Social rhythms refer to the frequency and regularity of daily activities.

A high prevalence of behavioral rhythm and sleep disturbances is not surprising given the extent of related risk factors that exist in this setting. Some of these risk factors are characteristic of patients who need skilled nursing care, such as acute and chronic illnesses and medication use. Others are inherent to the nursing home which operates more like a medical facility than a “home.” For example, noise and light at night related to nursing care practices disturb sleep. Another factor that may place elders at risk is a change in sleep timing. When moving into the nursing home, new residents may have to change their sleep and wake times to coincide with the facility schedule and availability of staff, especially if residents need assistance due to functional impairment. A change in sleep timing in this situation would have a similar effect to that which occurs during daylight savings time or travel between time zones. This poses a serious challenge to an aged circadian timing system. Changes in sleep timing can disrupt sleep in the short-term or have more lasting effects if the individual is unable to adjust to the new sleep schedule. Because the nursing home environment does not have strong inputs to the circadian timing system (eg. bright light) which help entrain the internal “clock” to the external environment, a change in sleep timing is a major concern. No data exist on sleep timing changes in newly admitted nursing home residents. A primary aim of this study is to identify whether and what type of sleep timing changes occur during this transition.

The process of institutionalization also interrupts daily activities and routines more generally. The regular pattern of an individual’s daily activities is collectively referred to as social rhythm. Changes in social rhythms may impact an elder’s adjustment to the nursing home. According to Social Zeitgeber Theory (SZT) (Ehlers, Frank, & Kupfer, 1988), significant life events (eg. nursing home placement) produce changes in

social zeitgebers (mealtimes, exercise, and other regular daily activities) that lead to social rhythm instability and disruption of biological rhythms which in turn increase the risk for depression. According to SZT, if instability in social rhythms persists, it could lead to disturbances in endogenous rhythms and depression. This theory might explain the convergence of behavioral rhythm, sleep, and mood disturbances in the nursing home. Social rhythms have not been studied in older adults in nursing homes, therefore another aim of the present study is to determine whether changes in social rhythm occur during the transition to nursing home care and whether they are associated with rest-activity rhythms, sleep and mood.

A factor that may play an important role in maintenance of social rhythms during the transition to the nursing home is chronotype, or preference for morning versus evening activity. An individual who prefers morning activity, also known as a lark, may transition more easily into the daily routine of an institution because nursing staff shifts and nursing care begin early in the morning and group activities are offered in the morning and early afternoon. Given the earlier scheduling of nursing home activities, a lark would be more likely to maintain a strong social rhythm, including sleep-wake times and daily activities. Conversely, an individual who prefers evening activity, also known as an owl, might have difficulty maintaining a daily routine because activities in the nursing home occur earlier in the day when staff is present. Early bed times and early morning awakenings typical in the nursing home may mark a greater change from an owl's past routine, so owls might suffer more profoundly from sleep timing changes. Chronotype, therefore, may serve as a strong predictor of adjustment to the nursing home, particularly in regard to sleep timing and social rhythms. Because no studies to date have

linked these factors in the context of the nursing home, identifying chronotypes in newly admitted nursing home residents and its relation to behavioral rhythms (both social rhythms and rest-activity rhythms), sleep and mood is another primary aim of this study.

In sum, understanding the process of disruption and accommodation of social rhythms including sleep timing during the transition to long-term care, and concurrent changes in rest-activity rhythms, sleep and mood may prove critical in assisting older adults to adjust and recover during a stay in the nursing home. Separate and sometimes intersecting lines of research on behavioral rhythms, sleep, and mood in late-life have increased in recent years but few studies have investigated these together in the context of the nursing home, and to my knowledge, no studies capture the relationship among these factors during the critical transition that occurs upon admission. Initial findings of the types of disruption and key correlates will help us better identify those at risk for developing sleep and mood problems.

LITERATURE REVIEW

Extent of the problem

Sleep. Estimates vary widely depending on the criteria used to define insomnia (Ohayon, 2002), but nearly all epidemiological data support the existence of increased prevalence with age (Johnson, 2006). The rate of insomnia in the general population lies roughly between 10 to 20% (Bloom et al., 2009; Johnson, 2006). In older adults, estimates are higher, between 30 and 40% (Foley et al., 1995). Insomnia is prevalent mostly among older adults in poor health (Ohayon, 2002). It is associated with medical and psychiatric illnesses, medication use, sleep apnea, pain, depression, and neurological disorders. Insomnia is more common in widows, and is reported 1.5 times more often by women than men (Johnson, 2006). Large-scale epidemiological data on primary sleep disorders in nursing homes is lacking (Martin & Ancoli-Israel, 2008), but because nursing home residents are largely elderly, female, widowed, and in poor health, it follows that this population carries a high risk for sleep disturbances. Indeed, significant sleep disruption has been well-documented in this population (Fetveit & Bjorvatn, 2002; Voyer, Verreault, Mengue, & Morin, 2006).

Sleep disruption is associated with serious health consequences including impaired attention, memory, and psychomotor functioning, disorientation, reduction in quality of life, and increased morbidity and mortality (Liu & Ancoli-Israel, 2006; Misra

& Malow, 2008; Van Someren, 2000). Sleep disturbances have been associated with and causally linked to, cardiovascular problems, endocrine dysfunction, suppression of immune function (Van Someren, 2000), limitations in activities of daily living, and chronic use of benzodiazepines (Newman, Enright, Manolio, & Haponik, 1997). Impaired cognitive functioning including problems with attention, memory, and response time related to impaired sleep (Bruce & Aloia, 2006) may place elders at risk for a misdiagnosis of dementia. Psychomotor impairment related to insomnia or sleep medications may increase the risk for falls (Van Someren, 2000). In addition to these and other negative consequences, insomnia is associated with high health care utilization. The exact financial impact is difficult to separate from those of comorbid conditions, but estimates are as high as billions of dollars annually (NIH, 2005).

Behavioral rhythms. Rest-activity rhythms (overall daily patterning of periods of rest and activity) are commonly used to study circadian rhythms in nursing home residents. In studies of endogenous circadian rhythms, researchers use tightly controlled experimental protocols to separate circadian from homeostatic sleep processes, and to minimize the effect of factors such as changes in body positioning, ambient temperature, auditory and visual cues that mask the true endogenous circadian rhythm. Such protocols include constant routines, forced desynchrony, induced phase-shifts, or shortened sleep-wake cycles. In a constant routine protocol, subjects are kept awake in a fixed posture in a laboratory with constant conditions for at least 24 hours. For example, Monk et al. (1997) explored circadian performance rhythms in relation to rhythms of subjective alertness, rectal temperature, plasma cortisol, and melatonin. A 36 hour unmasking condition included constant wakeful bedrest, temporal isolation, and regularly timed

“meals.” The laboratory environment had no time cues and a constant illumination of less than 300 lux. Subjects were monitored for wakefulness via EEG electrodes, a rectal probe for body temperature and a venous catheter. Every hour, the subjects were given a consistent amount of liquid supplement to fulfill their daily caloric needs. The study revealed that performance on nearly all tasks followed a circadian variation with a nocturnal trough that paralleled rectal temperature. This study illustrates the complexity of measuring endogenous circadian rhythms.

Related protocols require participants to be isolated from their normal environments for days at a time, a level of experimental control that is not feasible with nursing home residents who are often frail and medically unstable. Measurement of physiological indicators of central circadian regulation, such as continuous monitoring of rectal body temperature or blood draws to measure hormone levels also are too invasive in this population.

Fortunately, there is research demonstrating the predictive value of actigraphically recorded rest-activity rhythms and the importance of these measures in the quantification of circadian rhythm disturbances in elderly patients (Ancoli-Israel et al., 2003; Van Someren, 1997). For example, disruption of rest-activity rhythms are pronounced in patients with Alzheimer’s Disease and correlate with severity of dementia (Witting, Kwa, Eikelenboom, Mirmiran, & et al., 1990). Activity phase abnormalities as measured by actigraphy in patients with dementia predict shorter survival (Gehrman et al., 2004). Rest-activity rhythms have also been used as an outcome measure in treatment studies. For example, rest-activity rhythms have been used to study response to aerobic training in elderly men (Van Someren, Lijzenga, Mirmiran, & Swaab, 1997), indirect bright light in

dementia patients (Van Someren, Kessler, Mirmiran, & Swaab, 1997), and multicomponent nonpharmacological interventions in nursing homes (Martin, Marler, Harker, Josephson, & Alessi, 2007). Some researchers suggest that age-related disorders of the circadian timing system may first manifest as sleep-wake disturbances (Hofman, 2000). In sum, rest-activity rhythms have proven to be an important indicator in the study of circadian rhythms and sleep in the elderly, and actigraphy is the preferred method of study in nursing homes.

As mentioned, fragmentation of rest-activity rhythms is widespread in the nursing home. In a study of a cross-section of residents from multiple nursing homes, 97% of residents were found to have abnormal rest-activity rhythms (Martin et al., 2006). Normative data on older adults living in the community are not available, but when this sample was compared to a healthy community sample of adults (ages 45-85), only two of the 118 nursing home residents participating in the study had circadian rhythm F-values within two standard deviations of the mean of this “normative” comparison group.

At the extreme are patients suffering from neurological disorders. Nursing home residents with dementia have been observed to spend no full hour of the day or night exclusively asleep or awake (Jacobs, Ancoli-Israel, Parker, & Kripke, 1989). Dementia, particularly Alzheimer’s Disease (AD) in its advanced stages, can be devastating to circadian rhythms due to direct damage to the neural circuitry within the circadian timing system.

The most salient problem for the patient related to circadian rhythm disruption is a disturbance in the timing of the sleep-wake cycle. Lack of synchronization between an individual’s sleep-wake cycle and the environment characterizes circadian rhythm sleep

disorders including advanced sleep-phase syndrome, a problem that increases in prevalence with age. An inability to sleep at the appropriate time at night or to remain alert and awake during the day can seriously impair performance of social and job-related functions and represents a major concern for the health, safety, and productivity of a growing senior population (Edgar, 1994). Even more insidious, though, are internal changes that accompany disturbances in the circadian timing system. Nearly every physiological process undergoes daily variations, from renal to cardiovascular to endocrine function. Internal oscillatory processes within these systems are interdependent and loss of synchrony between them is thought to lead to increased vulnerability to illness and disease (Moore-Ede, Czeisler, & Richardson, 1983). Therefore, healthy functioning of the circadian timing system is critical for older adults who are often challenged by acute and chronic illness. If used as an indicator of central circadian function, the widespread disturbances in rest-activity rhythms pose a serious concern in the recovery, health and wellness of nursing home residents.

Depression. Like insomnia, depression is more prevalent in the nursing home than in community populations. Estimates vary widely depending on the assessment criteria used, but overall epidemiological data suggest that rates of major depressive disorder found in the nursing home are nearly double those found in the community. The rates in the nursing home range from 6-25% (Rovner & Katz, 1993) as compared to 0.4-10.2% in community samples (Beekman, Copeland, & Prince, 1999). Some studies have found rates three to four times as high in nursing homes as compared to community settings with as many as half of residents experiencing significant depressive symptoms (Jongeneelis et al., 2004; Rovner & Katz, 1993).

Recognition of depression in nursing homes appears to be on the rise. A recent study found that rates increased from approximately one third in 1999 to one half of nursing home residents being diagnosed in 2007 (Gaboda, Lucas, Siegel, Kalay, & Crystal, 2011). The trend toward increased diagnoses is a positive one and more closely parallels prevalence rates, but further work needs to address the concern that depression may be treated inadequately or inappropriately in this setting (Jones, Marcantonio, & Rabinowitz, 2003; Shah, Schoenbachler, Streim, & Meeks, in press).

Depressive symptoms in older adults are associated with increased service utilization, cost and longer hospital stays (Koenig, Shelp, Goli, Cohen, & Blazer, 1989). Late-life depression is associated with pain, cardiovascular disease, lower quality of life, and poorer health and well-being (Alexopoulos et al., 2002; Lebowitz & Olin, 2004). Long-term prognosis is poor, with a high risk of chronic course or relapse for older age groups (Cole, Bellavance, & Mansour, 1999). In a longitudinal study of depression in nursing homes, major depressive disorder was found to increase the likelihood of death by 59% (Rovner, 1993).

Sleep and depression. The association between sleep and depression is bidirectional. Between 50 and 90% of subjects with diagnosed depression complain of sleep problems (Tsuno, Besset, & Ritchie, 2005). Chronic insomnia confers increased risk for depression, and older age and female gender may further increase this risk (Perlis et al., 2006). Patients with insomnia are nearly 10 times more likely to have clinically significant depression than those without insomnia even after controlling for possible confounds including organic sleep disorders, medical disorders, ethnicity, and sex (Taylor, Lichstein, Durrence, Reidel, & Bush, 2005). Sleep disturbances are a strong

predictor of new or remitting depressive episodes; stable sleep-wake rhythms help prevent depression relapse (Tsuno et al., 2005); and persistent insomnia symptoms increase the likelihood for developing a major depressive illness (Ohayon, 2002). In addition to being a risk factor for a depressive episode, insomnia may perpetuate depression even in patients who receive depression treatment. In a study of elderly primary care patients, subjects with persistent insomnia were more likely to remain depressed (Pigeon et al., 2008).

In sum, the combined effects of sleep and mood disruption confer additional health burden upon patients and also complicate the ongoing identification and treatment of both conditions. Given their prevalence in the nursing home, the course of these frequently comorbid conditions warrants further investigation. Treatments that target both disorders in this setting may help mitigate the negative effects of one condition upon the other.

Circadian rhythms and aging

Researchers generally agree that circadian rhythm abnormalities coincide with advancing age, although the exact nature and source of that dysfunction remains a matter of debate (Monk, 2005; Monk & Kupfer, 2000). The following section provides an overview of the circadian timing system and age-related changes identified in the literature. This evidence is presented to illustrate how age-related changes in the circadian system leave elders vulnerable to disturbance in the face of environmental challenge. More thorough discussions of age-related changes to the circadian timing system are available elsewhere (Monk, 2005; Pandi-Perumal, Spence, & Sharma, 2010; Van Someren & Riemersma-Van Der Lek, 2007).

Circadian rhythm basics. Humans, like all mammals, adjust to changes in the environment courtesy of a circadian timing system. One of the strongest inputs to the system is the light-dark cycle, but inputs to the circadian timing system can also include behaviors that act as cues to the time of day (Elmore, Betrus, & Burr, 1994; Monk, 2010). The circadian timing system regulates behavioral activities to maximize energy at appropriate times. An opposing process, homeostatic sleep pressure (process S), regulates the intensity of sleep, and is dependent on prior wakefulness. Sleep deprivation increases homeostatic sleep pressure, whereas a nap during the day can reduce it. The circadian system (process C) interacts with a homeostatic process to consolidate sleep and wakefulness. When homeostatic sleep pressure is at its highest, typically in the evening, the circadian system maximizes wakefulness. During sleep, homeostatic sleep pressure dissipates and circadian sleep propensity increases to ensure sleep maintenance (Edgar, 1994; Schmidt, Collette, Cajochen, & Peigneux, 2007).

Nearly all physiological and behavioral processes undergo daily variations that follow a regular pattern, also known as a circadian rhythm. The period (τ) of the human circadian rhythm is typically longer than 24 hours in the absence of external cues or zeitgebers (Wever, 1988). Physical and social zeitgebers entrain the internal rhythm to the 24-hour light-dark cycle. These cues feed into the hierarchically structured circadian timing system which is comprised of a central pacemaker situated in a small region of neurons within the hypothalamus called the Suprachiasmatic Nucleus (SCN) (Stratmann & Schibler, 2006). Peripheral tissues contain local cell-based circadian clocks but rely on signals from the SCN to synchronize with each other and with the environment (Maywood, O'Neill, Wong, Reddy, & Hastings, 2006).

The circadian system is adaptive in that it is largely endogenous, allowing animals to retain a relatively stable pattern in the absence of external cues (eg. long dark days in winter), but at the same time to remain sensitive to external cues, allowing animals to adjust to environmental changes (eg. seasonal changes in daylight and temperature). In this way, the circadian timing system regulates behavioral activities to maximize energy at appropriate times, such as when food is available or when other important functions are needed.

According to recent literature, one of the strongest zeitgebers is the light-dark cycle (Lack & Wright, 2007), but inputs to the circadian timing system also include ambient temperature, noise, mealtimes, and physical or social activity. Without exogenous inputs, the internal clock drifts out of phase with the external light-dark cycle, causing circadian rhythm disruption (Rivkees, 2007). Deprivation from zeitgebers for an extended period of time or damage to the system can prevent adjustment, resulting in compromised health and well-being.

Theories. Adaptive functioning of an organism requires that the phase relationships between internal interdependent circadian processes follow a particular temporal order (Wever, 1988). During adaptation to a change in the environment, internal phase relationships undergo an initial dissociation followed by restorative stabilization. Circadian disorder occurs when internal oscillatory processes remain dissociated or when the internal system remains out-of-sync with the external environment (Welsh & Ptacek, 2010). Wever (1988) proposed that a defect exists in the stabilizing mechanism in older adults and psychiatric patients which creates a vulnerability to disorder following changes in the environment.

Along the same lines, Samis (1968) argued that an age-related dissociation between rhythmic processes within the circadian timing system results in loss of adaptive resiliency. The loss of synchrony is much like several clocks ticking slightly out of time; barely perceptible differences quickly lead to large discrepancies between the ticking clocks. Small changes in the environment may lead to large discrepancies between internal interdependent processes. The implication for nursing home residents is that an aged circadian system may be unable to re-establish internal synchrony or entrainment to a new sleep-wake schedule imposed by the nursing care facility. This type of rhythm disruption could manifest as rest-activity rhythm, sleep and mood disturbances.

Specific age-related changes. Broadly, evidence supports a theory of changes in the temporal relationship between internal oscillatory processes. Dissociation of internal rhythms appears to occur more frequently in older adults. Age-related changes in hormonal, temperature, and other physiological and behavior rhythms have been identified (Hofman, 2000). The relationship between internal oscillatory processes and the neuronal pathways that form a basis for these changes is highly complex and has not been completely elucidated. A brief overview of age-related circadian changes is presented here. These changes are thought to reflect a less robust and resilient circadian timing system in the elderly, that is vulnerable to disturbance. Debate continues as to where and why these changes occur. Age-related neuronal loss in the SCN may attenuate the ability of the master clock to orchestrate resynchronization of peripheral clocks, possibly by a failure to generate a strong central circadian signal. Other evidence suggests that age-related circadian dysfunction is a failure to “transduce” the signal to systems “downstream” from the central pacemaker (Monk & Kupfer, 2000).

Several age-related changes to the circadian timing system have been documented including difficulty tolerating phase shifts, endogenous and overt rhythm advancement, reduced rhythm amplitude, loss of entrainment stability and loss of synchrony between oscillatory processes (Pandi-Perumal et al., 2010). A shortened intrinsic period has been implicated in age-related phase advances and sleep fragmentation, but there is mounting evidence to refute this hypothesis. For example, in a study that controlled for the confounding effect of light, no age-related reduction in period length was found (Dijk, Duffy, & Czeisler, 2000; Monk, 2005).

Available data in both animals and humans demonstrate an age-related phase advance of endogenous rhythms (Dijk et al., 2000; Monk, 2005; Pandi-Perumal et al., 2010), which is consistent with earlier sleep and wake times commonly reported by older adults (Buysse et al., 1992; Czeisler et al., 1992; Monk, Reynolds, Buysse, & Hoch, 1991). In experiments using a constant routine protocol which minimizes the masking effects of the sleep-wake cycle on endogenous rhythms, the nadir of core body temperature and crest of melatonin rhythm were found to occur significantly earlier in older adults (Dijk et al., 2000). Other research demonstrates age-related phase advances in cortisol, blood pressure, iron, and magnesium (Monk, 2005).

Decreased amplitudes in endogenous rhythms have been documented in some but not all studies of older adults (Naylor & Zee, 2006). Reduced amplitudes in body temperature rhythms in entrained and free-running conditions were found in older versus younger adults although this was less evident in older women. Decreased amplitudes in rhythms of cortisol, growth hormone, thyroid-stimulating hormone, prolactin, and melatonin have also been found. Other studies showed no differences in amplitude of

core body temperature or melatonin in healthy older adults, suggesting that factors other than age may play a role.

Overt and endogenous rhythms both appear to advance with age, and a change in the internal phase relationship between the sleep-wake cycle and output of the circadian pacemaker has also been identified (Duffy & Czeisler, 2002). Older adults awaken at an earlier phase of melatonin and core body temperature rhythm (Duffy & Czeisler, 2002). The advanced phase of awakening and reduction in sleep consolidation in older adults is thought to relate to a reduction in the promotion of sleep by the circadian pacemaker along with reduced homeostatic sleep pressure.

The assertion that older adults have more difficulty tolerating phase shifts is supported by subjective ratings of sleep disturbances and poor sleep quality in older adults as compared to younger adults faced with shift work or transmeridian travel (Monk, 2005). Difficulty re-entraining to a phase shift is also supported by evidence in animal models (Van Someren, Riemersma, & Swaab, 2002). In the nursing home, a lack of daytime light exposure (Shochat, Martin, Marler, & Ancoli-Israel, 2000), may hamper phase adjustment particularly when coupled with age-related ocular problems such as cataracts and yellowing and increased density of the lens that further diminish light transmission to the brain and in turn, responsiveness of melatonin suppression (Herljevic et al., 2005; Van Someren et al., 2002). Age-related changes in neurotransmitter systems that play a role in circadian regulation, such as melatonin and serotonin, may also attenuate phase-resetting in older adults (Naylor & Zee, 2006; Sharma, Palacios-Bois, Schwartz, Iskandar, & et al., 1989). Difficulty adjusting to phase shifts in older adults is a

major concern if sleep timing changes are identified in newly admitted nursing home residents.

Chronotype and aging

The term chronotype is suggestive of the underlying role of circadian rhythm, and in fact, preference for morning versus evening activity has been linked to endogenous circadian rhythmicity. A meta-analysis of studies using objective measures of circadian phase such as melatonin and core body temperature identified moderate-to-large correlations between chronotype and endogenous circadian rhythm (Bernert, Hasler, Cromer, & Joiner Jr., 2006). Morningness is associated with an earlier circadian phase, whereas eveningness is associated with a later circadian phase. On the extreme ends of the continuum, morning-eveningness (M-E) can be linked to circadian abnormalities or disorder (Sack et al., 2007). It carries physiological implications related to timing of the circadian phase. This is of concern during nursing home placement, because residents whose chronotypes conflict with a new schedule in the nursing home may suffer from circadian maladjustment.

Aging is associated with a tendency toward morningness (Monk & Kupfer, 2007), consistent with findings of age-related phase advances in endogenous and overt rhythms. Eveningness is associated with higher levels of depression in both clinical and nonclinical samples (Chelminski, Ferraro, Petros, & Plaud, 1999; Drennan, Klauber, Kripke, & Goyette, 1991). Age has been investigated as a moderator of M-E, with the relationship between eveningness and depression being stronger in older and younger versus middle age groups, a finding that is argued to relate to intrinsic circadian instability (Kim et al., 2010).

Interestingly, investigations of changes in the phase relationship between endogenous rhythms and the sleep-wake cycle reveal that morning types wake at a later circadian phase than evening types (Duffy, Dijk, Hall, & Czeisler, 1999). This difference opposes the general findings in older adults who are typically morning types but wake at an earlier circadian phase (Duffy et al., 2002). Shorter circadian periods have also been associated with morningness (Duffy, Rimmer, & Czeisler, 2001). Although older age is associated with morningness, it is not associated with a shorter circadian period. These findings underscore the complexity of age-related changes in sleep regulation. Given its association with depression in older adults and to intrinsic endogenous rhythm, chronotype may prove to be an important predictor of behavioral rhythm, sleep and mood disturbances during the transition to nursing home care.

Aging and homeostatic sleep drive

According to the two-process model of sleep regulation, consolidated sleep and wake periods are the result of an interaction between homeostatic and circadian processes (Borbely & Achermann, 1992; Dijk et al., 2000; Edgar, 1994). Homeostatic sleep pressure, process S, builds during wakefulness and dissipates during sleep (Monk, Buysse, Reynolds, Jarrett, & Kupfer, 1992). The circadian or endogenous oscillatory process C, involves sleep propensity and interacts with process S. In the evening when sleep pressure is high, sleep propensity is at its lowest to ensure wakefulness, but later increases to facilitate sleep (Edgar, 1994; Schmidt et al., 2007).

Slow-wave sleep (SWS), a primary marker of sleep homeostasis, begins a continuous decline when humans reach their early 20s (Dijk et al., 2000). Because the threshold of arousal to stimuli is higher during SWS, a reduction in SWS could result in a

lower threshold of arousal to stimuli. Age-related reductions in SWS have been measured across circadian phases (Dijk, Duffy, Riel, Shanahan, & Czeisler, 1999) and declines in arousal thresholds have been found in old versus young adults (Dijk et al., 2000). This is particularly pertinent in the nursing home setting, where there are many internal and external stimuli that can disrupt sleep. A lower arousal threshold during sleep, especially on the rising limb of the temperature rhythm (Dijk et al., 2000), coupled with higher levels of arousing stimuli such as nighttime light and noise place nursing home residents at increased risk for sleep disruption. Internal stimuli such as pain, nocturia, or stimulating medications can also awaken a resident with lower arousal thresholds. Research substantiates that pain, noise, and nocturia are key causes of sleep disturbance in nursing home residents (Ersner et al., 1999). In sum, the interaction between circadian and homeostatic sleep mechanisms is important when considering entrainment in regulation of the sleep-wake cycle (Dijk et al., 2000; Dijk et al., 1999).

Circadian rhythms and sleep

Insomnia is defined as difficulty initiating or maintaining sleep, reduction in sleep quality, and associated daytime impairments. The circadian system regulates the timing of sleep, and sets an optimal sleep period. Sleep is inhibited before and after this major sleep period and these zones are referred to, respectively, as the wake maintenance and wake-up zones. Recurrent attempts to sleep in these “forbidden” sleep zones can result in insomnia.

As an example, an older woman who has an intrinsically advanced endogenous rhythm may unintentionally fall asleep in the evening (eg. 7 p.m.) while watching television, but then awaken and attempt to delay sleep to a more acceptable time (eg. 10

p.m.). Because homeostatic sleep pressure has been reduced by this “nap”, she will struggle to return to sleep. Later, she awakens at 3 a.m. and is unable to return to sleep because she is now in the “wake-up zone” of her underlying advanced endogenous rhythm. Because she remained awake in the late evening, she may become slightly sleep deprived and fatigued during the day. Retirement and fewer daytime obligations reduce social constraints that might otherwise limit daytime napping. Napping can further undermine the consolidation and timing of sleep by reducing sleep drive the following night.

Indeed, insomnia marked by early morning awakening has been associated with advanced circadian temperature and melatonin rhythms (Lack & Wright, 2007). The sleep of older adults is often characterized as less consolidated, frequently interrupted by brief awakenings, and with a final awakening occurring at an earlier time. Because aging is associated with a phase advance of the endogenous rhythm, the scenario previously described is not uncommon.

Sleep consolidation is determined by an interaction between circadian and homeostatic processes. If aging directly impacts central circadian regulation as previously described (eg. lower rhythm amplitude), a weakened circadian signal may result in changes in the distribution and consolidation of sleep (Dijk et al., 2000). A weak circadian signal may fail to promote wakefulness in the evening as homeostatic sleep drive reaches its peak. Conversely, age-related changes in homeostatic sleep mechanisms may also fail to promote a strong sleep drive leading to difficulties falling and staying asleep. The relative contribution of circadian and homeostatic sleep processes to age-

related sleep changes and the underlying neurobiological mechanisms have not been completely elucidated and continue to be investigated.

Circadian rhythms and mood

Alterations in circadian rhythms have also been closely linked to mood disturbances. In comparison to controls, depressed patients show altered circadian rhythms, particularly reduced amplitudes of body temperature, cortisol, melatonin, norepinephrine, and thyroid stimulating hormone (Souetre, Salvati, Belugou, Pringuey, & et al., 1989). The severity of depression is negatively correlated to amplitudes in hormone levels and core body temperature, and normal circadian profiles are restored following recovery (Van Someren et al., 2002). Some suggest that depression may be related to a weakened coupling between internal oscillators as well as an abnormal sensitivity to entraining stimuli (Souetre et al., 1989), conditions that are strikingly similar to those that characterize aged circadian systems.

Evidence supports a genetic basis in the development of depression. Mutations in circadian genes have been linked to depression in general, to recurrence of depressive episodes and to response to depression treatments. For a discussion of the genetic basis, molecular links and shared etiology between circadian and mood disturbances, see Mendlewicz (2009).

Bright light therapy, a chronobiological treatment used to treat circadian rhythm disturbances, has been found to improve mood in patients with seasonal and non-seasonal depression, healthy subjects, and in the elderly (Souetre et al., 1989). Stabilization of circadian rhythm may be a key method of action in pharmacological treatments for bipolar depression (Chellappa, Schröder, & Cajochen, 2009). Total sleep deprivation has

been shown to have a profound effect on depressed mood in a large percentage of patients, and this is thought to relate to concurrent changes in circadian rhythms (Wirz-Justice & Van den Hoofdakker, 1999).

Sleep and aging

The impact of age-related changes to circadian and homeostatic processes is disturbance in the timing and consolidation of sleep. This is manifested clinically as frequent, brief nocturnal awakenings with final wake times that occur at an earlier time of day. Researchers continue to try to unravel age effects from confounding factors in the study of age-related sleep changes, particularly medical illness, sleep apnea, and depression (Floyd, Janisse, Jenuwine, & Ager, 2007; Floyd, Medler, Ager, & Janisse, 2000; Ohayon, 2002; Ohayon, Carskadon, Guilleminault, & Vitiello, 2004). Meta-analyses that have controlled for these confounds demonstrate significant age-related increases in sleep latency, percentage of light sleep (stage 1 and 2), frequency of waking after sleep onset (WASO), and duration of WASO (Floyd et al., 2000; Ohayon et al., 2004). Age-related decreases were found for total sleep time (TST), percentage of slow-wave sleep (SWS), sleep efficiency, and rapid eye movement (REM) latency. TST was found to decline substantially with age, with an approximate 12 minute reduction in nighttime sleep per decade from the 20s to 80s.

Taken together, these results support older adults' self-reports of lighter, more fragmented sleep. Age-related sleep changes on all sleep variables are larger in magnitude when measured by objective (polysomnography or PSG) versus subjective measures, possibly due to the presence of many awakenings shorter than 3 minutes, which are below the threshold for subjective recall (Floyd et al., 2000), or due to the

tendency for older adults to adjust their expectations of sleep as they age, and consequently report fewer problems than they experience.

Sleep and mood

Sleep disturbances are among the core symptoms of depression and are a common complaint among depressed patients (Tsunno et al., 2005). Despite the strong association between sleep and emotion, the nature of this relationship is not well understood and has been understudied (Walker, 2010).

The sleep of depressed patients is patently different from nondepressed patients. Polysomnographic studies characterize the following alterations in depressed patients: a reduction in slow wave sleep, impaired duration and continuity of sleep, decreased REM latency, increase in REM in early part of the night, and increased number of eye movements during REM (Tsunno et al., 2005).

The important role of sleep in depression is also implicated in antidepressant treatments. For example, many effective antidepressant agents suppress REM sleep (Riemann, Berger, & Voderholzer, 2001). Sleep deprivation has been shown to alleviate depressive symptoms although the benefit is often transient and effective in a subset of depressed patients (Wirz-Justice & Van den Hoofdakker, 1999). Several explanations for the antidepressant effect of sleep deprivation have been proposed. As mentioned, theories implicate circadian rhythm stabilization, but also implicate modulation of neurochemical processes including dopamine or adenosine (see Riemann et al., 2001 for further discussion of the pathophysiology of sleep alterations in depression). Studies have also identified abnormalities in neuroendocrine function in depressed patients. For example, hyperactivity of the hypothalamic-pituitary-adrenocortical (HPA) system is found in

depressed patients. Additionally, reductions in the sleep-related growth hormone have been found in depressed patients (Riemann et al., 2001).

In the past, sleep disruption was viewed mainly as a symptom or clinical feature of depression, but more recently, interest has grown in a link between sleep and emotion regulation (Walker, 2010; Yoo, Gujar, Hu, Jolesz, & Walker, 2007). When sleep was restricted to 5 hours per night, subjects reported a progressive increase in emotional disturbances across a week-long study (Dinges et al., 1997). In a study of medical students, Zohar et al. (2005) found that sleep loss amplifies negative affect in the face of negative events. The study showed an overall increase in positive affect following sleep loss, consistent with the antidepressant effect of sleep deprivation. At the same time, sleep loss appeared to attenuate an expected increase in positive affect in response to “goal-enhancing events.”

To explore the role of sleep loss in modulation of emotional brain reactivity, Yoo and colleagues (2007), used functional magnetic resonance imaging to compare the brains of sleep-deprived participants to a control group during an affective stimulus viewing task. Sleep deprived subjects exhibited greater amygdala reactivity (>60%) in comparison to controls. The study also revealed a loss of connectivity in sleep deprived subjects between the amygdala and medial prefrontal cortex (mPFC). The mPFC is thought to exert inhibitory control of the amygdala. The authors concluded that in a sleep-deprived state, a hyper-limbic reaction occurs in response to negative emotional stimuli, with a failure of top-down inhibition of the amygdala by the prefrontal cortex.

Sleep is involved in memory consolidation and emotion appears to play an important role. Walker (2010) proposes a “sleep to forget and sleep to remember” model

of emotional memory processing, where sleep reduces the emotional tone associated with an experience but enhances the encoding of the information related to that experience. The author discusses several studies which support the benefit of sleep in retention of previously learned emotional versus neutral information. Subjects deprived of sleep following exposure to emotionally arousing images showed reduced recall and a lack of reduction in amygdala reactivity upon re-exposure as compared to a control group. Interestingly, the extent of improvement in memory is associated with the quality and quantity of REM sleep. Walker implicates this process in relation to posttraumatic stress disorder, in which hyperarousal may interrupt the memory consolidation process and prevent the separation of emotion from memory during REM episodes.

In sum, existing evidence suggests that sleep plays an important role in the neurophysiological process of emotion and emotion regulation.

Institutionalization and the nursing home setting

The discussion thus far has identified an increased prevalence and negative outcomes associated with disturbances in behavioral rhythms, circadian rhythm, sleep, and mood, with a focus on aging or older adults where available. Additionally, a broad overview of some of the theoretical relationships and research findings between these factors has been presented. The contribution of the process of institutionalization to the convergence of behavioral rhythm, sleep, and mood disturbances in the nursing home can only be surmised from research on other variables; it has not been studied directly.

The following sections will focus on factors related to institutionalization that may disrupt the sleep-wake cycle. Environmental factors that disturb sleep include light,

noise, temperature, and nursing care practices. Environmental conditions that may impede adjustment by the circadian timing system will also be discussed.

The nursing home environment. In the highly regulated, medically-focused nursing home environment, high levels of nighttime noise and light have been linked to sleep disruption (Cruise, Schnelle, Alessi, Simmons, & Ouslander, 1998). Much of the disruptive noise and light is the result of nursing staff, particularly incontinence checks. On average, more than 20 loud sounds and at least two light changes per resident per night were found (Cruise et al., 1998). Nursing home residents cite noise as a factor in delayed sleep onset and disturbances from roommates as a factor in nighttime awakenings (Middelkoop, Kerkhof, Smilde-van den Doel, Ligthart, & Kamphuisen, 1994). Noise pollution in nursing homes exceeds EPA recommended levels and approaches that found in a busy traffic area (Bharathan et al., 2007).

Transitions from dark to dim and dim to bright light prompt cortisol release, and when awakening also occurs at these times, cortisol levels double in comparison to those found when awakening in darkness (Copinschi & Caufriez, 2007). Light exposure and release of cortisol during the night is of concern as evidence suggests an inverse relationship between cortisol and melatonin.

The synthesis and release of melatonin, often referred to as the sleep-promoting hormone, is stimulated by darkness and inhibited by light. Nocturnal awakenings every 2 hours for incontinence checks and repositioning are policy driven due to practice guidelines aimed at prevention of pressure sores. As a result, the lights are routinely turned on, and 87% of incontinence checks are associated with awakenings of at least 2 minutes, with a mean wake time of 21 minutes (Bliwise & Breus, 2000). Pulses of

cortisol secretion follow nighttime awakenings of 10 minutes or more (Copinschi & Caufriez, 2007). Increased cortisol secretion during the “quiescent” period of the cortisol rhythm also has negative implications in regard to activation of the hypothalamo-pituitary-adrenal (HPA) axis. Studies have shown that even modest elevation of cortisol during the quiescent period is associated with serious central and peripheral disturbances including memory deficits and insulin resistance. See Copinschi and Caufriez (2007) for a thorough discussion of age-related sleep changes and the implications for the corticotropin axis and other endocrine functions.

Nursing home regulations stipulate that noise problems should be addressed before other therapies are used to treat sleep disturbances and evidence shows that individualized nighttime incontinence care can decrease awakenings (J. F. Schnelle, Cruise, Alessi, Al-Samarrai, & Ouslander, 1998). Although an intervention aimed at curbing nighttime noise alone did not appear to improve sleep (John F. Schnelle, Alessi, Al-Samarrai, Fricker, & Ouslander, 1999), interventions that combined exercise with a reduction in nighttime noise and light show improvement on nighttime sleep and daytime agitation in impaired nursing home residents (Alessi, Yoon, Schnelle, Al-Samarrai, & Cruise, 1999).

Light is considered one of the most powerful synchronizers in entrainment of the circadian timing system. Nursing home residents are exposed to inadequate levels of bright light during the day (Ancoli-Israel, Martin, Kripke, Marler, & Klauber, 2002) and disruptive levels of light during the night (Cruise et al., 1998). The consequence of continuous exposure to light is the gradual loss of circadian rhythmicity. Conversely,

increased daytime light exposure decreases agitation in dementia patients and has been linked to improvements in circadian rhythms, sleep, and mood (Gammack, 2008).

The biological clock is sensitive not only to light but also temperature fluctuations. Nursing homes lack modulation of both of these rhythm-enhancing stimuli. Absence of or a reduction in clear and consistent daily zeitgebers is associated with circadian and functional disturbances, particularly in the elderly and infirm. The following discussion of light and temperature is based on findings presented by Van Someren and colleagues (Van Someren & Riemersma-Van Der Lek, 2007) unless otherwise noted.

The sleep-wake cycle is closely linked to changes in body temperature across the 24-hour day. There is speculation that abnormalities in skin temperature regulation can contribute to sleep and circadian disturbances and that changes in skin temperature may affect the ability to initiate and maintain sleep (Raymann, Swaab, & Van Someren, 2007; Van Someren, 2003; Van Someren & Riemersma-Van Der Lek, 2007). Foot-warming techniques at bed time accelerate sleep onset, and although this effect is attenuated in older subjects with sleep problems, responsiveness to warming techniques may be improved by increasing the vasodilatory response through physical activity (Raymann et al., 2007). Increased regularity in physical activity and a decrease in bed rest could increase body temperature and enhance circadian adjustment by increasing the amplitude of the temperature rhythm.

The overall flattening of light exposure across the 24-hour day has serious health implications for frail nursing home residents who need clear and consistent environmental signals to enhance circadian rhythms. With suboptimal functioning of the

circadian timing system due to age or illness, enhanced external stimuli are necessary to maintain a healthy rhythm. Using a metaphor of a child on a swing, input signals to the circadian timing system should be equivalent to a regular, repeated, appropriately-timed push (Van Someren & Riemersma-Van Der Lek, 2007).

The relevance of environmental factors to the present investigation is twofold. First, changes in the regularity of daily activities during institutionalization are of interest and will be explored. Social rhythms or daily behaviors serve as a conduit to important physical zeitgebers including bright light. Maintaining regularity in behaviors ensures consistent, repeated exposure to light. Increased daytime activity also replaces sedentary behavior. This helps maintain a strong homeostatic sleep drive and possibly raises the overall body temperature during the day which also serves as input to the circadian system. Therefore, the benefit of regular daytime activity includes exposure to other important rhythm entraining stimuli. Second, the present study will investigate residents' self-report of nighttime awakenings related to environmental factors to determine the prevalence of these problems in this sample. Although this is not a primary aim of the study, it will help clarify the relative role of environment versus other factors in rest-activity rhythms.

Sleep changes and nursing home placement. A relatively small number of studies have investigated the relationship between nursing home placement and sleep. These studies include studies of the role of sleep disturbance in nursing home placement (Pollak & Perlick, 1991; Spira et al., 2012), pre-illness sleep and depression in patients admitted to postacute rehabilitation facilities (Martin, Jouldjian, Mitchell, Josephson, & Alessi, 2012), assessment of sleep nursing home residents (Clapin-French, 1986) and a

comparison of sleep variables in institutional versus community samples (Middelkoop et al., 1994).

According to data from these studies, 70 percent of caregivers cite nighttime sleep problems as a key reason for their decision to place an elderly relative in a nursing home (Pollak & Perlick, 1991). Despite this fact, sleep has been assessed only in a very cursory fashion in the nursing home (Clapin-French, 1986). Research reveals significant inadequacies of sleep-related data recorded by nursing staff in the Minimum Data Set (Martin & Alessi, 2006). When compared to subjective and objective measures, the MDS records significantly underestimate insomnia, with 6% of subjects with insomnia recorded on the MDS as compared to 72% experiencing significant nighttime sleep disruption as measured by actigraphy. Hypnotic use was also significantly underestimated in the MDS when compared to medication records in resident charts. Poor documentation of sleep problems and hypnotic use suggest a continuing need for more accurate assessment and recording procedures, especially because nursing staff are required to make decisions about hypnotics prescribed on an as needed basis.

Clapin-French (1986) indicated that there was an advancement in the timing of sleep at night but not in rise times following nursing home placement, a conclusion based on use of an overall distribution pattern. The use of overall patterns of sleep and wake times may have masked changes in individual rise times such that morning types may have awakened later than usual, and evening types may have awakened earlier than usual, with these opposing changes appearing as no change in the overall distribution. Indeed, evidence from a study of patients in a hospital setting revealed opposing shifts in phase of wake times in morning versus evening types when required to adjust to the rest-activity

pattern of the facility (Floyd, 1984). Changes in sleep-wake patterns during nursing home placement should be studied to determine if individuals experience significant phase shifts.

To investigate the role of institutionalization on sleep-wake patterns, researchers compared samples of elderly subjects in independent living (IL), service homes (SHs), and nursing homes (NHs) in the Netherlands (Middelkoop et al., 1994). With increased levels of care (IL to SH to NH), fewer residents had freedom to choose rise time (98%, 72%, 19% respectively), more were dissatisfied with bedtimes (4%, 16%, 29%), and more reported a regular nap (31.6%, 46.8%, 59.4%). Overall, the sleep-wake cycle was increasingly advanced with level of care. Based on this information and the graphical display of sleep-wake patterns presented in the paper, it appears that elders in the nursing homes awakened earlier and remained in bed longer compared to noninstitutionalized controls, thus prolonging time in bed while awake. Although satisfaction and freedom to choose were measured, the study did not explore phase shifts in individuals, particularly for morning versus evening types. Regular hypnotic use was significantly higher in institutionalized subjects, and a notable difference in prescription practices was found between the two NHs studied, 71% versus 33%, reflecting the prescribing practices of physicians between facilities. Sedative-hypnotic drug use did not correlate significantly with subjective sleep quality in the institutionalized groups, again indicating the need for more thorough assessment and refined treatment approaches.

Martin et al. (2012) found that pre-illness sleep complaints and depression predicted sleep disturbances in patients followed for up to 12 months after admission to inpatient postacute rehabilitation facilities. In addition, Spira et al. (2012) investigated

objectively measured sleep variables in older women as a predictor of nursing home placement. Those who had the lowest sleep efficiency and the most wake after sleep onset were at significantly greater odds for institutionalization 5 years later. Overall, these studies underscore the importance of pre-existing sleep-related factors in predicting nursing home placement and post-admission disturbances.

Daytime activity patterns. Intuitively, a move into a new dwelling will result in changes in the amount, regularity, and timing of daily activities. These changes may be transient or permanent, particularly if physical function is compromised and access to preferred activities is diminished. To my knowledge, no studies have investigated changes in activity patterns during the transition to a nursing home.

What happens during waking hours is as critical for circadian and homeostatic sleep mechanisms as what happens during sleep. The aforementioned study by Middlekoop and colleagues (1994) provides some evidence of changes in daytime activity in form of naps, but lacks evidence of other changes for individuals as they come to live in the nursing home including preferred timing, amount, and regularity of daytime activity.

Higher levels of daytime activity and daylight exposure are associated with stability of the rest-activity rhythm in the nursing home (Van Someren et al., 1996) and higher levels of physical and psychosocial activity predict circadian sleep-wake rhythm maintenance in residents with dementia (Sullivan & Richards, 2004). Day-to-day stability of the activity profile is also critical. Interdaily stability (IS) of the activity-rest rhythm was found to be a better predictor of mood disturbance in patients with dementia than nocturnal restlessness (Carvalho-Bos, Riemersma-van der Lek, Waterhouse, Reilly, &

Van Someren, 2007). Maintenance of daily routines in older community-dwelling adults was found to be associated with a reduced rate of insomnia (Zisberg, Gur-Yaish, & Shochat, 2010). These findings suggest that treatments that enhance daytime activity and stability of activity across days may improve behavioral rhythms, sleep, and mood in older adults. When used as an intervention strategy, exercise programs alone did not improve sleep in residents with dementia (Alessi et al., 1995), but when combined with improved nighttime noise and light (Alessi et al., 1999) and structured social activity, the combined interventions showed improvement on sleep variables.

In a study investigating a 14-day intervention involving social and low-intensity physical activities in assisted living facility residents, Naylor et al. (2000) found that the activity group showed increased amount of slow-wave sleep and greater overall performance on a procedural memory task, but no effect on the amplitude or phase of core body temperature or daily vigor or mood profiles. This study highlights the importance of light physical activity and social structure on sleep and memory performance. Lack of findings regarding phase and amplitude of body temperature and subjective mood ratings may be related to the relative timing, intensity, and duration of the intervention or of the outcome measures chosen in this study. Van Someren (Van Someren & Riemersma-Van Der Lek, 2007) implicates day-to-day and week-to-week variability in insomnia and dementia patients as a potential reason for equivocal results in some studies. He emphasizes a need for longer durations in outcome measurement or inclusion of measures of variability (Van Someren & Riemersma-Van Der Lek, 2007) as well as increased amount, regularity and duration of exposure to stimuli in older adults

due to failures in circadian and homeostatic mechanisms (Van Someren & Riemersma-Van Der Lek, 2007).

Timing of activities. Although there is a movement to become more patient-centered in nursing homes, the timing of sleep, meals, and baths must conform to staffing constraints. On the surface, this may seem only a minor inconvenience, but these changes can impede adjustment if they represent a shift in the timing of zeitgebers.

A study of a psychiatric inpatients as compared to community-dwelling outpatients provides some evidence for an interaction between the schedule of activities determined by a facility versus the sleep-wake cycle of patients (Floyd, 1984). Both morning types and evening types experienced phase changes during institutionalization when compared to their community-dwelling counterparts. Morning types reported a phase delay whereas evening types reported a phase advance. Phase shifts appeared to be the result of hospital rest-activity cycles (morning wake times of 7 a.m.) that were in opposition to circadian preference.

Changes in mealtime habits and the importance for health have been understudied in older adults (Engelheart, Lammes, & Akner, 2006). In animal models, scheduled, restricted feeding patterns have been shown to play a role in improvements of diabetes processes, slowing of tumor growth, and increased amplitude of circadian clock gene expression (Mendoza, 2007). Evidence from animal models also demonstrates that daily feeding cycles can strongly affect peripheral oscillators, and when coupled with caloric restriction, can entrain behavioral and physiological circadian rhythms (Mendoza, 2007).

Some notable changes have been documented in eating habits in nursing home residents. In a study comparing nursing home to community dwelling elders, eating

episodes were found to be more dispersed across the day and the length of fasting at night was significantly shorter in nursing home residents (Engelheart et al., 2006). Shifts in circadian patterns of food intake have been found in nursing home residents with Alzheimer's Disease, with the majority of caloric intake occurring at breakfast in patients with higher levels of behavioral problems (Young & Greenwood, 2001). In a study of the relationship between age and social rhythms, data suggest a marked increase across the lifespan of regularity of daytime activities including mealtimes (Monk, Reynolds, et al., 1997). Given evidence from animal models of the importance of food intake, the timing and regularity of meals may be an important factor in circadian adjustment during a transition to the nursing home.

Social Zeitgeber Theory

As mentioned previously, the Social Zeitgeber Theory (SZT) of mood disorders provides a framework through which the convergence of behavioral circadian rhythm, sleep, and mood disturbances in elderly nursing home residents might be better understood. Significant life events produce changes in social zeitgebers that lead to social rhythm instability and potential disruption of biological rhythms (Ashman et al., 1999). If this instability is prolonged and accompanied by other vulnerabilities, it can lead to a major mood disturbance (Ehlers et al., 1988). This theory is well-suited to a nursing home population because it integrates biological and psychosocial explanations in the etiology of depression. Changes in circadian rhythms as a result of social rhythm disturbances during institutionalization could be related to the high levels of sleep and mood disruption found in nursing homes.

Social influences were considered a major zeitgeber to the circadian timing system and received a great deal of attention in the 1970s, but this work was essentially eclipsed by discoveries of the influence of bright light (Mistlberger & Skene, 2004; Monk, Flaherty, Hoskinson, & Kupfer, 1990). Bright light has profound effects on the circadian timing system and rhythm entrainment, and is effective in treating rhythm disorders and depression, but is not well tolerated in the elderly (Suhner, Murphy, & Campbell, 2002). Social factors may be more amenable to change and may serve as a useful strategy in addressing rhythm, sleep and mood problems in this population.

Social rhythms (daily patterns of social and other daytime activities) can serve as a conduit to exposure to important physical stimuli including bright light but evidence also exists in support of distinct effects of social zeitgebers (Ehlers et al., 1988; Mistlberger & Skene, 2004). Entrainment of circadian rhythms has been demonstrated through scheduled bedtimes, mealtimes, and other timed social cues (Aschoff et al., 1971). Behavioral manipulations can attenuate or magnify the action of physical and pharmacological agents as demonstrated in animal models (Monk et al., 1990). In a study of differential effects of bright light and social cues, Honma et al. (1995) manipulated the social schedule of participants during a period of 15 days during which subjects were unaware of the natural day-night schedule. On the fourth day, sleep and social contacts were phase-advanced by 8 hours. Subjects were divided into two groups, one that received exposure to 3-hour bright light pulse in the morning and the other with no bright light. Bright light exposure accelerated the rate of entrainment, but subjects with no bright light exposure experienced phase shifts as well, suggesting the independent effect of sleep timing and social stimuli. Other studies also support reentrainment of rhythms in

absence of bright light, for example research has shown that a strict schedule including regular sleep timing prevents rhythms from free running in temporal isolation including total darkness (Aschoff et al., 1971).

Meal timing is also considered a social behavior but the timing of food intake has been shown to be a potent zeitgeber in animals (Mistlberger & Skene, 2004), again posing a challenge in differentiating the social aspects of mealtimes from the physiological component. Considerable debate remains as to whether and how much social stimuli influence circadian timing independently of the regulation of exposure to light or other stimuli. Regardless, the present study will focus on the frequency and regularity of daily activities and the relationship of these aspects of behavior to rest-activity rhythms, sleep and mood. Although we will not investigate the presence or absence of social contact at these times, collectively these daily activities are referred to as the “social” rhythm.

Social rhythms in relation to age, sleep, and mood. The Social Rhythm Metric (SRM; Monk et al., 1990) was created to measure the amount and regularity of daily activities. It measures “lifestyle regularity” or how consistently a person maintains a daily routine. Lifestyle regularity increases with age. Healthy adults in their 80s and 90s score one standard deviation higher on a common measure of lifestyle regularity when compared to adults in their 30s (Monk, Buysse, et al., 1992; Monk, Reynolds, et al., 1997). This age-related increase occurs independently of employment status or changes in other person involvement due to changes in marital status or having children (Monk, Petrie, Hayes, & Kupfer, 1994). The age-related increase in lifestyle regularity is consistent across groups of older adults including healthy controls, subjects experiencing

late-life challenges (loss of spouse or caregivers for spouses with dementia), and subjects with insomnia (Monk et al., 2006). In a study of community dwelling elders, stability in daily routine predicted shorter sleep latency, higher sleep efficiency, and better sleep quality, beyond the effects of age, functional status, and health (Zisberg et al., 2010).

When compared to a group of younger adults (19 to 28 years old), healthy older adults (71 to 91 years old) were found to have daily social rhythms that were more regular (Monk, Reynolds, Machen, & Kupfer, 1992). Advancement in the timing of daily activities including sleep and mealtimes was also found in the older group, consistent with research findings of age-related phase advances in endogenous rhythms. Monk postulated that the overall increase in lifestyle regularity seen in this group of healthy older adults may have been protective of their “success” in aging or may represent some compensation for a weakening in the circadian timing system.

To explore whether SRM scores increased across the entire lifespan, Monk and his colleagues (1997) studied 239 subjects ranging in age from 20 to 89 years. Lifestyle regularity increased reliably with age, and the amount of recorded daytime activities completed followed an inverted “U” shaped pattern with the peak of activities occurring at approximately 50 years of age. This pattern mimicked that of marriage and work status, but other factors likely contribute to a “busier” schedule in middle age.

Lifestyle regularity has also been found to relate to chronotype. Older adults have been found to have higher levels of both morningness and increased lifestyle regularity, although the correlation between morningness and lifestyle regularity is substantially weaker in older groups (Monk, Buysse, Potts, DeGrazia, & Kupfer, 2004). Associations between higher levels of lifestyle regularity and fewer self-reported sleep problems have

been documented in healthy adults (Monk, Reynolds, Buysse, DeGrazia, & Kupfer, 2003). In a study of 100 adults between the ages of 19 and 49 ($M = 31.2$), subjects with self-reported sleep problems had significantly lower SRM scores than subjects who reported sleep quality within the normal range. The opposite was also true; when SRM was used to categorize subjects into those with irregular lifestyles (at least one standard deviation below the mean), there were twice as many poor sleepers as compared to subjects with non-irregular lifestyle scores. In patients with Parkinson's Disease (PD), for whom lifestyle regularity is lower than for age-equivalent controls, lower lifestyle regularity based on SRM scores also related to poorer self-reported sleep quality and more depressive symptoms (Magalhães, Souza, Dias, de Bruin, & de Bruin, 2005).

Cross-sectional studies reveal a link between depression and social rhythms. Depressed patients have more irregular social rhythms than controls, and activity levels may have a moderating effect on the relationship between social rhythms and sleep in depressed patients (Brown et al., 1996; Haynes, Ancoli-Israel, & McQuaid, 2005; Szuba, Yager, Guze, Allen, & Baxter, 1992). Further supporting the SZT, changes in the sleep-wake cycle were found in depressed patients but not in controls following life events rated as disruptive to sleep and social rhythms (Haynes, McQuaid, Ancoli-Israel, & Martin, 2006).

As noted by Monk, the direction of causality between sleep and lifestyle regularity is unclear, as social rhythms may impact sleep or poor sleepers may make more irregular choices in their sleep-wake times and other activities. Similarly, depression may disrupt lifestyle regularity, but changes in lifestyle regularity could also increase the risk for depression.

Summary and statement of the problem

Evidence for a relatively high prevalence of behavioral rhythm, sleep, and mood disturbances in nursing home residents has been presented. Social rhythms are theorized to play a role in disturbances of endogenous circadian rhythms and mood when someone is challenged by a significant life event. To my knowledge, no studies to date have explored these factors in newly admitted nursing home residents, with institutionalization as the intervening “significant life event.”

Identification of behavioral interventions or environmental accommodations that facilitate circadian rhythm adjustment and possibly prevent sleep and mood disturbances could minimize the need for additional treatments in this frail and medically compromised population. Pharmacological treatments for sleep and mood disturbances have many disadvantages in the elderly including a high rate of polypharmacy and adverse drug effects. Bright light treatment shows promise in treatment of rhythm, sleep and mood disturbances in older adults (Lieverse et al., 2011) but further research is needed. Conflicting evidence exists regarding the durability of effect over time. Also, bright light treatment may not be well tolerated in older adults (Suhner et al., 2002). The effectiveness of another chronobiological treatment, exogenous melatonin, has yet to be established in older adults (Gehrman et al., 2009). As initiatives are underway to transform long-term care into a more person-centered home-like environment, identifying and supporting maintenance of residents’ preferred sleep-wake schedule and social rhythms, and manipulating the nursing home environment to enhance zeitgebers represent a promising area of study.

HYPOTHESES

Behavioral rhythm, sleep, and mood disturbances are prevalent in the broad nursing home population, but we know little about the course of these disturbances. Therefore, the present study is aimed at identifying the types of problems that exist in elders as they come to live in the nursing home.

- 1) Characterize the relationship between rest-activity rhythms, sleep, and mood in newly admitted nursing home residents. **H1:** Weaker rest-activity rhythms will be associated with more sleep and mood disturbances.

Older adults who come to live in the nursing home are typically medically compromised and vulnerable, therefore identifying risk factors that may predict adjustment and recovery is critical. It is widely accepted that older adults have difficulty adjusting to changes in sleep timing. If such a change occurs during nursing home placement and is associated with disturbances in rhythm, sleep, and mood disturbances, accommodating personal preference for sleep during this transition may serve as a potential intervention strategy.

- 2) Characterize changes in sleep timing (phase) in recently admitted nursing home residents and explore the relationship to rest-activity rhythms, sleep, and mood. **H2:** Significant changes in sleep timing will occur during the transition to nursing home care. **H3:** Larger changes in sleep timing will predict more disturbances in rest-activity

3) rhythms, sleep, and mood. **H4:** Larger changes in sleep timing will predict weaker social rhythms at T2.

Changes in social rhythms may be another contributing factor in this relationship.

According to Social Zeitgeber Theory, a significant life event can interrupt social zeitgebers, leading to social rhythm instability which may undermine biological rhythm stability in turn leading to depression. The transition to a nursing home is a significant life-changing event that could easily interrupt daily activities and social rhythms. The literature also suggests that maintenance of social rhythms may serve as a protective factor.

4) Characterize social rhythms in recently admitted nursing home residents and explore the relationship to rest-activity rhythms, sleep, and mood. **H5:** Stronger social rhythms at T2 will predict fewer disturbances in rest-activity rhythms, sleep, and mood.

Chronotype has been associated with social rhythms and mood and may serve as an important predictor of disturbances in sleep and mood in older adults attempting to adjust to the nursing home environment. Morning types may have less difficulty adjusting to the nursing home because their endogenous rhythms may more closely match the timing of activities in the nursing home. Evening types on the other hand may require more changes in the timing of their sleep to accommodate the morning-oriented nursing home schedule. Therefore, chronotype may serve as a predictor of adjustment.

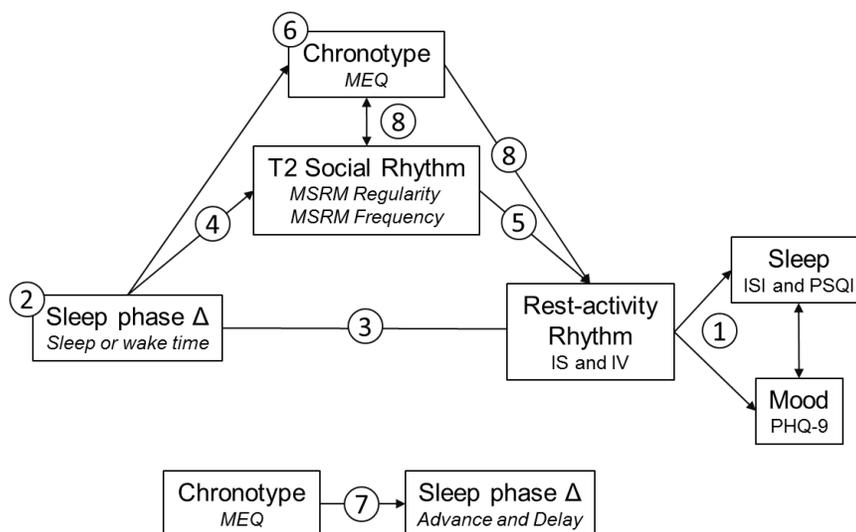
5) Characterize chronotypes in recently admitted nursing home residents and explore the relationship to circadian phase, behavioral rhythms (rest-activity and social rhythms), sleep, and mood. **H6:** Newly admitted nursing home residents will, on average, be

morning types. **H7**: Chronotype will predict the amount of change in sleep timing and evening types will experience larger changes in circadian phase. **H8**: Higher levels of morningness in nursing home residents will be associated with fewer disturbances in social and rest-activity rhythms, sleep, and mood.

Research suggests that strong social rhythms and morningness are associated with positive outcomes. In the face of challenges during institutionalization such as a change in timing of sleep, these factors may serve as protective factors. Therefore, a final aim is to assess the hypothesis that:

- 6) Residents who are morning types and have strong social rhythms will experience fewer disturbances in circadian rhythm, sleep and mood following a change in sleep phase. **H9**: Social rhythms and chronotype will moderate the relationship between a phase shift and circadian rhythm, sleep, and mood. Those who have stronger T2 social rhythms and morning preference will experience fewer disturbances in rest-activity rhythms, sleep, and mood following a significant phase shift than residents with less regular lifestyles and evening preference.

Figure 1. Hypothesized relationships between variables of interest



METHODS

Study Design

This study used a cross-sectional design to examine factors that place elders at risk for behavioral rhythm, sleep, and mood disturbance during the transition to long-term care. Residents were interviewed using self-report measures of pre-institutional activity patterns and preferences, sleep quality, and mood. Residents were also asked to wear an actigraph, a wristwatch-like device that captures movement as a measure of daily rest-activity patterns. The expected duration for each resident's participation was 7 days for collection of actigraphic data and approximately one to two hours of direct contact with investigators consisting of ½ to 1 hour at two separate time points. At Time 1, investigators interviewed the resident and placed an actigraph on the resident's non-dominant wrist. Residents were also given a brief daily diary to record sleep and wake times, daytime naps, and nighttime arousals for the next week. Seven days later (Time 2), investigators removed the actigraph, interviewed the resident, and collected data from the medical chart. Actigraphic data were downloaded to Actiware software and watches were reset and recharged for subsequent use.

Recruitment

A total sample size of 36 was targeted based on review of the data and power analyses. Eligible participants included all adults at least 65 years of age who were admitted to a long-term care facility within the past 30 days and who were expected to

remain in the facility for at least two weeks. Recruitment and data collection began at the earliest point of the resident's nursing home stay as was feasible within the context of the nursing home. Some challenges were anticipated in participant recruitment given the complexity of issues that confront residents as they come to live in nursing homes such as acute injury or illness and recovery for those in rehabilitation or chronic illness and loss of function and independence for those facing a long-term stay.

Because one important goal of the study was to explore variables that place elders at risk for rhythm disturbance during the transition to nursing home care, fairly inclusive recruitment criteria were used. Medical and psychiatric illnesses are often used as exclusionary criteria in studies of sleep and circadian rhythms, but these exclusions were limited in the present study. Chronic medical conditions are common in this population and often represent vulnerabilities that place patients at risk for sleep disturbance. Some specific conditions (and medications used to treat those conditions) including pain, nocturia, and neurological disorders, directly impact sleep and/or circadian rhythms. Residents typically take multiple medications which often include hypnotics or medications with sedating effects. Residents were not excluded based on medical condition or medication use, but data on these factors was collected, and was investigated in secondary analyses. Patients who were experiencing delirium or active psychosis were excluded from the study.

Many neurological disorders such as Alzheimer's and Parkinson's Disease increase in prevalence with age and are common in nursing homes. Neurological disorders, especially in the late stages of disease progression, are associated with sleep abnormalities. Although such disorders did not preclude participation in the study,

residents were required to communicate orally with investigators, provide informed consent, and respond reliably on self-report measures. Participants with cognitive impairment were excluded from the study, therefore those who may have had later stages of neurological disease and associated sleep dysfunction were likely ineligible for participation.

Measures

Demographic variables and medical information. Information on demographics was collected from the Minimum Data Set (MDS), a standardized assessment instrument administered upon admission to all nursing home residents. It is federally mandated, updated quarterly, and re-administered annually. The MDS includes information about medical diagnoses, treatments, activities of daily living (ADLs), cognitive status, routine and activity preferences, and mood (Saliba & Buchanan, 2008). For the present study, the MDS and medical chart supplied demographic data including age, gender, race/ethnicity, marital status, and education. Information on length of stay, goals for continuing care, sleep, ADLs, routine and activity preferences, functional status, disease diagnoses, medications, pain, and therapy were also be captured from the MDS.

Cognitive status. All residents are screened upon admission by nursing staff using the Brief Interview for Mental Health Status (Saliba & Buchanan, 2008). Because the present study relies upon self-report measures, this data was used to identify eligible residents. The Brief Interview for Mental Health Status (BIMS) is a seven-item measure of cognitive status. It assesses cognitive status via repetition of three words, temporal orientation, and recall. Scores range from 0 to 15 with lower scores suggesting more impairment. The BIMS classifies cognitive status as intact/borderline (13-15), moderate

impairment (8-12), and severe impairment (<8). Inter-rater reliability is excellent between trained assessors (.98) and between trained assessors and facility nurses (.97). The BIMS correlates highly with the Modified Mini-Mental Status Exam (.91). For any cognitive impairment, the optimal cut score is 12, yielding a sensitivity of .83 and specificity of .91. Residents with scores below 13 on the BIMS were not eligible for participation in the study.

Rest-activity rhythms. Actigraphy is an objective method of estimating disturbances in sleep using measures of rest-activity rhythms. The actigraph is a small monitor that can be worn like a wristwatch during normal activities, including baths. The Actiwatch 2 devices used in this study measure movement via a piezoelectric beam that generates voltage each time the device moves and captures light exposure via a photosensitive cell. Data was transferred from the device through a docking station onto a desktop computer. The accompanying Actiware 5.70.1 software was used to calculate sleep variables and export raw data for analysis in SPSS.

Actigraphy is widely used in the nursing home setting for evaluation of sleep and circadian rhythm disturbances. The “gold standard” for measurement of sleep is polysomnography (PSG) but this method is impractical in a frail elderly population. According to the American Academy of Sleep Medicine, actigraphy is appropriate for use in characterizing sleep and circadian patterns in older adults including those residing in nursing homes (Morgenthaler et al., 2007). Unlike PSG, actigraphy is nonintrusive and can measure rest and activity in the patient’s natural environment without any required changes in routine. The technology affords the researcher or clinician an ability to detect patterns for days and weeks at a time. This is especially useful for older adults or patients

with insomnia who may have high levels of night-to-night or even week-to-week sleep variability (Van Someren & Riemersma-Van Der Lek, 2007).

Sleep logs are also a standard method for assessing sleep but a daily diary poses a heavy burden on elders facing the transition to the nursing home. During the first weeks of life in a nursing home, residents undergo multiple assessments by different disciplines and they experience changes in routine that often include extensive rehabilitation and other therapies. These distractions make it difficult to ensure compliance with daily recording of activities by the participant. Indeed, only 11 of 38 participants completed sleep diaries for the present study and several of these diaries were incomplete.

Actiwatch devices were programmed to sample activity and light information every 10 seconds, logged at 30-second intervals for approximately 7 days, and analyzed at medium sensitivity. For those participants who provided a sleep diary, the appropriate sleep and wake times were compared to Actiwatch data and entered accordingly.

Participants who did not complete a sleep diary were asked to estimate their sleep and wake times from the past week. Each record was visually inspected to determine whether self-reported sleep and wake times were reasonably related to the Actiwatch recorded activity patterns. In cases where an obvious discrepancy existed, the times were edited based on consideration of all available data. For example, morning wake times are often evident with abrupt changes in activity and light (see Figure 2a). If an abrupt change in light and activity was evident earlier or later than the self-reported wake time, the wake time was adjusted according to the data. If data appeared to indicate a sleep time starting earlier in the evening, the bed time was adjusted to the closest major activity period that preceded an inactive period or reduction in light exposure, suggesting “lights out” (see

Figure 2b). If a resident's rhythm was highly fragmented, the self-reported sleep times were entered without modification (see figure 2c). The methods just described were used consistently across participants to reduce the impact of this procedure on the data.

Figure 2a. This participant indicated a 6 a.m. wake time. The exact wake time was adjusted to coincide with the beginning of a major activity period and abrupt increase in light exposure. Bed times were set according to self-reported bed time of 10 p.m. due to fragmented activity data in the evening and no clear change in light pattern.

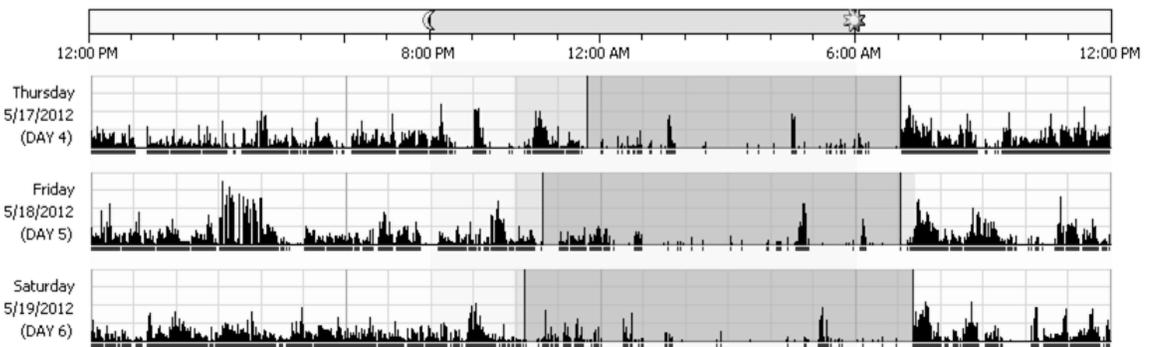


Figure 2b. An actogram for a participant who indicated an 8:30 p.m. bed time. Because data appeared to indicate an abrupt change in activity at earlier times, the bed time was adjusted to the first major inactive period following an active period and coinciding with a reduction in light exposure suggesting "lights out." Wake times were set according to abrupt change in activity data and closest to the self-reported wake times of 7 a.m.

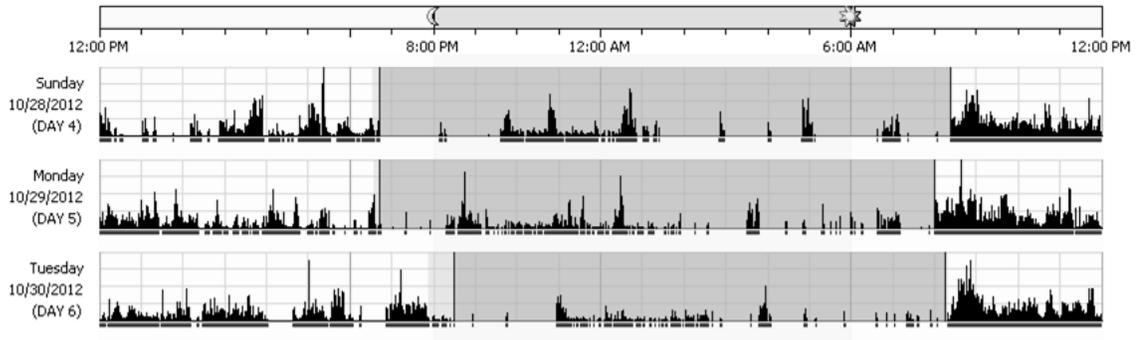
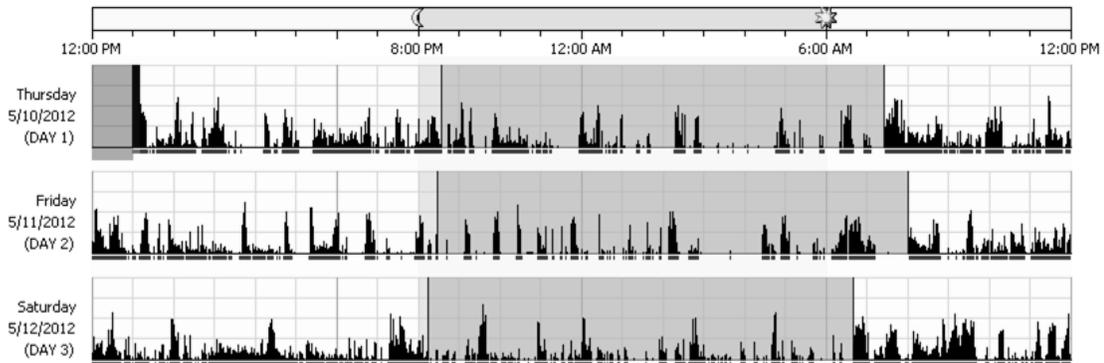


Figure 2c. Illustration of a highly fragmented rhythm where bed times were set according to participant's self-report of 8 p.m. without adjustment. Wake times were set at the closest point to the self-reported wake time where a major change in activity was noted.



Actigraphy data can be analyzed directly to track rest-activity patterns across the day and week. In older adults, more transitions between shorter periods of rest and activity occur throughout the circadian cycle (Van Someren, 2007), therefore the most appropriate variables for the present study include those that are sensitive in detecting patterns in patients with significant rhythm fragmentation. Two nonparametrically derived variables were used in the present study: interdaily stability (IS) and intradaily variability (IV). These variables are particularly appropriate because they do not rely on distinction of a major sleep and wake period. This also eliminates reliance on the aforementioned procedure used to set sleep and wake intervals. IS measures stability of activity across days and IV measures the frequency and extent of transitions between rest and activity. These variables have been used in study of patients with dementia who have highly fragmented rhythms. Other variables such as dichotomy indices quantify the relative differences in activity levels during major sleep and wake periods. This presents a disadvantage since they assume that the 24-hour period includes two distinct periods which is not necessarily the case in this population. Both 24-hour autocorrelation and IS

measure stability of activity across days, but the latter is more sensitive due to better use of all data points (Van Someren et al., 1999).

The calculation of IS and IV were based on detailed descriptions provided in the literature (Carvalho-Bos et al., 2007; Van Someren, Kessler, et al., 1997; Witting et al., 1990). IS is derived from the chi square periodogram (Sokolove & Bushell, 1978) with a value between 0 and 1. As described in Carvalho-Bos (2007), activity data were aggregated by day into hourly intervals with a count of minutes containing activity. An average 24-hour activity profile was calculated by averaging each corresponding hour across days. IS was calculated as the ratio between the variance of the 24-hour pattern around the mean and the overall variance of individual hourly averages (Figure 3). IS has been described as representing a “loose coupling” between the rest-activity rhythms and assumedly stable zeitgebers. Higher values represent more predictability in subsequent daily patterns and lower values indicate more day-to-day variation in activity patterns.

Figure 3. Calculation of Interdaily Stability.

$$IS = \frac{N \sum_{h=1}^P (\bar{X}_h - \bar{X})^2}{p \sum_{i=1}^N (X_i - \bar{X})^2}$$

For IV, differences between successive hourly counts of minutes of activity and the related variance were calculated. IV was the ratio of this, the first derivatives, and the overall variance of the complete series of hourly averages (Figure 4). Higher IV scores represent more transitions between rest and activity states across the day.

Figure 4. Calculation of Intradaily Variability.

$$IV = \frac{N \sum_{i=2}^N (X_i - X_{i-1})^2}{(N - 1) \sum_{i=1}^N (\bar{X} - X_i)^2}$$

Sleep. Subjective (self-report measures) and objective (actigraphy) measures of sleep were obtained. The two self-report measures, the Insomnia Severity Index (ISI) and the Pittsburgh Sleep Quality Index (PSQI) capture unique aspects of an individual's subjective experience of sleep. The ISI (Morin, Belleville, Belanger, & Ivers, 2011) is commonly used by clinicians and measures severity of sleep onset, sleep maintenance and early morning awakening as well as the impact of insomnia on daytime functioning. It consists of 7 items coded on a 5-point Likert scale (0-4) from very satisfied to very dissatisfied. The total score ranges from 0 to 28 which can be interpreted as follows: absence of insomnia (0-7); sub-threshold insomnia (8-14); moderate insomnia (15-21); and severe insomnia (22-28). The ISI uses a time reference of the past month. For the present study, the reference was changed at T1 to reflect their sleep in the week preceding hospitalization or nursing home placement and at T2 to reflect the past week which coincided with actigraphy data. This measure has been demonstrated to have adequate internal consistency and reliability (Bastien, Vallieres, & Morin, 2001).

The PSQI (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) has been used extensively in research and clinical trials, and has been translated into several languages. The measure evaluates sleep quality and over the past month. The time referent was changed as noted above for the ISI. The questions require open-ended answers about sleep timing and multiple-choice responses regarding the severity or frequency of other sleep habits and problems. The 19 questions are combined into seven clinically derived

component scores, broadly defined as: sleep quality, sleep efficiency, daytime dysfunction, sleep latency, sleep disturbances, sleep duration, and use of sleep medications. The component scores range from 0 to 3 and are added to obtain a global score ranging from 0 to 21 with higher scores indicating worse sleep quality. Validity and reliability have been well established (Buysse et al., 2008). A score at or above 5 is considered indicative of sleep pathology with a sensitivity of 89.6% and specificity of 86.5%. Good internal consistency (.89), test-retest reliability (.85), and construct validity have been established.

Objective sleep measures obtained from actigraphic recordings include total sleep time (TST), sleep efficiency (SE), average number of nighttime awakenings (AA), and wake after sleep onset (WASO). Values for these variables were based on Actiware software definitions (see Table 1). As mentioned, actigraphy has been found to be reliable and valid in the study of sleep and circadian rhythm (Ancoli-Israel et al., 2003). For example, no differences were found in new versus older devices worn on the same wrist, and correlations of activity counts from devices worn on the same wrist were .96 with 99% agreement in sleep/wake scores. Validity has been studied by comparing sleep variables from actigraphy to PSG but such comparisons are complicated by the use of different scoring algorithms in actigraphy. Broadly speaking, actigraphy tends to overestimate total sleep time and is less reliable for detecting sleep when it becomes more disturbed. Conversely, sleep logs may underestimate TST due to recall bias or sleep state misperception. Newer actigraphic devices and algorithms have improved accuracy of sleep measurement.

The actigraphic devices in the present study also capture light exposure. Daytime and nighttime average white light exposure and daily bright light exposure (>1000 lux) were explored in preliminary and post-hoc analyses.

Table 1. Definitions of sleep variables from Actiware software.

Total Sleep Time (TST)	The sum of the total sleep time for all sleep intervals associated with the 24-hour day.
Sleep Efficiency (SE)	The total sleep time divided by time in bed multiplied by 100.
Average Awakenings (AA)	The total number of wake bouts within the sleep intervals associated with the 24-hour day.
Wake After Sleep Onset (WASO)	The total number of minutes scored as wake within the sleep intervals associated with the 24-hour day.

Mood. Mood was measured using the Patient Health Questionnaire-9 (PHQ-9).

The PHQ-9 (Kalpakjian et al., 2009; Saliba & Buchanan, 2008; Williams et al., 2009) is a nine-item measure that assesses symptoms of depression. Items are rated according to symptom presence within the past two weeks (Yes, No, or No Response) and symptom frequency (1 Day/“Rarely”-0 to 12-14 Days/“Nearly every day”-4). Scores range from 0 to 27, and may be used to classify depression as none (0-4), mild (5-9), moderate (10-14), moderately severe (15-19), and severe (20-27). The inter-rater reliability of the PHQ-9 is excellent between trained assessors (.94) and between trained assessors and facility nurses (.96). Moderate correlations were found with other measures of mood typically used in nursing homes including the Modified Schedule for Affective Disorders and Schizophrenia (.69) and the Cornell Scale for Depression in Dementia (.63). The PHQ-9 has been determined to have two factors, one consisting of cognitive or affective items and the second consisting of somatic items. The PHQ-9 was implemented at T1 to assess

mood retrospectively and at T2 to coincide with the past week of actigraphic data collection.

Social rhythm. The Social Rhythm Metric (Monk et al., 1990; Monk, Kupfer, Frank, & Ritenour, 1991) was developed to quantify the stability of an individual's daily routine by counting activities and behaviors that occur on a regular basis. The SRM includes 15 specified and 2 optional events. The subject specifies whether, when and with whom each event occurs. To determine an individual score on the SRM, the "normal" time of day at which an event occurs is calculated, and the number of events that occur close to that time (within 45 minutes) are counted as "hits." Averaging these hit counts over the contributing event categories then yields an overall score ranging from 0 to 7. Higher values represent more regularity and lower numbers less regularity. The Activity Level Index (ALI) represents the number of activities performed in a week, with a maximum of 119, or 17 activities occurring on each of 7 days. The pilot study of 50 healthy subjects who completed the original measure for two consecutive weeks revealed adequate test-retest reliability ($r = .44$, $p < .001$) and conceptual validity. Also, the number of events each week did not differ significantly over a 12-week period.

The original SRM is a daily diary but a modified version (MSRM) can be used to calculate lifestyle regularity retrospectively (Shen, Alloy, Abramson, & Sylvia, 2008). Because residents were asked to provide retrospective accounts of activities prior to entrance to the nursing home, the MSRM was used for the present study. Items included for analysis on the measure are those that occur at least three times per week because circadian rhythm research shows that at least three daily cycles are necessary (Monk et al., 1990). The modified version asks if an activity occurred regularly and at

approximately the same time (within 45 minutes) over the past month. A time referent of the past week was used for the present study. Regularity was calculated as the number of “hits” or activities that occurred more than 3 times within the habitual time frame during the past week (range = 0-17). Total frequency was calculated as the total number of times all activities that were endorsed as habitual occurred (range = 0-119). The MSRM was found to have good consistency over time ($r = .61, .62$).

Additionally, a few slight modifications were made to accommodate life in a nursing home versus the community. This same procedure was used in a study of psychiatric inpatients (Szuba, Yager, Guze, Allen, & Baxter, 1992). Item 6 was changed to “start activities” rather than “start school, work, housework, child/family care.” Item 17 was changed to read “retire to bedroom” rather than “return home.”

Chronotype. The Morningness-Eveningness Questionnaire (Horne & Ostberg, 1976) is the most widely used measure of chronotype in both healthy and patient populations. The MEQ consists of 19 questions pertaining to habitual sleep times, peak times for physical and mental performance, and alertness after rising and before going to bed. Scores range from 16 to 86, with higher scores representing greater morningness and lower scores representing greater eveningness. Individuals may also be classified categorically as morning-types (59-86), evening-types (16-41), and neutral-types (42-58). Another categorization scheme further differentiates types: definite morning (70-86); moderate morning (59-69); neutral (42-58); moderate evening (31-41); and definite evening (16-30). The measure has been validated against other scales of morningness including the full ($r = .89$) and reduced version ($r = .85$) of the Composite Scale of Morningness (Randler, 2009). Medium to large effect sizes have been found between

chronotype and circadian phase in meta-analyses (Bernert et al., 2006). Morningness was associated with an earlier circadian phase, whereas eveningness was associated with a later circadian phase. Although it is not recommended as a diagnostic tool, the MEQ is widely used to identify individuals with extreme circadian tendencies that have been linked to circadian abnormalities or disorder (Sack et al., 2007).

Procedures

A list of nursing homes in the Louisville area was obtained from Nursing Home Compare, a national nursing home database. Facility administrators were contacted and informed of the study aims and specific protocol. Once facility participation was approved, a procedure was established with a designated staff member to obtain an on-going list of newly admitted residents who could be approached for participation in the study. All eligible residents (65 years or older, admitted within the past 30 days, and with a score of 13 or above on the BIMS) were approached and invited to participate in the study. BIMS scores were either provided by a designated staff member or found in resident charts by research study staff. A copy of the consent form was given to the prospective participant and the details were discussed, including the purpose and procedures of the study. Residents were informed that they could decline to participate or withdraw from the study at any time. Issues of confidentiality and handling of data were reviewed and residents were given the opportunity to ask questions. Those who wished to participate were given written details about the study aims, the specific protocol, and withdrawal procedures. A copy of the signed consent form was placed in participating residents' charts.

At T1, the resident was interviewed and the actigraph was secured on his/her non-dominant wrist with a non-removable hospital band. This approach is common in nursing homes and was instituted to ensure that the device was not removed during the testing period, particularly during baths or at night. Despite this precaution, two of four devices were removed and lost when residents were hospitalized. No input to the device such as event marking was required from the resident. Residents were asked to make sure that the device was not covered by a shirt sleeve so that light data could be measured accurately. All self-report measures were read aloud to the residents. At T2, the resident was interviewed and the actigraph was removed. The research study staff then obtained relevant chart data including education level, a full copy of the last MDS, and the medication administration record (MAR). Precautions were taken to ensure that all data and protected health information was de-identified before being taken out of the facility. The data was stored in a locked drawer within the Mental Health and Aging laboratory on the University of Louisville campus.

RESULTS

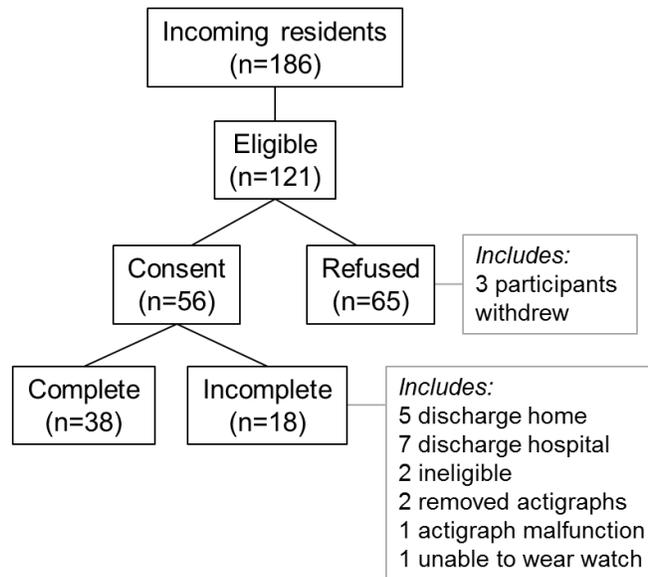
Sample characteristics

Six skilled nursing care facilities in the Louisville area agreed to participate in the present study. Chart data was collected on all eligible residents and at least 10 ineligible incoming residents at each facility for comparison purposes. Comparisons were made on demographic variables between eligible versus ineligible participants and eligible participants who agreed to participate versus those who were eligible but did not participate. One participating facility denied access to a chart study of residents who were ineligible therefore data was collected only on eligible residents who agreed to participate at this facility. The collection period began in the Spring of 2012 and continued for approximately 1 year until an adequate number of participants was recruited.

Demographic and health data were collected on 186 residents of which 112 were eligible for participation and 56 agreed to participate. For a breakdown of the process of recruitment, see Figure 5. The most common reasons given by eligible residents for refusal to participate included pending discharge (n=17), disinterest (n=11), and rehabilitation activities (n=4). Other reasons included concerns about memory, poor sleep, language production problem, and low energy. Three participants withdrew from the study, one due to a pending discharge, one due to “illness and pain,” and one stated no specific reason. Of those who agreed to participate, 38 had complete data. Of the 18

with incomplete data: 5 were discharged home; 7 residents were discharged to the hospital; 2 did not meet eligibility criteria; 2 removed their actigraphs during the collection period; 1 lost actigraph data due to device malfunction; and 1 was unable to wear the actigraph due to bilateral wrist splints.

Figure 5. Study flow



Demographics. The demographic characteristics of the overall sample, eligible versus noneligible residents, and participants versus eligible nonparticipants are presented in Table 2 and 3. Participant ages ranged from 65 (the minimum requirement) through 92, with a mean age of 78.58 years old (SD = 7.31). Education appeared to be normally distributed with the largest proportion of participants falling in the middle categories of “high school graduate” (n=12) and “some college” (n=9), and only a few participants with lower levels “no formal education” and highest levels of “advanced degree.” More females than males were found in the overall sample (66.1% and 33.9% respectively) and participant group (63.2% and 36.8%). The overall sample and participant group were largely White (94.1% and 92.8%) with limited representation from other racial groups.

Only 1 resident was identified as Asian. 5.4% of the total sample and 7.2% of the participant group identified as Black or African American.

Table 2. Demographic characteristics of overall sample (n=186)

Age	Range	40 to 96	
	Mean (SD)	78.80 (9.36)	
		<i>Frequency</i>	<i>Percentage</i>
Education	No formal	3	1.6%
	Some grade school	2	1.1
	8 th grade	21	11.3
	Some high school	30	16.1
	High school grad	67	36.0
	Some college	29	15.6
	Associate's degree	3	1.6
	Bachelor's degree	7	3.8
	Advanced degree	11	5.9
Gender	Male	63	33.9
	Female	123	66.1
Race	Asian	1	0.5
	Black or AA	10	5.4
	White	175	94.1
Marital status	Never married	10	5.4
	Married	51	27.4
	Widowed	88	47.3
	Separated	1	0.5
	Divorced	36	19.4

No significant differences were found on age ($t(184) = -.73, p = .464$), gender ($\chi^2 (1) = .94, p = .332$), education ($\chi^2 (8) = 11.78, p = .161$), race ($\chi^2 (2) = 2.01, p = .367$), or marital status ($\chi^2 (4) = 3.88, p = .423$) between eligible and ineligible residents.

No significant differences were found on age ($t(119) = .59, p = .558$), gender ($\chi^2 (1) = .76, p = .383$), education ($\chi^2 (8) = 12.33, p = .137$), race ($\chi^2 (1) = 2.89, p = .089$), or marital status ($\chi^2 (3) = 2.44, p = .486$) between participants and eligible nonparticipants.

Table 3. Demographic characteristics and comparisons among sample subsets

	Eligible		Ineligible		Participants		Eligible Nonparticipants		
	Freq	Percent	Freq	Percent	Freq	Percent	Freq	Percent	
Age	65 to 96		40 to 96		65 to 92		65 to 96		
	79.17 (7.41)		78.11 (12.22)		78.58 (7.31)		79.43 (7.49)		
Sample size	121	65.1%	65	34.9%	38	20.4%	83	44.6%	
Education	No formal	1	0.8	2	3.1	1	2.6	0	0
	Some grade school	1	0.8	1	1.5	1	2.6	0	0
	8 th grade	11	9.1	10	15.4	5	13.2	6	7.2
	Some high school	19	15.7	11	16.9	2	5.3	17	20.5
	High school grad	38	31.4	29	44.6	12	31.6	26	31.3
	Some college	23	19.0	6	9.2	9	23.7	14	16.9
	Associate's degree	3	2.5	0	0	2	5.3	1	1.2
Gender	Bachelor's degree	6	5.0	1	1.5	3	7.9	3	3.6
	Advanced degree	9	7.4	2	3.1	2	5.3	7	8.4
	Male	38	31.4	25	38.5	14	36.8	24	28.9
Race	Female	83	68.6	40	61.5	24	63.2	59	71.1
	Asian	0	0	1	1.5	0	0	0	0
	Black or AA	6	5.0	4	6.2	6	7.2	0	0
Marital status	White	115	95.0	60	92.3	77	92.8	38	100
	Never married	8	6.6	2	3.1	3	7.9	5	6.0
	Married	31	25.6	20	30.8	11	28.9	20	24.1
	Widowed	60	49.6	28	43.1	15	39.5	45	54.2
	Separated	0	0	1	1.5	0	0	0	0
	Divorced	22	18.2	14	21.5	9	23.7	13	15.7

Health. Approximately 90% of participants in the study came from an acute hospital setting (n=34). Two participants came from the community, one from a nursing home, and one from an inpatient rehabilitation facility. The average time from the participant's last day at home to nursing home admission was 28.76 days (*SD* = 13.21), with a range of 7 to 56 days. Nine participants were unable to estimate how long it had been since they were home. Reasons for nursing home placement were obtained from medical charts for all incoming residents for whom data was collected in this study and details are reported for study participants (n=38) in Table 4.

Table 4. Reasons cited in chart for nursing home placement

Fractures or orthopedic:

Humerus and hip fracture
Pelvis fracture
Rib and vertebrae fracture
Total left hip revision
Left wrist fracture, left rotator cuff arthropathy
Post-back surgery rehabilitation, spinal stenosis
Right femur fracture
Pubic symphysis fracture
Lumbar compression fracture
Foot fracture
Right femoral fracture and lung cancer
Hip fracture rehabilitation, acute respiratory failure

Cardiovascular:

Myocardial infarction
Orthostatic hypertension, renal insufficiency
Recurrent syncope episodes
Myocardial infarction, lowered mobility
Parkinson's, CVA w/ left-sided weakness
Colectomy-diverticulitis, CVA, new G tube
CVA-Left sided immobility
Post-stroke physical therapy

Table 4 (continued). Reasons cited in chart for nursing home placement

Cancer:

Lung cancer with brain metastases; deep vein thrombosis

Multiple myeloma

Intercranial mass

Pulmonary embolism with lung cancer

Other/multiple:

Falls, confusion (no fracture or infection)

Post-fall rehabilitation, chronic obstructive pulmonary disease (COPD)

Extreme weakness

Bilateral leg weakness, low mobility, endstage ischemic cardiomyopathy

Chest pain related to GERD

End stage renal disease, congestive heart failure

End stage renal disease, ischemic cardiomyopathy

Acute kidney injury, COPD

Left big toe amputation, chronic diabetic extremity infection

Cirrhosis of the liver, hepatic encephalopathy

Pancreatitis and atrial fibrillation

Chest pain, leg swelling, rehabilitation

Urinary tract infection (UTI), toxic metabolic encephalopathy, weakness

UTI, iron-deficiency anemia

Neurological disease can cause circadian rhythm and sleep disturbances due to direct damage to the related neural circuitry. Although diagnosis of specific neurological conditions did not preclude participation in the study, residents were required to exhibit intact cognitive abilities as determined by a screening measure. Therefore, residents with moderate to advanced neurological disease would likely be excluded from the study. See Table 5 for the distribution of pertinent neurological conditions in participant versus nonparticipant groups. No residents who participated in the present study were diagnosed with Alzheimer's Disease, but 13.2% were diagnosed with dementia of a non-Alzheimer's type, 7.9% with Parkinson's Disease, and 18.4% with Stroke which includes

those who experienced either a transient ischemic attack (TIA) or cerebrovascular accident (CVA).

Table 5. Neurological disease and stroke in study sample

	Participants	Nonparticipants
Alzheimer’s Disease	0%	6.8%
Dementia (Non-Alzheimer’s)	13.2%	20.9%
Parkinson’s Disease	7.9%	6.1%
Stroke	18.4%	12.2%

Residents with BIMS scores of 12 or below were excluded from the study, therefore the average performance of eligible residents on the BIMS was higher ($M = 14.34$) than ineligible residents ($M = 8.91$). In the sample of all incoming residents, 69.4% fell in the category defined as “borderline/intact” cognitive performance, 15.1% in the category representing “moderate” cognitive impairment, and 11.3% in the “severe” category.

Other health conditions common in this population can disturb sleep, including Gastroesophageal Reflux Disease (GERD) and nighttime incontinence. A higher proportion of participants versus nonparticipants were diagnosed with GERD, 42.1% and 18.2% respectively. Of the participant group, 36.8% had urinary incontinence and 26.3% had bowel incontinence.

Functional ability can impact performance of daily tasks and routines and consequently rest-activity patterns. Characteristics of study participants’ functional status are described in detail below from data obtained from the MDS. Details on the amount of staff assistance needed for movement within the facility is described in Table 6.

Approximately half of the study participants required extensive one-person assistance for

movement within their beds and with transferring. Nearly 40% required assistance from two or more staff members for movement in bed and transferring. Some never ambulated within or outside of their room: 20% did not walk within their room and 40% never walked in the corridor. Almost three quarters of the participants needed one-person assistance and 10% were totally dependent on staff for locomotion on the unit. One participant never left her room/corridor and approximately 80% required one-person assistance to go to off-unit locations (eg. dining room, activities, etc).

Table 6. Need for staff assistance with mobility and ambulation.

Bed mobility	<u>Frequency</u>	<u>Percent</u>
No setup	4	10.5%
Setup help only	1	2.6%
One person physical assist	19	50.0%
Two+ person physical assist	14	36.8%
Transfer		
No setup	2	5.3%
One person physical assist	21	55.3%
Two+ person physical assist	15	39.5%
Walk in room		
No setup	1	2.6%
Setup only	2	5.3%
One person physical assist	26	68.4%
Two+ person physical assist	1	2.6%
Activity did not occur	8	21.1%
Walk in corridor		
Setup only	3	7.9%
One person physical assist	18	47.4%
Two+ person physical assist	1	2.6%
Activity did not occur	16	42.1%
Locomotion on unit		
No setup	4	10.5%
Setup only	6	15.8%
One person physical assist	28	73.7%
Locomotion off unit		
No setup	1	2.6%

Setup only	5	13.2%
One person physical assist	31	81.6%
Activity did not occur	1	2.6%

A majority of participants were also dependent on staff for activities of daily living such as dressing, bathing, toileting, and personal hygiene (see Table 7). More than 90% of participants required at least one person to assist with dressing. Most residents (80%) were able to eat independently with some supervision or limited assistance. Older adults are at increased risk of falls and injury in the bathroom, therefore related activities can be an area of concern for staff. Requesting assistance for toileting can represent a barrier for residents who often have incontinence and cannot delay their urgent need when staff members are otherwise occupied. All participants in this study required at least one-person assistance with toileting and bathing. A majority, nearly 75% of participants in the study also required one-person assistance with personal hygiene.

Table 7. Need for staff assistance in activities of daily living

	Frequency	Percent
Dressing		
Setup help only	1	2.6%
One person physical assist	35	92.1
Two+ person physical assist	2	5.3
Eating		
Setup only	30	78.9
One person physical assist	8	21.1
Toileting		
One person physical assist	28	73.7
Two+ person physical assist	10	26.3
Personal hygiene		
Setup only	10	26.3
One person physical assist	28	73.7
Bathing		
One person physical assist	32	84.2
Two+ person physical assist	6	15.8

Over half (58.1%) of the overall sample and a larger percent of eligible (62.8%) versus ineligible residents (49.2%) endorsed having current pain symptoms (See Table 8). A slightly smaller proportion of residents who consented and completed the study endorsed pain and an impact on sleep (61.4% and 10.5% respectively) than those who were eligible but did not complete the study (65.8% and 14.5%). These differences were not significant ($\chi^2(1) = .21, p = .646$ and $\chi^2(1) = .57, p = .449$). A slightly higher proportion of participants (23.7%) versus eligible nonparticipants (22.9%) reported an effect of pain on activities, but this difference was not significant ($\chi^2(1) = .01, p = .915$).

Table 8. Percent of sample endorsing pain and related effects on sleep and activities

	Total Sample	Eligible	Ineligible	Participants	Eligible Nonparticipants
Pain present	58.1%	62.8%	49.2%	61.4%	65.8%
Effect on sleep	13.4%	13.2%	13.8%	10.5%	14.5%
Effect on activities	22.0%	23.1%	20.0%	23.7%	22.9%

Sleep disorders are not designated as a separate category within the “Active Diagnoses” section of the MDS but a few sleep-related diagnoses were found in the “Other” category including 4 residents diagnosed with Insomnia Not Otherwise Specified, 3 with Restless Legs, and 4 with Obstructive Sleep Apnea. The 4 residents with diagnoses of insomnia were eligible but declined participation in the study and 2 of the residents with Restless Legs participated and 1 was eligible but declined participation. A separate item on the MDS is used to document whether a resident receives bilevel positive airway pressure (BIPAP) or continuous positive airway pressure (CPAP) treatment. Only 3.2% of the overall sample was designated as receiving these treatments. Of these 6 residents who were designated as having BIPAP/CPAP, 5 were eligible for the study of which 1 participated.

Psychiatric and mood disorders specified within the MDS (See Table 9) include Anxiety Disorder, Depression, Manic Depression, Psychotic Disorder, Schizophrenia, and Posttraumatic Stress Disorder (PTSD). No significant differences were found between eligible/ineligible or participant/eligible nonparticipant groups on any of these diagnoses. Approximately 25% were diagnosed with Anxiety Disorder and 35% with depression on the MDS. Four residents of 7 with Manic Depression diagnoses were eligible of which half participated in the study. Of the two residents with MDS diagnoses of Psychotic Disorder, one was eligible and participated in the study. Of the two with Schizophrenia diagnoses on the MDS, 1 was eligible but did not participate in the study.

Table 9. Psychiatric diagnoses designated on the MDS.

Diagnosis	Total sample		Eligible		Ineligible		Participants		Eligible Nonparticipants	
	<i>Freq</i>	%	<i>Freq</i>	%	<i>Freq</i>	%	<i>Freq</i>	%	<i>Freq</i>	%
Anxiety disorder	48	25.8	31	25.6	17	26.2	9	23.7	22	26.5
Depression	65	34.9	44	36.4	21	32.3	12	31.6	32	38.6
Manic depression	7	3.8	4	3.3	3	4.6	2	5.3	2	2.4
Psychotic disorder	2	1.1	1	.8	1	1.5	1	2.6	0	0
Schizophrenia	2	1.1	1	.8	1	1.5	0	0	1	1.2
PTSD	1	0.5	0	0	1	1.5	0	0	0	0

The average number of medications prescribed in the overall sample was 15.33 ($SD = 5.87$). Eligible residents were prescribed more medications ($M = 16.21$, $SD = 6.18$) than ineligible residents ($M = 13.68$, $SD = 4.87$) and this difference was found to be significant ($t(184) = -2.87$, $p = .005$). Participants were prescribed more medications ($M = 17.82$, $SD = 6.52$) than eligible nonparticipants ($M = 15.48$, $SD = 5.54$) but this difference was not significant ($t(119) = -1.95$, $p = .053$).

Sleep-related medicines were used by 34.9% of the total sample and 23.7% of participants. See Table 10 for frequency of hypnotic and antidepressant use obtained

from MAR and MDS records. This categorization included use of any of the following medications: Benzodiazepine Receptor Agonists, Trazadone, Temazepam, Mirtazapine, Melatonin, Ropinirole (used for Restless Legs Syndrome), and Pramipexole (used for Parkinson’s or RLS). According to an item on the MDS used to monitor use of hypnotics, only 7.4% of the entire sample and only 1 participant used hypnotics.

Table 10. Frequency and percentage of hypnotic and antidepressant use.

	Total sample		Eligible		Ineligible		Participants		Eligible non-participants	
	<i>Freq</i>	%	<i>Freq</i>	%	<i>Freq</i>	%	<i>Freq</i>	%	<i>Freq</i>	%
Sleep-related meds	65	34.9	43	35.5	22	33.8	9	23.7	34	41.0
MDS Hypnotic ^a	14	7.4	11	9.4	3	4.5	1	2.6	10	12.0
BzRA ^b	15	8.1	12	9.9	3	4.6	1	2.6	11	13.3
Trazadone (Desyrel)	7	3.8	5	4.1	2	3.1	2	5.3	3	3.6
Temazepam (Restoril)	7	3.8	5	4.1	2	3.1	1	2.6	4	4.8
Mirtazapine (Remeron)	22	11.8	14	11.6	8	12.3	3	7.9	11	13.3
Melatonin	11	5.9	7	5.8	4	6.2	0	0	7	8.4
Ropinirole (Requip)	9	4.8	6	5.0	3	4.6	2	5.3	4	4.8
Pramipexole (Mirapex)	2	1.1	1	0.8	1	1.5	1	2.6	0	0
Antidepressants	86	46.2	54	44.6	32	49.2	17	44.7	37	44.6
MDS Antidepressant ^a	82	44.0	52	43.0	30	46.2	14	36.8	38	45.8
SARI ^c	7	3.8	5	4.1	2	3.1	2	5.3	3	3.6
TCA	6	3.2	4	3.3	2	3.1	1	2.6	3	3.6
SSRI	51	27.4	32	26.4	19	29.2	9	23.7	23	27.7
SNRI	22	11.8	15	12.4	7	10.8	6	15.8	9	10.8
Mood stabilizer	15	8.1	7	5.8	8	12.3	2	5.3	5	6.0
Bupropion (Wellbutrin)	3	1.6	2	1.7	1	1.5	0	0	2	2.4

^a Separate MDS items document use of Hypnotic and Antidepressant

^b Acronyms defined: Benzodiazepine receptor agonist (BzRA); Serotonin antagonist and reuptake inhibitor (SARI); Monoamine oxidase inhibitor (MAOI); Tricyclic antidepressants (TCA); Selective serotonin reuptake inhibitor (SSRI); Serotonin-norepinephrine reuptake inhibitor (SNRI)

^c SARI category is equivalent to Trazadone

Antidepressants were used by 46.2% of the total sample and 44.7% of participants. According to an item on the MDS used to monitor use of antidepressants, 44% of the entire sample and 36.8% of participant used antidepressants.

Actigraphy was used to record the total minutes of exposure to white light at or above an intensity of illumination above 1000 lux. Participants were exposed to approximately 11 minutes at or above 1000 lux per day on average ($SD = 25.54$). Study participants were exposed to an average illumination of 48 lux ($SD = 69.15$) during the day and 1.89 ($SD = 2.58$) at night. Lux is the unit of illuminance which equals one lumen per square meter. Typical indoor lighting is 50 lux. An overcast day registers at approximately 1000 lux and bright light in full daylight but not in direct sun from approximately 10,000 to 25,000 lux. Light therapy used for treatment of circadian rhythm and mood disturbances using a light box typically provides between 7,500 to 10,000 lux of illumination. The maximum level of light exposure recorded for any participant was 1308 lux.

Because light exposure serves as a key input to the circadian timing system and has been shown to be effective in the treatment of depression and circadian rhythm sleep disorders, correlations between light, sleep and mood were analyzed. Average daytime light exposure (maximum amount, average, and bright light) were not associated with any of the objective or subjective sleep measures or mood. Higher average light exposure at night was associated with more WASO ($r = .366, p = .024$) and more nighttime awakenings ($r = .396, p = .024$). Higher average daily light exposure was associated with more interdaily stability of the rest-activity rhythm ($r = .361, p = .026$). The maximum average daily light exposure was also related to some of the predictors including

chronotype ($r = -.371, p = .022$), wake-time change ($r = -.333, p = .044$) and pre-institutional social rhythm regularity ($r = -.349, p = .032$) and frequency ($r = -.342, p = .035$).

Performance on outcome measures

Rest-activity rhythms. Two variables were calculated to characterize rest-activity patterns in the present study, intradaily variability (IV) and interdaily stability (IS). Higher IV values represent more transitions between rest and activity states across the day. Higher IS values represent more predictability in subsequent daily patterns and lower values indicate more day-to-day variation in activity patterns. The mean value of IV was .89 ($SD = .30$) with a range from .38 to 1.57. The mean value of IS was .55 ($SD = .18$) with a range from .07 to .87. The variables were significantly negatively correlated ($r = -.46, p = .003$).

Sleep. Subjective sleep data were collected via two self-report measures: the Insomnia Severity Index (ISI) and the Pittsburgh Sleep Quality Index (PSQI). ISI total scores range from 0 to 28 which can be interpreted as follows: absence/subclinical insomnia (0-14); moderate insomnia (15-21); and severe insomnia (22-28). See Table 11 for categorization of insomnia severity in participants who completed the study. The mean ISI score was 4.68 ($SD = 6.31$) at T1 and 5.66 ($SD = 6.18$) at T2 and this average increase ($M = -.974, SD = 6.14$) in insomnia from T1 to T2 was not significant ($t(37) = -.978, p = .335$). Residents who completed the ISI but did not complete the study did not significantly differ on T1 scores ($t(43) = .185, p = .854$), T2 scores ($t(43) = -.989, p = .358$), or change in insomnia severity from T1 to T2 ($t(43) = -1.121, p = .268$).

Table 11. Insomnia measured by the Insomnia Severity Index (ISI).

ISI score categories		Frequency	Percentage
Absent/subclinical insomnia	T1	33	86.8%
	T2	35	92.1
Moderate insomnia	T1	5	13.2
	T2	2	5.3
Severe insomnia	T1	0	0.0
	T2	1	2.6

PSQI scores range from 0 to 21 with higher scores indicating worse sleep quality. Scores above 5 are considered indicative of sleep pathology. See Table 12 for categorization of sleep disturbances as measured on the PSQI in study participants. The mean PSQI score was 6.34 ($SD = 3.62$) at T1 and 7.54 ($SD = 4.57$) at T2 and this average increase ($M = 1.2, SD = 5.22$) in sleep disturbance from T1 to T2 was not significant ($t(34) = -1.36, p = .183$). Residents who completed the PSQI but did not complete the study did not significantly differ on T1 scores ($t(38) = .14, p = .886$), T2 scores ($t(38) = -.07, p = .947$), or change in PSQI score from T1 to T2 ($t(38) = -.17, p = .867$).

Table 12. Sleep disturbance measured by the Pittsburgh Sleep Quality Index (PSQI).

PSQI Score		Frequency	Percentage
Below threshold for sleep disturbance	T1	14	36.8%
	T2*	11	28.9%
Clinical sleep disturbance (>5)	T1	24	63.2%
	T2	24	63.2%

*Data was missing for 3 participants (7.9%) at T2

The 19 PSQI questions can be combined into seven component scores measuring sleep quality, sleep efficiency, daytime dysfunction, sleep latency, sleep disturbances, sleep duration, and need for sleep medications. See Table 13 for participant performance on PSQI subscales at T1 and T2.

Table 13. Participant performance on PSQI subscales at T1 and T2.

PSQI Subscale		Number and percent participants endorsing sleep disturbance									
		Not during past month		< 1 time per week		1-2 times per week		≥ 3 times per week		Missing	
Duration of sleep	T1	28	73.7%	5	13.2%	2	5.3%	3	7.9%	-	-
	T2	19	50.0	7	18.4	4	10.5	7	18.4	1	2.6%
Sleep disturbance	T1	3	7.9	19	50.0	15	39.5	1	2.6	-	-
	T2	2	5.3	20	52.6	16	42.1	0	0.0	-	-
Sleep latency	T1	16	42.1	10	26.3	5	13.2	7	18.4	-	-
	T2	15	39.5	15	13.2	1	2.6	13	34.2	4	10.5
Daytime dysfunction	T1	17	44.7	15	39.5	6	15.8	0	0.0	-	-
	T2	23	60.5	9	23.7	4	10.5	2	5.3	-	-
Sleep efficiency	T1	19	50.0	7	18.4	2	5.3	10	26.3	-	-
	T2	12	31.6	6	15.8	5	13.2	13	34.2	2	5.3
Sleep quality	T1	14	36.8	14	36.8	8	21.1	2	5.3	-	-
	T2	11	28.9	15	39.5	6	15.8	6	15.8	-	-
Sleep medicine use	T1	24	63.2	0	0.0	3	7.9	11	28.9	-	-
	T2	23	60.5	1	2.6	2	5.3	10	26.3	2	5.3

Sleep variables derived from actigraphy data include wake after sleep onset (WASO), sleep efficiency (SE), average number of awakenings (AA), and total sleep time (TST). Sleep efficiency, the amount of time in bed spent asleep at night, was 75.4% ($SD = 14.79$). The average amount of time awake after sleep onset was 76.76 minutes ($SD = 45.03$). The average number of awakenings was 41.8 ($SD = 16.74$) and total sleep time was 7.5 hours ($SD = 1.95$). Actigraphically recorded sleep efficiency was associated with more sleep complaints on the ISI ($r = -.526, p = .001$) and PSQI ($r = -.525, p = .001$), and more depression on the PHQ9 ($r = -.411, p = .01$).

A separate item was added to the PSQI asking participants directly whether they noted a change in the timing of their sleep since coming to the nursing home. A majority

of participants identified a change in their sleep patterns (65.8%), approximately one-fifth of participants reported no change (21.1%), and the remaining participants either did not respond or data was missing (13.2%). When asked an open-ended question of how their sleep changed since coming to the nursing home, 15 participants (36.4%) responded that their sleep changed to earlier bed and rise times, 1 participant stated there was no change, 2 participants reported later bed and/or rise times, 2 reported inconsistency in sleep timing, 2 reported getting less total sleep, 1 reported getting more sleep, 2 reported better sleep, and 1 reported more nighttime awakenings.

Mood. PHQ-9 total scores may be used to classify depression as none (0-4), mild (5-9), moderate (10-14), moderately severe (15-19), and severe (20-27). See Table 14 for categorization of depression in study participants. The mean PHQ-9 score was 6.33 ($SD = 4.99$) at T1 and 6.03 ($SD = 5.33$) at T2 and this average decrease ($M = -0.303$, $SD = 5.60$) in depression from T1 to T2 was not significant ($t(37) = .33$, $p = .74$). T1 and T2 PHQ-9 scores were correlated ($r = .41$, $p = .01$). Residents who completed the PHQ-9 but did not complete the study did not significantly differ on T1 scores ($t(43) = -.31$, $p = .761$), T2 scores ($t(43) = -.08$, $p = .938$), or change in depression severity from T1 to T2 ($t(43) = .21$, $p = .839$).

Table 14. Depression measured by the Patient Health Questionnaire (PHQ-9).

PHQ-9 depression categories		<i>Frequency</i>	<i>Percentage</i>
None	T1	15	39.5%
	T2	17	44.7
Mild depression	T1	11	28.9
	T2	12	31.6
Moderate depression	T1	11	28.9
	T2	5	13.2
Moderately severe depression	T1	1	2.6
	T2	3	7.9

Severe depression	T1	0	0
	T2	1	2.6

Social rhythm. Data from the Modified Social Rhythm Metric (MSRM) was used to calculate both the frequency and regularity of daily activity. Higher numbers represent more and lower numbers less frequency or regularity. The mean MSRM regularity score was 8.55 ($SD = 2.20$) at T1 and 9.21 ($SD = 2.30$) at T2 and this average increase ($M = 0.66$, $SD = 2.43$) from T1 to T2 was not significant ($t(37) = -1.67$, $p = .104$). The mean MSRM frequency score was 52.43 ($SD = 16.02$) at T1 and 54.88 ($SD = 17.14$) at T2 and this average increase ($M = 2.46$, $SD = 16.38$) was not significant ($t(37) = -.92$, $p = .362$). Residents who completed the MSRM but did not complete the study ($n=7$) did not significantly differ from participants on T1 ($t(43) = .50$, $p = .628$) or T2 ($t(43) = -1.23$, $p = .225$) regularity scores, T1 ($t(43) = -.24$, $p = .815$) or T2 ($t(43) = -.61$, $p = .543$) frequency scores, or change in regularity from T1 to T2 ($t(43) = -1.70$, $p = .096$) or change in frequency from T1 to T2 ($t(43) = -.48$, $p = .652$).

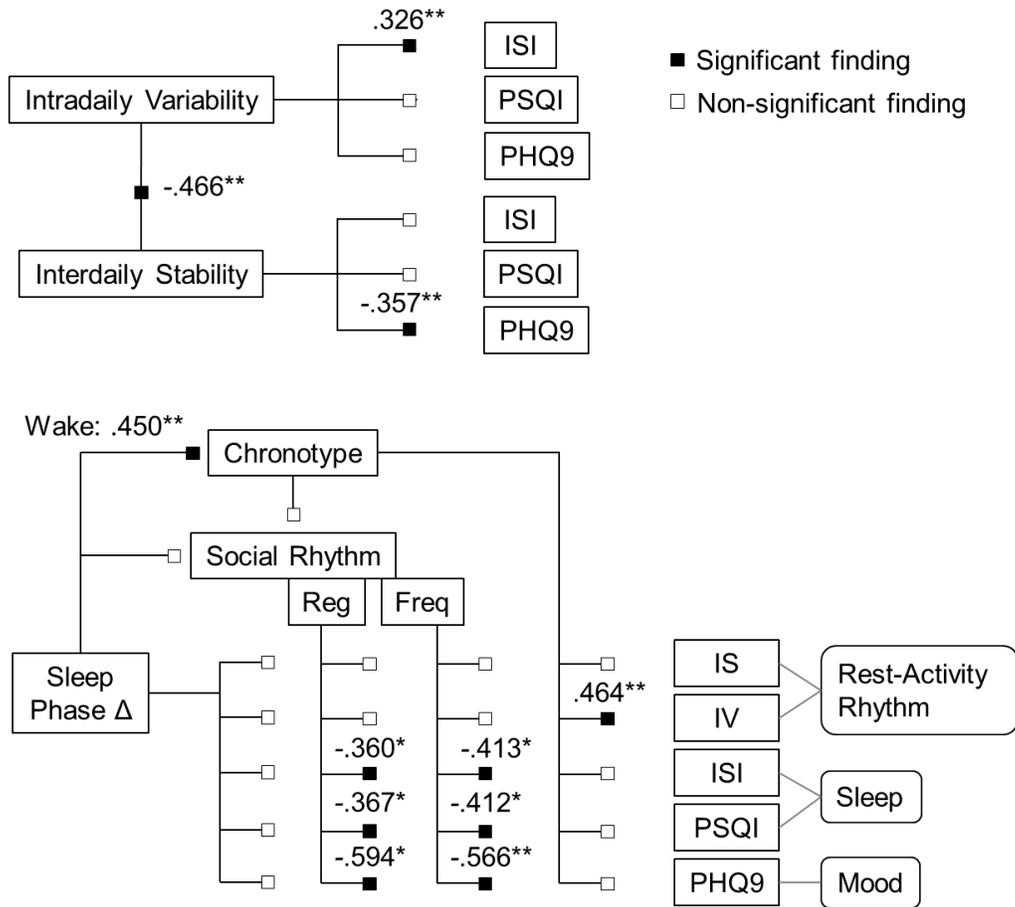
Chronotype. The mean MEQ score was 59.16 ($SD = 10.06$) which falls in the “morning type” category. Residents who completed the MEQ but did not complete the study ($n=14$) showed significant differences from participants on the MEQ ($t(50) = -2.34$, $p = .023$). This group of study non-completers had lower scores ($M = 51.86$, $SD = 9.773$), which lies in the “neutral type” range.

Associations between primary variables and other related factors

A summary of significant associations related to the hypothesized model are presented in Figure 6. Associations among hypothesized outcomes, predictors, and predictors and outcomes are presented in Table 15, 16, and 17 respectively. Sleep variables were calculated from subjective (self-report) and objective (actigraphic)

measures. The primary sleep measures were the Insomnia Severity Index (ISI) and the Pittsburgh Sleep Quality Index (PSQI). Sleep efficiency (SE), wake after sleep onset (WASO), average number of awakenings (AA), and total sleep time (TST) were exported from the actigraphy software. Associations among sleep variables are presented in Table 18.

Figure 6. Summary of significant correlations related to hypothesized model.



*Correlation is significant at the 0.05 level (2-tailed)
 **Correlation is significant at the 0.01 level (2-tailed)

Table 15. Correlations among hypothesized outcome variables

	IS ^{ab}	IV	ISI T2	PSQI T2	PHQ-9 T2
IS	--				
IV	-.466**	--			
ISI T2	-.262	.326*	--		
PSQI T2	-.275	.207	.859**	--	
PHQ-9 T2	-.357*	.245	.732**	.663**	--

^a Cases for correlations excluded pairwise; for PSQI pairs N=35, for all others N=38

^b Abbreviations: Interdaily Stability (IS), Intradaily Variability (IV), Insomnia Severity Index (ISI), Pittsburgh Sleep Quality Index (PSQI), and Patient Health Questionnaire-9 (PHQ9)

*Correlation is significant at the 0.05 level (2-tailed)

**Correlation is significant at the 0.01 level (2-tailed)

Table 16. Correlations among hypothesized predictor variables

	MEQ ^{abc}	Bed Time Δ	Bed Absolute Value ^d	Wake Time Δ	Wake Absolute Value	MSRM T1 Reg	MSRM T2 Reg	MSRM Reg Δ	MSRM T1 Freq	MSRM T2 Freq	MSRM Freq Δ
MEQ	--										
Bed Time Δ	.329	--									
Bed Time Δ Absolute Value	-.346*	-.082	--								
Wake Time Δ	.450**	.076	-.388*	--							
Wake Time Δ Absolute Value	-.192	.080	.420*	-.665**	--						
MSRM T1 Reg	.497**	.052	-.222	.225	-.413*	--					
MSRM T2 Reg	-.045	-.091	-.009	-.159	-.265	.498**	--				
MSRM Reg Δ	-.545**	-.143	.215	-.383*	.154	-.516**	.486**	--			
MSRM T1 Freq	.476**	.026	-.239	.201	-.361*	.944**	.524**	-.434**	--		
MSRM T2 Freq	.040	-.158	-.039	-.039	-.389*	.563**	.947**	.368*	.588**	--	
MSRM Freq Δ	-.484**	-.202	.222	-.265	-.025	-.431**	.456**	.884**	-.466**	.442**	--

^a Cases for all correlations excluded listwise, N=35

^b Predictors used in primary analyses and related correlations are designated in bold

^c Abbreviations: Morning-Eveningness Questionnaire (MEQ), change score (Δ), Modified Social Rhythm Metric (MSRM)

^d Averaging sleep phase advances and delays (positive and negative values) across participants reduces the overall value of change so absolute value of change was explored here

*Correlation is significant at the 0.05 level (2-tailed)

**Correlation is significant at the 0.01 level (2-tailed)

Table 17. Correlations among predictor and outcome variables

	IS^{abc}	IV	ISI T1	ISI T2	ISI Δ	PSQI T1	PSQI T2	PSQI Δ	PHQ9 T1	PHQ9 T2	PHQ9 Δ
Bed Time Δ Absolute Value	-.078	-.180	.216	-.116	-.307	.264	-.108	-.276	.109	-.088	-.182
Wake Time Δ Absolute Value	-.048	-.111	.056	.099	.037	.126	.138	.033	.235	.145	-.070
Bed Time Δ	-.306	.261	.292	.010	-.264	.300	.038	-.174	.287	.140	-.120
Wake Time Δ	-.106	.189	-.156	.107	.243	-.238	.172	.315	-.266	.219	.447^{**}
MEQ	.050	.464^{**}	-.359[*]	.058	.389[*]	-.230	.090	.238	-.252	.104	.324
MSRM T1 Reg	.183	.120	-.363 [*]	-.307	.061	-.007	-.258	-.220	-.297	-.283	-.008
MSRM T2 Reg	.162	-.085	-.129	-.360[*]	-.206	.001	-.367[*]	-.320	-.127	-.594^{**}	-.458^{**}
MSRM Reg Δ	-.024	-.207	.241	-.048	-.269	.008	-.105	-.097	.175	-.307	-.451 ^{**}
MSRM T1 Freq	.218	.168	-.433 [*]	-.426 [*]	.019	-.078	-.397 [*]	-.291	-.327	-.337	-.034
MSRM T2 Freq	.152	-.036	-.253	-.413[*]	-.138	-.123	-.412[*]	-.273	-.194	-.566^{**}	-.372[*]
MSRM Freq Δ	-.075	-.227	.206	.022	-.173	-.048	-.009	.026	.151	-.245	-.370 [*]

^a Cases for all correlations excluded listwise, N=34

^b Predictors and outcome variables used in primary analyses and related correlations are designated in bold

^c Abbreviations: Change score (Δ), Interdaily Stability (IS), Intradaily Variability (IV), Insomnia Severity Index (ISI), Pittsburgh Sleep Quality Index (PSQI), Patient Health Questionnaire-9 (PHQ9), Morning-Eveningness Questionnaire (MEQ), Modified Social Rhythm Metric (MSRM)

*Correlation is significant at the 0.05 level (2-tailed)

**Correlation is significant at the 0.01 level (2-tailed)

Table 18. Correlations among objective and subjective sleep measures

	SE ^{ab}	WASO	AA	TST	ISI T1 ^c	ISI T2 ^d	ISI Δ	PSQI T1	PSQI T2	PSQI Δ	PSQI Sleep Quality ^e
SE	--										
WASO	-.349*	--									
AA	-.142	.608**	--								
TST	.847**	-.088	.161	--							
ISI T1	-.253	.369*	.297	-.123	--						
ISI T2	-.608**	.102	.005	-.525**	.416*	--					
ISI Δ	-.320	-.252	-.272	-.366*	-.554**	.527**	--				
PSQI T1	-.260	.183	.288	-.153	.713**	.233	-.453**	--			
PSQI T2	-.525**	.236	.078	-.451**	.393*	.859**	.418*	.202	--		
PSQI Δ	-.279	.079	-.131	-.289	-.150	.589**	.679**	-.516**	.735**	--	
PSQI T2 Sleep Quality	-.479	.132	.000	-.373*	.333	.796**	.417*	.149	.760**	.562**	--

^a Cases for all correlations excluded listwise, N=35

^b Variables derived from actigraphy: Sleep efficiency (SE), wake after sleep onset (WASO), average awakenings (AA), total sleep time (TST)

^c Abbreviations defined: Insomnia Severity Index (ISI), Pittsburgh Sleep Quality Index (PSQI), change score (Δ)

^d Predictors used in primary analyses and related correlation are designated in bold

^e PSQI subscale measuring subjective sleep quality at T2

*Correlation is significant at the 0.05 level (2-tailed)

**Correlation is significant at the 0.01 level (2-tailed)

Analyses of Main Hypotheses

SPSS 21 was used for data analyses and Actiware software version 5.70.1 was used to calculate objective sleep and rest-activity variables. All variables of interest were centered at the sample mean before being entered into regression analyses as recommended by Kraemer and Blasey (2004).

Hypothesis 1: Multiple linear regression was used to test whether rest-activity rhythms (IS and IV) were associated with subjective mood (PHQ-9) and sleep (PSQI and ISI) in the nursing home at T2. As noted in Table 16, the correlation between IS and PHQ-9 at T2 ($r = -.357$) and IV and ISI at T2 ($r = .326$) were significant but no other correlations were significant, including those between rest- rest-activity variables and PSQI. Therefore, the independent variables of IS and IV were regressed onto the dependent variable PHQ-9 at T2 and separately onto ISI at T2, but not onto PSQI. The overall regression model of the independent variables IS and IV and dependent variable PHQ-9 at T2 was not significant $F(2, 35) = 2.741, p = .078$. IS explained 12.8% of the variance in PHQ-9 at T2 ($R^2 = .128; F(1,36) = 5.266, p = .028$) but the effect of IV was not significant ($F(1,35) = .317, p = .577$). The association between IS and PHQ-9 at T2 was in the predicted direction such that more stability of the rest-activity rhythm across days was associated with fewer depressive symptoms.

The overall regression model of the independent variables IS and IV with dependent variable ISI at T2 was not significant $F(2, 35) = 2.43, p = .103$. IV explained 10.6% of the variance in ISI at T2 ($R^2 = .106; F(1,36) = 4.29, p = .046$) but the effect of IS was not significant ($\Delta R^2 = .015; F(1,35) = .62, p = .438$). The significant association between IS and ISI at T2 scores was in the predicted direction such that more

fragmentation of the rest-activity rhythm across the day was associated with more depressive symptoms. Details of all regression analyses performed in relation to the primary analyses are presented in Table 19.

Table 19. Summary of regression analyses for primary analyses.

Variable	B ^a	SE B	β	R ²	ΔR ²	p of ΔR ²	N
PHQ9 T2							37
IS	-9.274	5.301	-.311	.128	.128	.028	
IV	1.760	3.128	.100	.135	.008	.577	
ISI T2							37
IV	5.327	3.657	.261	.106	.106	.046	
IS	-4.866	6.198	-.141	.122	.015	.438	
PHQ9 T2							37
MSRM T2 Reg	-1.109	1.038	-.479	.331	.331	<.001	
MSRM T2 Freq	-.031	.140	-.101	.332	.001	.824	
ISI T2							37
MSRM T2 Reg	.414	1.399	.278	.068	.068	.114	
MSRM T2 Freq	-.204	.188	-.566	.098	.030	.285	
PSQI T2							34
MSRM T2 Reg	.544	.987	.264	.138	.138	.028	
MSRM T2 Freq	-.189	.135	-.673	.188	.050	.170	

^a Abbreviations: Patient Health Questionnaire-9 (PHQ9), Interdaily Stability (IS), Intradaily Variability (IV), Pittsburgh Sleep Quality Index (PSQI), Modified Social Rhythm Metric (MSRM), Insomnia Severity Index (ISI)

Hypothesis 2: Sleep timing changes were calculated from self-reports on the PSQI at T1 and T2. The average self-reported bed time prior to admission to the nursing home was 9:24 p.m. and the average wake time was approximately 7:59 a.m. At T2, participants reported an average bed time of 8:52 p.m. and average wake time of 7:02 a.m. T1 and T2 bed times were correlated ($r = .89, p < .01$) and rise times were not correlated ($r = .26, p = .129$). Changes in sleep timing from pre- to post-admission were approximately one half hour advance in bed time ($M = 32$ minutes, $SD = 1$ hour 47 minutes) and approximately one hour advance in wake time ($M = 57$ minutes, $SD = 1$ hr

59 minutes). The change in bed times was not significant ($t(35) = 1.78, p = .083$) whereas the change in rise time was significant ($t(35) = 2.86, p = .007$). The changes in sleep timing include delays and advances across participants; when these negative and positive values are averaged together, they result in an overall advance. Estimation of the overall change in sleep timing, whether it was a delay or an advance, was accomplished by taking the absolute value of the difference between sleep timing at T1 and T2. The difference between T1 and T2 in bed times that changed to either an earlier or later clock times was 1.34 hours ($SD = 1.31$) and the difference in wake times was 1.60 hours ($SD = 1.61$).

To better understand the types and amount of changes in sleep timing that occurred, participants were divided into subgroups to differentiate delays versus advances in bed and wake times. In other words, four groups were created: residents with 1) wake-time delays, 2) wake-time advances, 3) bed-time delays, and 4) bed-time advances. Significant differences in either rise or bed-times were found between T1 and T2 in all groups (see Table 20). The largest change in sleep timing between T1 and T2 occurred in residents who experienced an advance in wake time.

Table 20. Sleep timing changes in participants with delays and those with advances

	N	T1	T2	Mean Diff	SD	<i>t</i>	<i>df</i>	<i>p</i>
Wake delay	9	6:10	7:20	1:10	1:09	-3.00	8	.017
Wake advance	28	8:34	6:50	1:44	1:43	5.39	27	.000
Bed time delay	9	20:05	21:40	1:35	1:41	-2.80	8	.023
Bed time advance	27	21:50	20:36	1:14	1:10	5.46	26	.000

Hypothesis 3 & 4: Linear regressions were planned to evaluate whether larger sleep phase changes were associated with more disturbances in rest-activity rhythms, sleep, and mood (hypothesis 3) and to test whether larger sleep phase changes were associated with weaker social rhythms at T2 (hypothesis 4). Preliminary analyses revealed no significant associations between sleep timing changes and the outcome variables of interest, therefore these relationships were not modeled via regression.

Hypothesis 5: Linear regression was conducted to evaluate whether stronger social rhythms (independent variable) were associated with fewer disturbances in rest-activity rhythms, sleep, and mood (dependent variables). Significant correlations were found between MSRM and these outcome variables in preliminary analyses so related regression analyses were performed. No significant association was found between MSRM at T2 and rest-activity variables, therefore these relationships were not evaluated further.

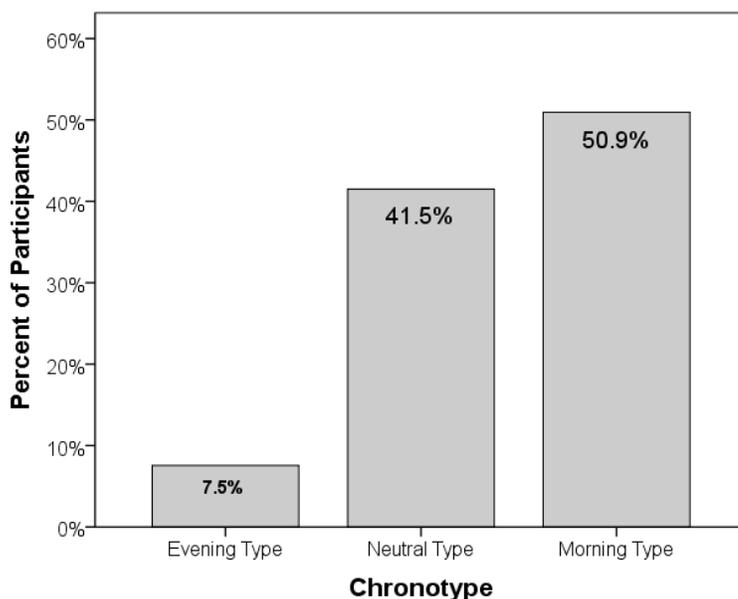
The overall regression model of the independent variables MSRM Frequency and Regularity and dependent variable PHQ-9 at T2 was significant $F(2, 35) = 8.684, p = .001$. MSRM Regularity explained 33.1% of the variance in PHQ-9 at T2 scores ($R^2 = .331; F(1,36) = 17.788, p < .001$) but MSRM Frequency at T2 did not account for a significant proportion of the remaining variance ($\Delta R^2 = .001; F(1,35) = .050, p = .824$). The association was in the predicted direction such that less lifestyle regularity (weaker social rhythm) predicted more depressive symptoms.

The overall regression model of the independent variables MSRM Frequency and Regularity at T2 and dependent variable PSQI at T2 was significant ($F(2, 32) = 3.695, p = .036$). MSRM Regularity explained 13.8% of the variance in PSQI scores ($R^2 = .138$;

$F(1,33) = 5.263, p = .028$) but MSRM Frequency did not account for a significant proportion of the remaining variance ($\Delta R^2 = .050; F(1,32) = 1.972, p = .170$). The association was in the predicted direction such that less lifestyle regularity (weaker social rhythm) was associated with more sleep disturbance. No significant relationships between MSRM T2 scores and ISI T2 score were found in regression analyses.

Hypothesis 6: Descriptive statistics were used to determine whether newly admitted nursing home residents were morning types on average. Individuals were classified into Evening, Neutral and Morning Types based on MEQ scores. The percent of participants falling in MEQ categories are presented in Figure 7.

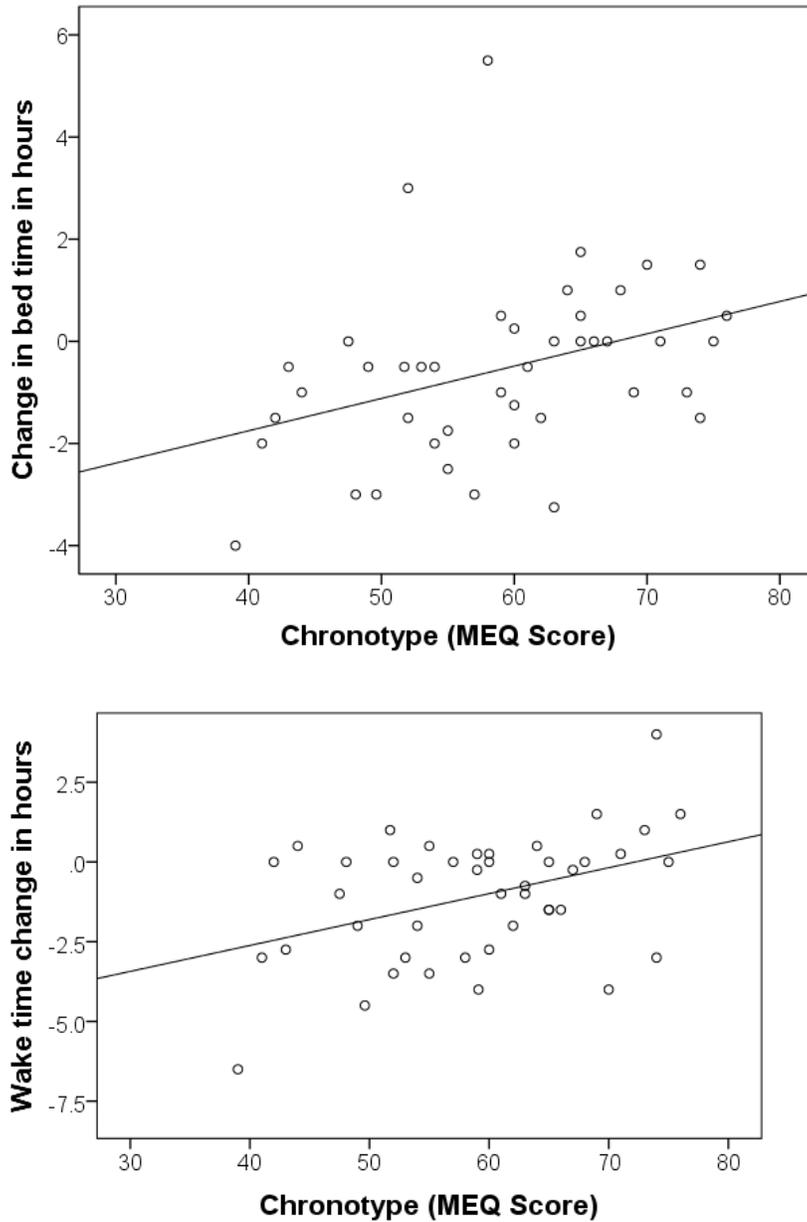
Figure 7. Chronotypes based on MEQ categories.



Hypothesis 7: Linear regression was used to examine whether chronotype (independent variable) predicted the amount of phase change (dependent variable) and one-way analysis of variance (ANOVA) was conducted to examine whether morning and evening types differed from neutral types on the amount of phase change. The independent variable chronotype explained 10.8% of the variance in bed time change (R^2

= .108; $F(1,34) = 4.122, p = .05$) and 19.1% of the variance in wake time change ($R^2 = .191; F(1,35) = 8.268, p = .007$). Higher MEQ score indicate more morningness and lower score more eveningness, Figure 8 illustrates the regression line between chronotype and bed and wake time changes.

Figure 8. Linear regression between chronotype and bed and wake time changes.

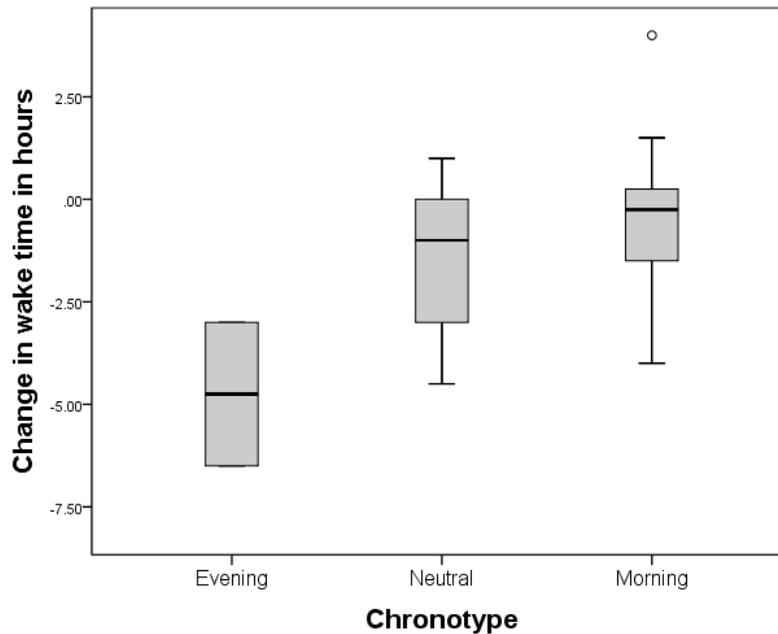


The means and standard deviations of wake time changes based on chronotype categories are presented in Table 21 and the mean differences are illustrated in Figure 9. Based on the ANOVA, the effect of chronotype on wake time change was significant $F(2, 44) = 5.55, p = .007$. The strength of the relationship as assessed by η^2 , was strong, with chronotype accounting for 21.3% in the variance of the wake time change. To examine whether evening types or morning types were required to make a greater change in their wake times, post-hoc analysis using Bonferonni criterion for significance compared neutral to morning and evening types. Compared to the neutral category, morning types did not appear to experience a greater change in wake time ($p = .441$). A significant difference was found between evening and neutral types ($p = .047$). This difference was in the expected direction, such that evening types experienced a larger advance in wake times.

Table 21. Means, standard deviation, and confidence intervals of wake time change in different chronotype groups

Chronotype	N	Mean	SD	95% Confidence Interval	
				Lower Bound	Upper Bound
Evening	2	-4.75	2.48	-7.291	-2.209
Neutral	17	-1.40	1.73	-2.269	-.525
Morning	25	-.57	1.78	-1.289	.149

Figure 9. Amount of change in wake time based on chronotype.

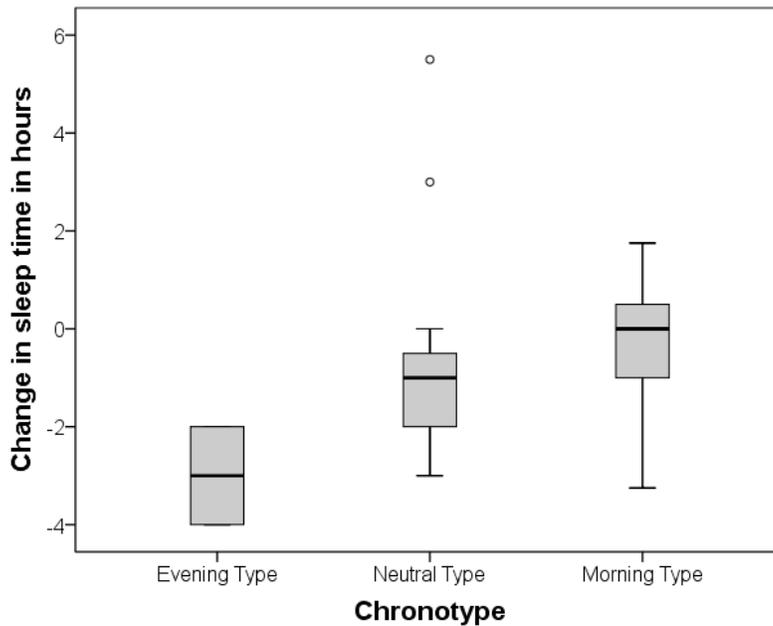


The means and standard deviations of bed time changes based on chronotype categories are presented in Table 22 and the mean differences are illustrated in Figure 10. The ANOVA showed the effect of chronotype category on sleep time change was not significant $F(2, 43) = 2.882, p = .068$.

Table 22. Means, standard deviation, and confidence intervals of bed time change in different chronotype groups

Chronotype	N	Mean	SD	95% Confidence Interval	
				Lower Bound	Upper Bound
Evening	2	-3.00	1.41	-5.39	-.615
Neutral	17	-.779	2.18	-1.60	.04
Morning	24	-.188	1.21	-.88	.50

Figure 10. Amount of change in bed time based on chronotype.



Hypothesis 8: T-tests were used to examine whether stronger morningness was associated with fewer problems in social and rest-activity rhythms, sleep, and mood. Chronotype categories that included a higher level of distinction (5 versus 3 categories) were used for this analysis so that those with the highest amount of morningness could be compared to neutral types. Participants who were classified as Definite Morning Types were compared to Neutral Types on related measures. A significant difference was found between Definite Morning versus Neutral Types on the rest-activity variable of intradaily variability but no other variables (see Table 23). Definite Morning Types demonstrated less fragmented rest-activity rhythms as measured by intradaily variability which quantifies transitions between rest and activity states across the day.

Table 23. Comparisons of morning versus neutral types on outcome measures.

Chronotype	<i>t</i>	<i>df</i>	Mean Difference	sig	95% Confidence Interval	
					Lower Bound	Upper Bound
MSRM Regularity T2	-.350	19	-.357	.730	-14.963	13.731
MSRM Frequency T2	-.090	19	-.616	.929	-16.367	15.135
Interdaily Stability	-.635	19	-.056	.533	-.241	.129
Intradaily Variability	2.368	19	.350	.029	.041	.660
PSQI T2	.803	17	1.964	.433	-3.196	7.125
ISI T2	.305	19	.929	.763	-5.433	7.291
PHQ9 T2	.695	19	1.857	.496	-3.738	7.453

Hypothesis 9: Linear regression analyses were planned according to the method discussed in Holmbeck (2003) to evaluate social rhythms and chronotype as potential moderators of the relationship between the independent variable sleep phase and dependent variables of rest-activity rhythm, sleep, and mood. Due to a lack of significant findings in several of the key relationships (see Figure 6), the full model of hypothesized relationships (see Figure 1) was not evaluated. Correlational analyses revealed a significant relationship between wake time and chronotype ($r = .450$) and between chronotype and intradaily variability of the rest-activity rhythm ($r = .464$). Although no significant association was found between sleep timing change and intradaily variability, the originally hypothesized relationship was tested such that chronotype was explored as a moderator between wake-time change and intradaily variability.

Using a hierarchical linear regression model with a dependent variable of intradaily variability, the independent variables of wake time change and chronotype

were entered in step one followed by the interaction term (cross-product of two independent variables) in step two. The overall model was significant $F(3,33)=2.97, p = .046$, but this effect was driven mainly by the strength of the relationship between MEQ and IV ($R^2 = .185; F(2,34) = 3.86, p = .031$). The interaction effect did not account for an additional amount of the variance after controlling for the relationship between MEQ and IV ($\Delta R^2 = .027; F(1,33) = 1.15, p = .291$).

Secondary analyses

Based on the two-process model of sleep consolidation, changes in wake times versus bed times may impact sleep and related variables in different ways. Wake timing is typically associated with circadian rhythm processes, whereas bed times may be associated more strongly with homeostatic processes. So, for secondary analyses, the sample was separated into subgroups based on the type (wake or bed-time) and direction (advance or delay) of sleep timing change. Participants were divided into those with 1) no bed-time change, 2) no wake-time change, 3) wake-time delays, 4) wake-time advances, 5) bed-time delays, and 6) bed-time advances. In participants with no change in sleep timing, the following relationships were found: 1) in participants with no bed-time change, chronotype and social rhythm were strongly positively correlated ($r = .776, p = .040$), and 2) in participants with no wake-time change, social rhythm variables of regularity and frequency were associated with sleep disturbances on the PSQI ($r = -.779, p = .039$ and $r = -.753, p = .05$, respectively). No associations between any other variables of interest including rest-activity rhythms, sleep, and mood were present in these two subgroups.

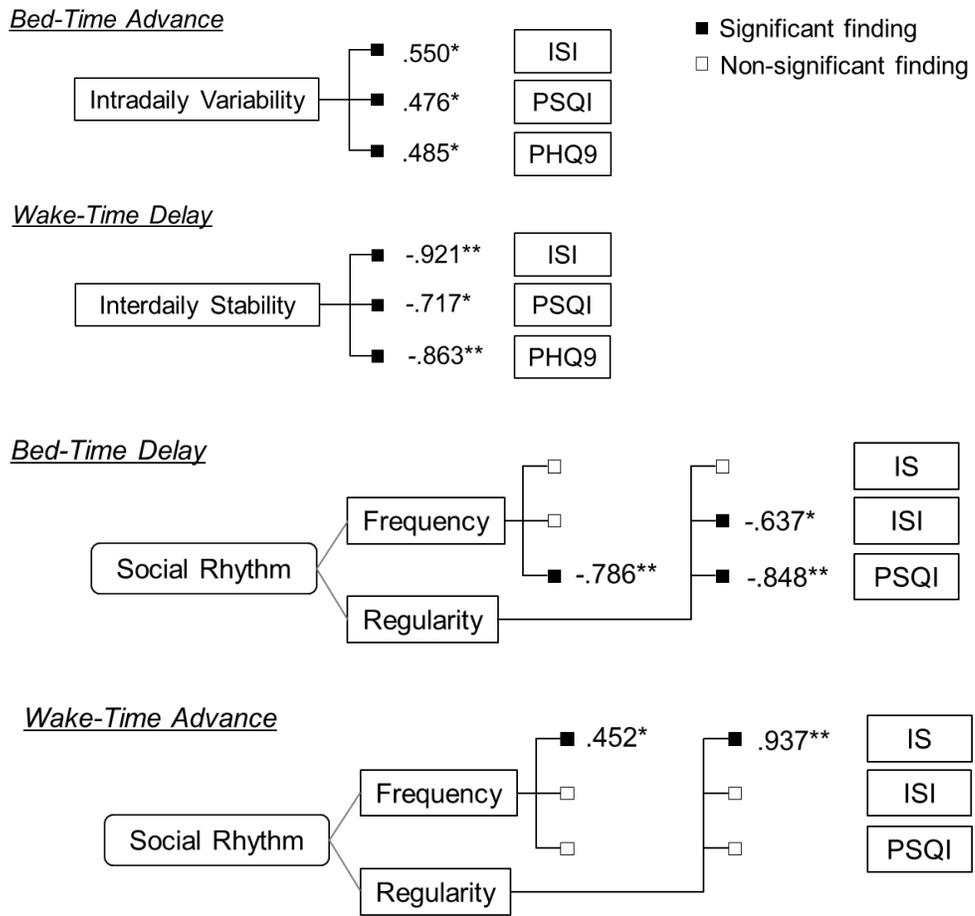
Chronotype was positively associated with IV in all participant subgroups with a sleep timing change except those with a bed-time delay. Chronotype was only associated with a sleep timing change, in this case wake time, in participants with a bed-time delay ($r = .638, p = .035$). Bed time and wake-time changes were associated only in wake-time delay ($r = .617, p = .043$) and bed-time advance groups ($r = .414, p = .040$). A sleep timing change (wake time) was associated with social rhythm only in the wake-time delay group (MSRM frequency, $r = -.604, p = .049$). Lastly, sleep timing was associated with none of the outcome variables (rest-activity, sleep, or mood) in any of the groups except for a bed-time change which was associated with IS in the wake-time delay group ($r = -.740, p = .023$).

Social rhythms and mood were correlated in all participants who experienced concurrent changes in bed and wake times (see Table 24) but not in participants with no bed-time change or no wake-time change. No relationship was found among rest-activity, sleep, and mood except in participants with a bed-time delay or wake-time advance. Social rhythms were associated with sleep variables only in participants with a bed-time delay and social rhythms were associated with interdaily stability only participants with a wake-time advance (see Figure 11).

Table 24. Associations between social rhythms and mood in sleep-timing change subgroups

	Social Rhythm Regularity			Social Rhythm Frequency		
	<i>r</i>	<i>p</i>	<i>n</i>	<i>r</i>	<i>p</i>	<i>n</i>
Bed-time advance	-.422	.036	25	-.417	.038	25
Bed-time delay	-.791	.004	11	-.711	.014	11
Wake-time advance	-.539	.006	25	-.531	.005	25
Wake-time delay	-.686	.020	11	-.654	.029	11

Figure 11. Patterns of relationships between outcome variables based on sleep timing change subgroups.



DISCUSSION

This study explored factors related to disturbances in behavioral rhythms, sleep, and mood in recently admitted nursing home residents with two overarching goals, first to identify the types of problems that exist in older adults as they come to live in the nursing home and second to explore factors that might contribute to increased risk or protection from such problems. In support of those goals, one primary aim was to identify changes in the timing of sleep because adjustment to this type of change is difficult for older adults. Additionally, factors that might enhance or undermine adjustment to sleep timing changes such as chronotype (preference for morning versus evening activity) and social rhythms (a regular daily routine) were explored. Ultimately, all of these factors were considered within a larger hypothesized model such that chronotype and social rhythms serve as potential moderators between a change in the timing of sleep and disturbances in rest-activity rhythms, sleep, and mood.

Summary of findings

Chronotype predicted the type and amount of sleep timing change that occurred during the transition to the nursing home. Secondary analyses revealed a unique pattern of relationships between variables that was dependent on the type (wake- or bed-time) and direction (advance or delay) of sleep timing change. These relationships were not apparent in the primary analyses. This is thought to reflect a limitation of the

hypothesized model and analytical approach. A reformulation of the model would need to include a more nuanced approach to chronotype and the type and direction of phase shift, and the relationship with social rhythms and the outcome variables.

Secondary analyses revealed associations among variables of interest in participants who experienced concurrent bed- and wake-time changes, but few associations were found in participants who experienced only a wake-time change or only a bed-time change. The type and direction of sleep timing change appeared to play a role in the interrelationships among behavioral rhythms, sleep, and mood. Stronger social rhythms were associated with fewer mood symptoms in participants with concurrent bed- and wake-time changes, but not in participants who experienced only a bed-time change or only a wake-time change. Stronger social rhythms were associated with fewer sleep disturbances only in participants with a bed-time delay. Stronger social rhythms were associated with more interdaily stability of the rest-activity rhythm only in participants with a wake-time advance. More intradaily variability of the rest-activity was associated with more sleep and mood disturbances only in participants with a bed-time advance. Less interdaily stability of the rest-activity rhythm was associated with more sleep and mood disturbances only in participants with a wake-time delay. Why these unique patterns of associations emerged is unclear but could relate to the influence of circadian versus homeostatic processes as well as the impact of phase advance versus phase delays on the outcome variables. Replication of these findings and an explanatory model to guide the study of sleep timing changes during institutionalization is needed.

Study aims and hypotheses

A primary aim of this study was to describe problems related to behavioral rhythms, sleep, and mood in older adults as they come to live in the nursing home. Medical comorbidities can contribute to any or all of these problems. The participant sample carried a heavy burden of illness and injuries that left most dependent on staff for movement within and outside of their rooms and for assistance with activities of daily living. Nearly all residents were admitted from a hospital and the reasons for placement included fractures, cardiovascular issues, cancer, and other acute and chronic problems requiring skilled nursing care. Polypharmacy is common in nursing homes and participants in the present study were no exception with an average of 17.82 medications prescribed per individual ($SD = 6.52$). One in ten residents reported an impact of pain on sleep, and 1 in 4 reported an impact of pain on daily activities.

Approximately 32% of participants were diagnosed with depression on the MDS and 46% were prescribed antidepressants. According to self-reports, approximately 40% were categorized as having no depression, approximately 30% mild, and the remainder of participants were categorized as having moderate to severe depression. The rates of depression found here are consistent with the literature which shows that rates have increased over the years from one third in 1999 to more recent estimates of as much as one half of nursing home residents being diagnosed (Gaboda et al., 2011).

In sum, this sample of incoming nursing home residents was acutely and chronically ill, highly medicated, and largely dependent on staff for movement and daytime activities. Many were diagnosed with health issues related to sleep and/or mood disturbances including pain, cardiovascular issues, GERD, incontinence to name a few.

The mean of rest-activity variables in the present sample appear to be comparable to patient versus control groups from other studies. Normative data on rest-activity rhythm variables was not found via a literature search, but potential comparison groups are presented in Table 25. IV scores in the present sample ranged from .38 to 1.57 and IS from .07 to .87. Higher values on IV indicate more transitions between rest and activity across the day. Lower scores on IS represent less stability of activity across days and is thought to measure a “loose coupling” between the internal rhythm and external zeitgebers.

Table 25. Comparisons of IS and IV to published data.

Study	Participants	IS	IV
Current study	Recently admitted nursing home residents	.55 (.18)	.89 (.30)
Maaskant, van de Wouw, van Wijck, Evenhuis, and Ehteld (2013)	Adults 50 years and older with intellectual disabilities	.53 (.15)	.97 (.32)
	Control group of adults 50 and older	.57 (.10)	.81 (.17)
Whitehead, Davies, Playfer, and Turnbull (2008)	Older adults with Parkinson’s Disease	.55 (.13)	1.18 (.37)
	Control group of older adults without neurological disease	.63 (.14)	.79 (.20)
Song et al. (2009)	Nursing home residents with dementia	.47 (.14)	1.36 (.27)

The findings in this study are comparable to those of Meadows et al. (2010) who compared community-dwelling elders to nursing home residents and found significantly more intradaily variability, reduced amplitude of the rest-activity rhythm and overall activity levels in an institutionalized group even after controlling for individual factors such as age, gender, medication use, level of dependency, and incontinence. Their study

did not find any differences in interdaily stability suggesting consistency of day-to-day activities, which, as noted earlier, may be a function of the highly regular institutional routine.

Risk for many sleep disorders increases with age, medical illnesses and psychiatric conditions, so one would expect a fairly high rate of sleep disorders and complaints in this population. Estimation of the amount of sleep problems in this sample was gleaned from several different sources, including MDS diagnoses, medication use, actigraphic data and self-reports. There is no specific item on the MDS to indicate a sleep disorder diagnosis so documentation in the MDS likely underestimates the prevalence of sleep disorders or disturbances. Eleven of 186 (5.9%) residents in this sample carried sleep-related diagnoses in the “other” diagnosis category on the MDS. Based on epidemiological data, sleep apnea alone in older adults falls between 7% and 44%, and would likely be higher than the lower end of this range in this sample because of the high prevalence of type 2 diabetes, hypertension, coronary artery disease, congestive heart failure, and stroke, all of which confer greater risk for sleep apnea (Lee, Nagubadi, Kryger, & Mokhlesi, 2008). Another possible indicator of sleep problems is use of sleep medication. According to the MDS, only 7.4% of the sample used hypnotics. A research assistant on the present study categorized medication listed for each participant from medication administration records (MARs) and found that 35% were prescribed sleep-related medicines. According to patients themselves on the PSQI, 39% used medications to sleep at T1 and 32% at T2.

When asked about changes in sleep since coming to the nursing home, approximately 66% identified a change in their sleep patterns. Based on the PSQI, 63%

of patients endorsed sleep disturbances consistent with clinical sleep pathology. A smaller percent, approximately 10%, endorsed the presence of insomnia. The reason for the incongruence between measures may be due to the fact that the PSQI measures a broader range of sleep-related complaints. Actigraphy data confirmed significant sleep disturbances as measured by sleep efficiency (SE), total sleep time (TST), wake after sleep onset (WASO), and average number of awakenings (AA). PSQI and ISI scores were highly correlated ($r = .803, p < .001$) and both were correlated with objectively recorded sleep efficiency and total sleep time but not WASO or number of awakenings. Actigraphy becomes less reliable for differentiating sleep from wake in patients with more disturbed sleep (Ancoli-Israel et al., 2003) and this may account for the lack of association between these measures. In a study of older women, Blackwell et al. (2008) reported an overestimation of SE and underestimation of WASO, problems that were greatest in participants with fragmented sleep. Therefore sleep parameters from actigraphy should be interpreted cautiously.

Daylight has a direct effect on the circadian timing system and bright light has been used to help reset the timing of the circadian rhythm and treat depression. Bright light exposure was inadequate in this sample, a finding that is consistent with other studies of nursing home residents. Participants were exposed to approximately 11 minutes at or above 1000 lux per day on average ($SD = 25.54$). The maximum level of light exposure recorded for any participant was 1308 lux. Ancoli Israel et al. (2002) pointed out that “young adults are, on average, exposed to approximately 58 minutes of bright light a day (2,000 lux), healthy older people to 60 minutes a day, and AD patients living at home to 30 minutes a day. Our early research showed that nursing home

residents were exposed to 11 to 19 minutes of light brighter than 1,000 lux and that none were exposed to light above 2,000 lux.”

More stability of day-to-day activity (IS) measured by actigraphy was associated with higher average daily light exposure. Maximum light exposure, which represents the largest light value for the given interval, was also related to some of the predictors including chronotype, wake-time change and pre-institutional social rhythm regularity and frequency. An association between social rhythm and IS, both of which measure stability of activity across days, suggests that day-to-day regularity of behavioral rhythms may facilitate exposure to more light. Chronotype is associated with maximum daily light exposure but in a direction that is the opposite of what one might expect in that eveningness is more strongly related to maximum light exposure. This may be due to the fact that evening types would be more likely to be active in the early afternoon versus early morning, thus exposing them to the highest levels of daylight. Chronotype therefore might be influencing the association among maximum light exposure, wake-time advances, and pre-institutional (T1) social rhythms because evening types are more likely to experience a wake-time advance during the transition to nursing home care and also would be more likely to have less regular social rhythms.

Eveningness was associated with less regularity and frequency of social rhythms, and this is consistent with other studies (Monk, Buysse, Potts, DeGrazia, & Kupfer, 2004). Monk and colleagues found that morningness was associated with stronger social rhythms in a sample of healthy adults. The association between eveningness and social rhythms was only significant at T1 but not T2, which makes sense given that participants' daily routines at home would have been determined by personal factors (T1) such as

chronotype and in the nursing home (T2) their routines would be determined more strongly by institutional factors. This is consistent with the work of Floyd (1984).

Chronotype was associated with the timing of sleep in outpatients but not inpatients, and the authors concluded that this was due to the strength of the coupling of inpatients' rest-activity pattern with the hospital's routine.

Sleep Timing. Another primary aim of the study was to identify changes in sleep timing that occur during the move into a nursing home. For more than a decade, nursing home quality improvement initiatives have been aimed at transforming an institutional culture from a medical model to a person-centered model. The most recent version of the MDS reflects these efforts with inclusion of items that ask residents about preference for sleep and daily activity. Questions that are pertinent to the present study ask "how important is it to you to choose your own bedtime" or go outside. In the present sample, 90% indicated that bedtime choice was somewhat or very important. When asked in the present study whether residents noted a change in the timing of their sleep during the transition to the nursing home, approximately 66% identified a change. Seventy seven percent of the sample indicated going outside was somewhat or very important on the MDS. Given the extent of functional dependence for mobility in this group coupled with current staffing shortages in nursing homes, it is unlikely that this preference could be accommodated. Lack of bright light exposure in this sample suggests that participants did not spend time outdoors.

Self-report data based on the PSQI further quantified a sleep timing change during the transition to the nursing home with 52.6% citing a phase advance in bed times, 55.3% an advance in wake times, 23.7% a delay in bed times, and 23.7% a delay in wake times.

Only 18.4% reported no change bed time and 18.4% reported no change in wake time. The extent of these changes is concerning given that adjustment in sleep timing places physiological stress on an already medically compromised, aged and vulnerable population.

When all sleep timing changes were averaged together, an overall advance in bed time of one half hour and advance in wake time of one hour were found. When further partitioned into the type (bed or wake time) and direction (delay or advance) of change, all changes in these groups were found to be significant with an average wake time delay of 1 hour 10 minutes, average bed time delay of 1 hour 35 minutes, average wake time advance of 1 hour 44 minutes and bed time advance of 1 hour and 14 minutes.

The amount of sleep timing change averaged across participants was not significantly associated with rest-activity rhythms, social rhythms, sleep and mood. This absence of positive findings relates to a flaw in the study design. Including all timing changes in this average, both delays and advances, appears to have masked the effect of the type of change on other predictors and outcome variables. When the type and direction of sleep timing was explored in secondary analyses, a unique pattern of associations emerged among social rhythms, rest-activity rhythms, sleep, and mood. In participants with concurrent changes in bed and wake times, stronger social rhythms were associated with fewer depressive symptoms and the effects were moderate to large.

In participants with wake time delays, strong associations between interdaily stability, subjective sleep and mood were found. In participants with bed time advances, strong positive associations were found between intradaily variability, sleep, and mood. No associations were found between these variables in participants with wake advance or

delays or in those with no change in sleep timing. In participants with bed time advances and wake time delays, an association emerged between changes in bed times and wake times which was not present in other groups. Why and how these differential changes occur is difficult to discern but the findings underscore the importance of sleep timing changes during the transition to the nursing home. Strong associations among rest-activity rhythms, sleep and mood in the presence of certain types of sleep timing changes suggests that these changes may indeed be impacting sleep and mood via a disturbance in daily rhythms.

In a study of healthy young adults using a forced desynchrony protocol, a complex interaction of the sleep-wake cycle and endogenous circadian phase was investigated in relation to diurnal variation in affective states (Boivin et al., 1997). The authors concluded that “moderate changes in the timing of the sleep-wake cycle may have profound effects on subsequent mood.” Boivin’s work and the present study demonstrate the importance of sleep timing changes in predicting self-reported mood symptoms.

Monk et al. investigated the effects of a two-hour bed time change on the sleep of healthy community dwelling seniors and found that earlier bed times resulted in an increase in total sleep time (30 minutes), but at the expense of sleep efficiency, WASO and self-reported sleep quality (Monk, Buysse, Begley, Billy, & Fletcher, 2009). The researchers also found that a bed time delay resulted in better subjective sleep ratings. In the present study, only participants with a bed time delay exhibited an association between social rhythms and sleep. Stronger social rhythms were associated with fewer sleep disturbances in participants with a bed-time delay. This suggests that in the

presence of a bed time delay, maintenance or enhancement of social rhythms may represent a potential intervention strategy to improve sleep and mood.

Social Rhythms. Exploring social rhythms was another primary aim of this study. Social Zeitgeber Theory would predict that the process of nursing home placement could disrupt exposure to social zeitgebers which could interfere with maintenance of social rhythms which could in turn disturb the underlying biological rhythm leading to increased risk for depression. Interpersonal and social rhythm therapy (IPSRT) has been established as an effective treatment for recurrence of mood disturbances in bipolar disorder and is thought to “enhance circadian integrity” by establishing regular daily routines which become disrupted by significant life events (Frank, 2007).

While the nature of daily routines (different activities and social contacts) may have changed during the transition to the nursing home, the regularity and frequency of social rhythms did not significantly change from T1 to T2 in this sample. This is likely due to the consistency of daily routines within an institutional setting.

In the present sample, social rhythm regularity explained 33.1% of the variance in mood at T2. Another interesting finding from secondary analyses and one that bears further investigation is that stronger social rhythms were found to be associated with fewer depressive symptoms, only in those who experienced a concurrent change in both sleep- and wake-times. The effects were found to be moderate to strong in nature. Again, although evidence was not found for the overall model proposed in this study, the association of social rhythms with depression only in the presence of certain types of phase changes demonstrates the important role of both factors in depression.

Associations also were found between interdaily stability and social rhythm regularity and frequency only in residents with a wake-time advance. In other words, in those residents who were adjusting to an earlier wake time, social rhythms were associated with stability of rest-activity rhythms across days. This might indicate that stronger social rhythms provide protection from instability of the rest-activity rhythm and depressive symptoms when sleep timing is advanced. Evidence from IPSRT studies investigating the relationship between social rhythms and depression suggest that this is the case (Frank, 2007). Frank demonstrated that increasing social rhythm stability reduced the risk of recurrence of an affective episode in patients with bipolar disorder.

Using a measure of social rhythm disruption, Haynes, Ancoli-Israel, and McQuaid (2005) found that subjects with major depressive disorder experienced more disturbances in actigraphically recorded WASO and TST. In our sample, we found an association between regularity of social rhythms and sleep in participants who experienced a bed-time delay as measured by the ISI and PSQI. Those with bed-time delays also exhibited a strong association between depression and social rhythm regularity and frequency.

Chronotype. Another aim of the study was to investigate the role of chronotype in adjustment during the transition to the nursing home. Research has shown that aging is associated with a tendency toward morningness (Monk & Kupfer, 2007). The present findings were consistent with this in that participants were, on average, morning types. The data also supported the hypothesis that chronotype would predict the amount of change in sleep timing and that evening types would experience a larger change in circadian phase. Chronotype explained 10.8% of the variance in bed time change and 19.1% of the variance in wake time change. Indeed, evening types experienced a

significantly greater change in wake time than neutral or morning types. As noted previously, in participants with a wake advance, social rhythms were associated with interdaily stability and mood. Thus, although the present findings do not demonstrate causality, the findings suggest that chronotype predicts the amount of change in sleep timing, such that participants with more eveningness experience a significant change in wake times and that only this group showed an association among social rhythms, interdaily stability and mood, and between chronotype and intradaily variability. The finding of chronotype as a predictor of changes in sleep timing is consistent with the work of Floyd (1984) who studied the relationship between chronotype and sleep timing in psychiatric inpatient versus outpatients. Floyd identified changes in sleep timing for both morning (delays) and evening (advances) types and warned that it should not be assumed that the sleep-wake cycles of morning types would more closely match the daily routine of an institution. Also, the authors pointed out that prior research demonstrates that morning types may have more difficulty adjusting their sleep-wake cycle to a new environmentally imposed rest-activity rhythm and that the process of coupling the individual's sleep-wake rhythm with such a change differs depending on the direction of the phase shift. Further investigation of these processes in the literature could inform an appropriate modification of the current model to address the differential effects of sleep timing changes on outcomes in the present study.

Hypothesized model. A relatively limited number of significant associations were found among variables in the hypothesized model, despite strong empirical and theoretical foundation to support such findings. Because some key relationships did not emerge between related variables, the overall model was not tested. As noted, the absence

of findings appears to have been a possible flaw in the model itself as well as a function of the approach to the analyses.

Although the proposed model was not supported by the data and analyses, the overall pattern of relationships between variables did support some of the key hypothesized relationships. First, evening types experienced a larger change in the timing of their sleep, particularly wake times. One would assume that this finding was driven by the necessary adjustment to the morning-oriented nursing home schedule. In the presence of a wake time advance, stronger social rhythms were associated with more interdaily stability of the rest-activity rhythm and less depression. Oddly, in these participants, greater morningness was associated with more intradaily variability of the rest-activity rhythm, although research would suggest the opposite in that greater eveningness is typically associated with more disturbances in behavioral rhythms, sleep, and mood (Hasler, Allen, Sbarra, Bootzin, & Bernert, 2010; Hidalgo et al., 2009; Kim et al., 2010; Ong et al., 2007).

Implications

The present study demonstrated that evening types experienced more changes in the timing of their sleep, particularly wake times, during the transition to the nursing home. This is no small concern because adjustment to changes in the timing of the sleep-wake cycle are difficult for older adults, and this change can place a significant physiological burden on an already frail and medically compromised population. The quantification of sleep timing changes, coupled with research evidence that links phase changes to endogenous rhythm disturbances and negative health outcomes, suggests that accommodation of sleep preferences during the transition to the nursing home are not

only niceties that bring comfort in an institutional environment but fundamentally important considerations in the health and well-being of aged residents as they recover from acute and chronic illnesses and injuries.

Extant research demonstrates that evening types suffer from more sleep disturbances and depression than morning types. In the present study, participants who experienced a wake time advance which was predicted by evening preference, stronger social rhythms were associated with more interdaily stability of the rest-activity rhythm and less depression. Although this finding relied on correlational analyses, it does lend support for social rhythm therapy as an intervention strategy to prevent behavioral rhythm disturbances and depression in older adults, particularly in evening types who are more likely to experience a change in sleep timing as they transition to the nursing home.

The functional status data for this sample illustrates how physical limitations might impinge on rest-activity patterns. If residents spend a large portion of the day in bed because they are physically unable to move within their room or ambulate independently, they may receive less social contact, physical activity, and exposure to bright light. Spending excessive time in bed also increases the risk for insomnia as daytime napping reduces homeostatic sleep drive and residents struggle to sleep at night. This underscores the importance of staff and environmental factors in maintenance of daily activity.

Strengths and limitations

To my knowledge, this was the first study to directly quantify the amount and type of sleep timing change during a transition into the nursing home, and the first to examine factors that can predict or facilitate adjustment to this change. A relative strength

of this study was use of limited exclusionary criteria. This sample of newly admitted nursing home residents was heavily burdened by illness, functional impairment, and polypharmacy. The participant group was comparable to the sample of all incoming residents during the collection period on demographic and health variables with the exception of Alzheimer's Disease which was essentially excluded from the participant group due to the requirement of intact cognitive functioning. Nonetheless, several participants carried diagnoses of dementia in their medical records. These results may be considered generalizable to other nursing home residents because the exclusionary criteria were limited and no differences were found between participant and nonparticipant groups on basic demographics or socioeconomic status.

Another strength of the present study was the use of both subjective and objective measures to quantify behavioral rhythms and sleep. Both types of data have advantages and disadvantages. Subjective measures can be influenced by many factors, including depression and cognitive status. Subjective sleep measures can underestimate total sleep time, particularly in patients with insomnia, and actigraphy can underestimate sleep onset latency as compared to polysomnography (Morgenthaler et al., 2007). Actigraphy has the advantage of data collection over multiple days. Older women tend to report more subjective sleep complaints but demonstrate fewer sleep problems on actigraphic sleep measures than men (van den Berg et al., 2009). Significant associations were found with both actigraphically-derived variables and self-report measures which lends further support to the conclusions in the present study.

The average number of days of actigraphy in the present study was 6.92 (SD = .49) with a minimum of 4 days and maximum of 7 days. Van Someren (2007)

recommends collecting at least 7 days of actigraphy data but more optimally 14 days to improve reliability of estimating interdaily stability in subjects with insomnia or dementia. He attributes this in part to the presence of a high level of variability between days and possibly week-to-week variability in insomnia. Although our sample is neither a group of patients with primary insomnia or nursing home residents with dementia as in the Van Someren study, this sample did have a host of factors that may increase variability of rhythms including illness, functional dependence and other institutional factors so collection of data over more days could increase the reliability of this data.

This was a cross-sectional study and the results are correlational so causal inferences should be interpreted cautiously. Because of the high number of comparisons in the current study, there is a possibility that some of the significant associations found in secondary analyses were the result of Type I error, therefore it will be important to replicate these findings, and to do so based on a well-articulated model given the complexity of the interrelationships among these variables. Type II errors also should be considered as the current study may have lacked power to detect hypothesized relationships given the small sample size.

Determining an optimal number of participants to ensure minimization of both Type I and Type II errors is critical because data collection was particularly challenging in this population. Recently admitted nursing home patients are often medically unstable and at risk of re-hospitalization. During the data collection period, two of the four actigraphs were lost when residents were hospitalized, even though extensive precautions were put in place to prevent this loss. Non-removable hospital bands were used to secure the actigraphs, flyers were given to staff regarding the study and presence of actigraphs,

and when individuals were recruited, nursing staff and social services were informed of watch placement. A note was placed within the hospital band indicating a phone number to call should the watch be removed.

Another problem that was anticipated but not averted in data collection was incomplete sleep diaries. New residents are typically ill or injured and they are often highly involved in physical, occupational, speech or other rehabilitation services. When they are not occupied in rehab, they are often fatigued and in pain. Many residents were reluctant to complete the diaries but encouraged to do so and instructed on proper completion. Because incomplete data was anticipated, other methods were utilized such as objective sleep measures and followup questions aimed at collecting essential data. Residents who did not complete the diary were asked about their typical or average sleep and wake times that occurred during the past week. Thus, an essential component of the study, the sleep and wake times were estimated retrospectively and subject to the effects of memory or recall bias. Mood, pain, or other immediate mental or physical health conditions could impact the subjective recall of sleep and wake times. Nonetheless, recall of daily routines prior to entering the nursing home should be reliable, particularly if participants demonstrate intact cognitive functioning including temporal orientation. The BIMS cognitive screening measure used for determination of study eligibility includes items that measure temporal orientation and this measure was used as a determination of eligibility for the study. Use of collateral reports might increase confidence in the accuracy of reports but would require significant effort that would be time prohibitive. Also, it would add little value unless the informant was living in the same household. A

child, relative or friend may not be aware of the participant's daily routine, especially sleep and wake times, thus bringing into question informant reliability.

Future directions

This study marks a first step in identifying changes in the sleep-wake cycle, behavioral rhythms, sleep and mood in older adults as they move into a nursing home. Individualized care has been a goal of nursing home reform. This study demonstrates the importance of accommodating personal preferences for sleep timing and daily activities. Many barriers stand in the way of implementing individualized treatment plans in the nursing home including inadequate staffing levels and training, competing needs of residents in shared rooms, to name a few. Therefore it is imperative that future studies demonstrate the high cost of neglecting an individual's sleep and activity patterns. The present findings should be replicated based on a reformulated model that accounts for the type (bed-time versus wake-time) and direction (advance versus delay) of sleep-wake cycle changes in relation to rest-activity rhythms, sleep, and mood. Social rhythms represent a promising intervention strategy and should be explored further during the transition to nursing home care or in residents more generally who exhibit sleep or mood problems.

The present study would have benefited from a longitudinal design, but following patients from their homes to the hospital and into the nursing home is a challenging proposition. Studying residents in a continuum of care community may be one possible approach to recruiting subjects for such a study. Additionally, other forms of chronobiological data (salivary cortisol, skin temperature or other non-invasive methods) may strengthen the findings and implications of sleep-wake cycle changes.

Lastly, pain, functional dependence, and other health characteristics are prevalent and strongly related to the outcomes of interest. These should be considered within future studies either as covariates or as components of a reformulated model.

REFERENCES

- Alessi, C. A., Schnelle, J. F., MacRae, P. G., Ouslander, J. G., al-Samarrai, N., Simmons, S. F., et al. (1995). Does physical activity improve sleep in impaired nursing home residents? *Journal of the American Geriatric Society*, *43*(10), 1098-1102.
- Alessi, C. A., Yoon, E. J., Schnelle, J. F., Al-Samarrai, N. R., & Cruise, P. A. (1999). A randomized trial of a combined physical activity and environmental intervention in nursing home residents: Do sleep and agitation improve? *Journal of the American Geriatrics Society*, *47*(7), 784-791.
- Alexopoulos, G. S., Borson, S., Cuthbert, B. N., Devanand, D. P., Mulsant, B. H., Olin, J. T., et al. (2002). Assessment of late life depression. *Biological Psychiatry*, *52*(3), 164-174.
- Ancoli-Israel, S., Cole, R., Alessi, C., Chambers, M., Moorcroft, W., & Pollak, C. P. (2003). The role of actigraphy in the study of sleep and circadian rhythms. *Sleep: Journal of Sleep and Sleep Disorders Research*, *26*(3), 342-392.
- Ancoli-Israel, S., Martin, J. L., Kripke, D. F., Marler, M., & Klauber, M. R. (2002). Effect of light treatment on sleep and circadian rhythms in demented nursing home patients. *Journal of the American Geriatrics Society*, *50*(2), 282-289.
- Aschoff, J., Fatranska, M., Giedke, H., Doerr, P., Stamm, D., & Wisser, H. (1971). Human circadian rhythms in continuous darkness: entrainment by social cues. *Science*, *171*(3967), 213-215.

- Ashman, S. B., Monk, T. H., Kupfer, D. J., Clark, C. H., Myers, F. S., Frank, E., et al. (1999). Relationship between social rhythms and mood in patients with rapid cycling bipolar disorder. *Psychiatry Research*, 86(1), 1-8.
- Bastien, C. H., Vallieres, A., & Morin, C. M. (2001). Validation of the Insomnia Severity Index as an outcome measure for insomnia research. *Sleep Medicine*, 2(4), 297-307.
- Beekman, A. T. F., Copeland, J. R. M., & Prince, M. J. (1999). Review of community prevalence of depression in later life. *British Journal of Psychiatry*, 174(4), 307-311.
- Bernert, R. A., Hasler, B. P., Cromer, K. R., & Joiner Jr., T. E. (2006). Diurnal preference and circadian phase: a meta-analysis. *Sleep*, 29, A54-A55.
- Bharathan, T., Glodan, D., Ramesh, A., Vardhini, B., Baccash, E., Kiselev, P., et al. (2007). What do patterns of noise in a teaching hospital and nursing home suggest? *Noise & Health*, 9(35), 31-34.
- Blackwell, T., Redline, S., Ancoli-Israel, S., Schneider, J. L., Surovec, S., Johnson, N. L., et al. (2008). Comparison of sleep parameters from actigraphy and polysomnography in older women: The SOF study. *Sleep: Journal of Sleep and Sleep Disorders Research*, 31(2), 283-291.
- Bliwise, D. L., & Breus, M. J. (2000). Insomnia in dementia and in residential care. In K. L. Lichstein & C. M. Morin (Eds.), *Treatment of Late-Life Insomnia* (pp. 321-344). Thousand Oaks: Sage Publications, Inc.
- Bloom, H. G., Ahmed, I., Alessi, C. A., Ancoli-Israel, S., Buysse, D. J., Kryger, M. H., et al. (2009). Evidence-based recommendations for the assessment and management of sleep disorders in older persons. *Journal of the American Geriatrics Society*, 57(5), 761-789.

- Boivin, D. B., Czeisler, C. A., Dijk, D. J., Duffy, J. F., Folkard, S., Minors, D. S., et al. (1997). Complex interaction of the sleep-wake cycle and circadian phase modulates mood in healthy subjects. *Archives of General Psychiatry*, 54(2), 145-152.
- Borbely, A. A., & Achermann, P. (1992). Concepts and models of sleep regulation: an overview. *Journal of Sleep Research*, 1(2), 63-79.
- Bruce, A. S., & Aloia, M. S. (2006). Sleep and Cognition in Older Adults. *Sleep Medicine Clinics*, 1(2), 207-220.
- Buysse, D. J., Browman, K. E., Monk, T. H., Reynolds, C. F., Fasiczka, A. L., & Kupfer, D. J. (1992). Napping and 24-hour sleep/wake patterns in healthy elderly and young adults. *Journal of the American Geriatrics Society*, 40(8), 779-786.
- Buysse, D. J., Hall, M. L., Strollo, P. J., Kamarck, T. W., Owens, J., Lee, L., et al. (2008). Relationships between the Pittsburgh Sleep Quality Index (PSQI), Epworth Sleepiness Scale (ESS), and clinical/polysomnographic measures in a community sample. *Journal of Clinical Sleep Medicine*, 4(6), 563-571.
- Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatry Research*, 28(2), 193-213.
- Carvalho-Bos, S. S., Riemersma-van der Lek, R. F., Waterhouse, J., Reilly, T., & Van Someren, E. J. W. (2007). Strong association of the rest-activity rhythm with well-being in demented elderly women. *American Journal of Geriatric Psychiatry*, 15(2), 92-100.
- Chellappa, S. L., Schröder, C., & Cajochen, C. (2009). Chronobiology, excessive daytime sleepiness and depression: Is there a link? *Sleep Medicine*, 10(5), 505-514.

- Chelminski, I., Ferraro, F. R., Petros, T. V., & Plaud, J. J. (1999). An analysis of the "eveningness-morningness" dimension in "depressive" college students. *Journal of Affective Disorders, 52*(1-3), 19-29.
- Clapin-French, E. (1986). Sleep patterns of aged persons in long-term care facilities. *Journal of Advanced Nursing, 11*(1), 57-66.
- Cole, M. G., Bellavance, F., & Mansour, A. (1999). Prognosis of depression in elderly community and primary care populations: A systematic review and meta-analysis. *The American Journal of Psychiatry, 156*(8), 1182-1189.
- Congressional Budget Office. (2004). *Financing long-term care for the elderly*. Congress of the United States Retrieved from <http://www.cbo.gov/ftpdocs/54xx/doc5400/04-26-LongTermCare.pdf>.
- Copinschi, G., & Caufriez, A. (2007). Age-related Sleep Alterations: Implications for Endocrine Function. *Sleep Medicine Clinics, 2*(2), 171-185.
- Cruise, P. A., Schnelle, J. F., Alessi, C. A., Simmons, S. F., & Ouslander, J. G. (1998). The nighttime environment and incontinence care practices in nursing homes. *Journal of the American Geriatrics Society, 46*(2), 181-186.
- Czeisler, C. A., Dumont, M., Duffy, J. F., Steinberg, J. D., Richardson, G. S., Brown, E. N., et al. (1992). Association of sleep-wake habits in older people with changes in output of circadian pacemaker. *Lancet, 340*(8825), 933-936.
- Dijk, D. J., Duffy, J., & Czeisler, C. (2000). Contribution of circadian physiology and sleep homeostasis to age-related changes in human sleep. *Chronobiology International: The Journal of Biological & Medical Rhythm Research, 17*(3), 285.

- Dijk, D. J., Duffy, J. F., Riel, E., Shanahan, T. L., & Czeisler, C. A. (1999). Ageing and the circadian and homeostatic regulation of human sleep during forced desynchrony of rest, melatonin and temperature rhythms. *Journal of Physiology*, 516(Pt 2), 611-627.
- Dinges, D. F., Pack, F. M., Williams, K., Gillen, K. A., Powell, J. W., Ott, G. E., et al. (1997). Cumulative sleepiness, mood disturbance and psychomotor vigilance performance decrements during a week of sleep restricted to 4-5 hours per night. *Sleep: Journal of Sleep Research & Sleep Medicine*, 20(4), 267-277.
- Drennan, M. D., Klauber, M. R., Kripke, D. F., & Goyette, L. M. (1991). The effects of depression and age on the Horne-Ostberg morningness-Eveningness score. *Journal of Affective Disorders*, 23(2), 93-98.
- Duffy, J. F., & Czeisler, C. A. (2002). Age-related change in the relationship between circadian period, circadian phase, and diurnal preference in humans. *Neuroscience Letters*, 318(3), 117-120.
- Duffy, J. F., Dijk, D. J., Hall, E. F., & Czeisler, C. A. (1999). Relationship of endogenous circadian melatonin and temperature rhythms to self-reported preference for morning or evening activity in young and older people. *Journal of Investigative Medicine*, 47(3), 141-150.
- Duffy, J. F., Rimmer, D. W., & Czeisler, C. A. (2001). Association of intrinsic circadian period with morningness-eveningness, usual wake time, and circadian phase. *Behavioral Neuroscience*, 115(4), 895-899.
- Duffy, J. F., Zeitzer, J. M., Rimmer, D. W., Klerman, E. B., Dijk, D. J., & Czeisler, C. A. (2002). Peak of circadian melatonin rhythm occurs later within the sleep of older

- subjects. *American Journal of Physiology - Endocrinology & Metabolism*, 282(2), E297-303.
- Edgar, D. M. (1994). Sleep-wake circadian rhythms and aging: Potential etiologies and relevance to age-related changes in integrated physiological systems. *Neurobiology of Aging*, 15(4), 499-501.
- Ehlers, C. L., Frank, E., & Kupfer, D. J. (1988). Social zeitgebers and biological rhythms. *Archives of General Psychiatry*, 45(10), 948-952.
- Elmore, S. K., Betrus, P. A., & Burr, R. (1994). Light, social zeitgebers, and the sleep-wake cycle in the entrainment of human circadian rhythms. *Research in Nursing & Health*, 17(6), 471-478.
- Engelheart, S., Lammes, E., & Akner, G. (2006). Elderly peoples' meals. A comparative study between elderly living in a nursing home and frail, self-managing elderly. *Journal of Nutritional Health and Aging*, 10(2), 96-102.
- Ersser, S., Wiles, A., Taylor, H., Wade, S., Walsh, R., & Bentley, T. (1999). The sleep of older people in hospital and nursing homes. *Journal of Clinical Nursing*, 8(4), 360-368.
- Fetveit, A., & Bjorvatn, B. (2002). Sleep disturbances among nursing home residents. *International Journal of Geriatric Psychiatry*, 17(7), 604-609.
- Floyd, J. A. (1984). Interaction between personal sleep-wake rhythms and psychiatric hospital rest-activity schedule. *Nursing Research*, 33(5), 255-259.
- Floyd, J. A., Janisse, J. J., Jenuwine, E. S., & Ager, J. W. (2007). Changes in REM-sleep percentage over the adult lifespan. *Sleep*, 30(7), 829-836.

- Floyd, J. A., Medler, S. M., Ager, J. W., & Janisse, J. J. (2000). Age-related changes in initiation and maintenance of sleep: a meta-analysis. *Research in Nursing & Health*, 23(2), 106-117.
- Foley, D. J., Monjan, A. A., Brown, S., Simonsick, E. M., Wallace, R. B., & Blazer, D. G. (1995). Sleep complaints among elderly persons: An epidemiologic study of three communities. *Sleep: Journal of Sleep Research & Sleep Medicine*, 18(6), 425-432.
- Frank, E. (2007). Interpersonal and social rhythm therapy: A means of improving depression and preventing relapse in bipolar disorder. *Journal of Clinical Psychology*, 63(5), pp.
- Gaboda, D., Lucas, J., Siegel, M., Kalay, E., & Crystal, S. (2011). No Longer Undertreated? Depression Diagnosis and Antidepressant Therapy in Elderly Long-Stay Nursing Home Residents, 1999 to 2007. *Journal of the American Geriatrics Society*, 59(4), 673-680.
- Gammack, J. K. (2008). Light Therapy for Insomnia in Older Adults. *Clinics in Geriatric Medicine*, 24(1), 139-149.
- Gehrman, P. R., Connor, D. J., Martin, J. L., Shochat, T., Corey-Bloom, J., & Ancoli-Israel, S. (2009). Melatonin fails to improve sleep or agitation in double-blind randomized placebo-controlled trial of institutionalized patients with Alzheimer disease. *American Journal of Geriatric Psychiatry*, 17(2), 166-169.
- Gehrman, P. R., Marler, M., Martin, J. L., Shochat, T., Corey-Bloom, J., & Ancoli-Israel, S. (2004). The timing of activity rhythms in patients with dementia is related to survival. *Journals of Gerontology Series A-Biological Sciences & Medical Sciences*, 59(10), 1050-1055.

- Hasler, B. P., Allen, J. J., Sbarra, D. A., Bootzin, R. R., & Bernert, R. A. (2010). Morningness-eveningness and depression: Preliminary evidence for the role of the behavioral activation system and positive affect. *Psychiatry Research, 176*(2-3), 166-173.
- Haynes, P. L., Ancoli-Israel, S., & McQuaid, J. (2005). Illuminating the impact of habitual behaviors in depression. *Chronobiology International, 22*(2), 279-297.
- Herljevic, M., Middleton, B., Thapan, K., Skene, D. J., Herljevic, M., Middleton, B., et al. (2005). Light-induced melatonin suppression: age-related reduction in response to short wavelength light. *Experimental Gerontology, 40*(3), 237-242.
- Hidalgo, M. P., Caumo, W., Posser, M., Coccaro, S. B., Camozzato, A. L., & Chaves, M. L. F. (2009). Relationship between depressive mood and chronotype in healthy subjects. *Psychiatry & Clinical Neurosciences, 63*(3), 283-290.
- Hofman, M. A. (2000). The human circadian clock and aging. *Chronobiology International, 17*(3), 245-259.
- Holmbeck, G. N. (2003). Toward terminological, conceptual, and statistical clarity in the study of mediators and moderators: Examples from the child-clinical and pediatric psychology literatures *Methodological issues & strategies in clinical research* (3rd ed., pp. 77-105). Washington, DC: American Psychological Association; US.
- Honma, K., Honma, S., Nakamura, K., Sasaki, M., Endo, T., & Takahashi, T. (1995). Differential effects of bright light and social cues on reentrainment of human circadian rhythms. *American Journal of Physiology, 268*(2 Pt 2), R528-535.

- Horne, J. A., & Ostberg, O. (1976). A self-assessment questionnaire to determine morningness-eveningness in human circadian rhythms. *International Journal of Chronobiology*, 4(2), 97-110.
- Jacobs, D., Ancoli-Israel, S., Parker, L., & Kripke, D. F. (1989). Twenty-four-hour sleep-wake patterns in a nursing home population. *Psychology and Aging*, 4(3), pp.
- Johnson, E. O. (2006). Epidemiology of insomnia: From adolescence to old age. *Sleep Medicine Clinics*, 1(3), 305-317.
- Jones, R. N., Marcantonio, E. R., & Rabinowitz, T. (2003). Prevalence and Correlates of Recognized Depression in U.S. Nursing Homes. *Journal of the American Geriatrics Society*, 51(10), 1404-1409.
- Jongenelis, K., Pot, A., Eisses, A., Beekman, A., Kluiters, H., & Ribbe, M. (2004). Prevalence and risk indicators of depression in elderly nursing home patients: The AGED study. *Journal of Affective Disorders*, 83(2-3), 135-142.
- Kalpakjian, C. Z., Toussaint, L. L., Albright, K. J., Bombardier, C. H., Krause, J. K., & Tate, D. G. (2009). Patient health Questionnaire-9 in spinal cord injury: an examination of factor structure as related to gender. *Journal of Spinal Cord Medicine*, 32(2), 147-156.
- Kim, S. J., Lee, Y. J., Kim, H., Cho, I. H., Lee, J.-Y., & Cho, S.-J. (2010). Age as a moderator of the association between depressive symptoms and morningness-eveningness. *Journal of Psychosomatic Research*, 68(2), 159-164.
- Koenig, H. G., Shelp, F., Goli, V., Cohen, H. J., & Blazer, D. G. (1989). Survival and health care utilization in elderly medical inpatients with major depression. *Journal of the American Geriatrics Society*, 37(7), 599-606.

- Kraemer, H. C., & Blasey, C. M. (2004). Centring in regression analyses: A strategy to prevent errors in statistical inference. *International Journal of Methods in Psychiatric Research*, 13(3), 141-151.
- Lack, L. C., & Wright, H. R. (2007). Treating chronobiological components of chronic insomnia. *Sleep Medicine*, 8(6), 637-644.
- Lebowitz, B. D., & Olin, J. T. (2004). The social and financial burden of late-life depression to society and individuals *Late-life depression* (pp. 12-16). New York, NY: Oxford University Press; US.
- Lee, W., Nagubadi, S., Kryger, M. H., & Mokhlesi, B. (2008). Epidemiology of obstructive sleep apnea: a population-based perspective. *Expert Review of Respiratory Medicine*, 2(3), 349-364.
- Lieverse, R., Van Someren, E. J., Nielen, M. M., Uitdehaag, B. M., Smit, J. H., & Hoogendijk, W. J. (2011). Bright light treatment in elderly patients with nonseasonal major depressive disorder: A randomized placebo-controlled trial. *Archives of General Psychiatry*, 68(1), 61-70.
- Liu, L., & Ancoli-Israel, S. (2006). Insomnia in the older adult. *Sleep Medicine Clinics*, 1(3), 409-421.
- Maaskant, M., van de Wouw, E., van Wijck, R., Evenhuis, H. M., & Echteld, M. A. (2013). Circadian sleep-wake rhythm of older adults with intellectual disabilities. *Research in Developmental Disabilities*, 34(4), 1144-1151
- Magalhães, C., Souza, C. V., Dias, T. R., de Bruin, P. F. C., & de Bruin, V. M. S. (2005). Lifestyle regularity measured by the social rhythm metric in Parkinson's disease. *Chronobiology International*, 22(5), 917-924.

- Martin, J. L., & Alessi, C. A. (2006). Limited validity of minimum data set items on sleep and hypnotic use in predicting falls and hip fracture in nursing home residents. *Journal of the American Geriatrics Society, 54*(7), 1150-1151.
- Martin, J. L., & Ancoli-Israel, S. (2008). Sleep disturbances in long-term care. *Clinics in Geriatric Medicine, 24*(1), 39-50.
- Martin, J. L., Jouldjian, S., Mitchell, M., Josephson, K., & Alessi, C. (2012). A Longitudinal Study of Poor Sleep After Inpatient Post-Acute Rehabilitation: The Role of Depression and Pre-Illness Sleep Quality. *American Journal of Geriatric Psychiatry, 20*(6), 477-484.
- Martin, J. L., Marler, M. R., Harker, J. O., Josephson, K. R., & Alessi, C. A. (2007). A multicomponent nonpharmacological intervention improves activity rhythms among nursing home residents with disrupted sleep/wake patterns. *Journals of Gerontology: Series A: Biological Sciences and Medical Sciences, 62A*(1), 67-72.
- Martin, J. L., Webber, A. P., Alam, T., Harker, J. O., Josephson, K. R., & Alessi, C. A. (2006). Daytime sleeping, sleep disturbance, and circadian rhythms in the nursing home. *American Journal of Geriatric Psychiatry, 14*(2), 121-129.
- Maywood, E. S., O'Neill, J., Wong, G. K., Reddy, A. B., & Hastings, M. H. (2006). Circadian timing in health and disease. *Progress in Brain Research, 153*, 253-269.
- Meadows, R., Luff, R., Evers, I., Venn, S., Cope, E., & Arber, S. (2010). An actigraphic study comparing community dwelling poor sleepers with non-demented care home residents. *Chronobiology International, 27*(4), 842-854.
- Mendlewicz, J. (2009). Disruption of the circadian timing systems: molecular mechanisms in mood disorders. *CNS Drugs, 23 Suppl 2*, 15-26.

- Mendoza, J. (2007). Circadian Clocks: Setting Time By Food. *Journal of Neuroendocrinology*, 19(2), 127-137.
- Middelkoop, H. A., Kerkhof, G. A., Smilde-van den Doel, D. A., Ligthart, G. J., & Kamphuisen, H. A. (1994). Sleep and ageing: the effect of institutionalization on subjective and objective characteristics of sleep. *Age Ageing*, 23(5), 411-417.
- Misra, S., & Malow, B. A. (2008). Evaluation of Sleep Disturbances in Older Adults. *Clinics in Geriatric Medicine*, 24(1), 15-26.
- Mistlberger, R. E., & Skene, D. J. (2004). Social influences on mammalian circadian rhythms: animal and human studies. *Biological Reviews of the Cambridge Philosophical Society*, 79(3), 533-556.
- Monk, T. H. (2005). Aging Human Circadian Rhythms: Conventional Wisdom May Not Always Be Right. *Journal of Biological Rhythms*, 20(4), 366-374.
- Monk, T. H. (2010). Enhancing circadian zeitgebers. *Sleep: Journal of Sleep and Sleep Disorders Research*, 33(4), 509-514.
- Monk, T. H., Buysse, D. J., Begley, A. E., Billy, B. D., & Fletcher, M. E. (2009). Effects of a Two-Hour Change in Bedtime on the Sleep of Healthy Seniors. *Chronobiology International: The Journal of Biological & Medical Rhythm Research*, 26(3), 526-543.
- Monk, T. H., Buysse, D. J., Hall, M., Nofzinger, E. A., Thompson, W. K., Mazumdar, S. A., et al. (2006). Age-related differences in the lifestyle regularity of seniors experiencing bereavement, care-giving, insomnia, and advancement into old-old age. *Chronobiology International*, 23(4), 831-841.

- Monk, T. H., Buysse, D. J., Potts, J. M., DeGrazia, J. M., & Kupfer, D. J. (2004). Morningness-eveningness and lifestyle regularity. *Chronobiology International*, 21(3), 435-443.
- Monk, T. H., Buysse, D. J., Reynolds, C. F., 3rd, Berga, S. L., Jarrett, D. B., Begley, A. E., et al. (1997). Circadian rhythms in human performance and mood under constant conditions. *Journal of Sleep Research*, 6(1), 9-18.
- Monk, T. H., Buysse, D. J., Reynolds, C. F., 3rd, Jarrett, D. B., & Kupfer, D. J. (1992). Rhythmic vs homeostatic influences on mood, activation, and performance in young and old men. *Journal of Gerontology*, 47(4), P221-227.
- Monk, T. H., Flaherty, J. F. F., E., Hoskinson, K., & Kupfer, D. J. (1990). The Social Rhythm Metric: An instrument to quantify the daily rhythms of life. *Journal of Nervous and Mental Disease*, 178(2), 120-126.
- Monk, T. H., & Kupfer, D. J. (2000). Circadian rhythms in healthy aging--Effects downstream from the pacemaker. *Chronobiology International*, 17(3), 355-368.
- Monk, T. H., & Kupfer, D. J. (2007). Which aspects of morningness-eveningness change with age? *Journal of Biological Rhythms*, 22(3), 278-280.
- Monk, T. H., Kupfer, D. J., Frank, E., & Ritenour, A. M. (1991). The Social Rhythm Metric (SRM): Measuring daily social rhythms over 12 weeks. *Psychiatry Research*, 36(2), 195-207.
- Monk, T. H., Petrie, S. R., Hayes, A. J., & Kupfer, D. J. (1994). Regularity of daily life in relation to personality, age, gender, sleep quality and circadian rhythms. *Journal of Sleep Research*, 3(4), 196-205.

- Monk, T. H., Reynolds, C. F., 3rd, Kupfer, D. J., Hoch, C. C., Carrier, J., & Houck, P. R. (1997). Differences over the life span in daily life-style regularity. *Chronobiology International, 14*(3), 295-306.
- Monk, T. H., Reynolds, C. F., Buysse, D. J., DeGrazia, J., & Kupfer, D. J. (2003). The Relationship Between Lifestyle Regularity and Subjective Sleep Quality. *Chronobiology International: The Journal of Biological & Medical Rhythm Research, 20*(1), 97.
- Monk, T. H., Reynolds, C. F., Buysse, D. J., & Hoch, C. C. (1991). Circadian characteristics of healthy 80-yr-olds and their relationship to objectively recorded sleep. *Journals of Gerontology, 46*(5), M171-175.
- Monk, T. H., Reynolds, C. F., Machen, M. A., & Kupfer, D. J. (1992). Daily social rhythms in the elderly and their relation to objectively recorded sleep. *Sleep: Journal of Sleep Research & Sleep Medicine, 15*(4), 322-329.
- Moore-Ede, M. C., Czeisler, C. A., & Richardson, G. S. (1983). Circadian timekeeping in health and disease. Part 2. Clinical implications of circadian rhythmicity. *New England Journal of Medicine, 309*(9), 530-536.
- Morgenthaler, T., Alessi, C., Friedman, L., Owens, J., Kapur, V., Boehlecke, B., et al. (2007). Practice parameters for the use of actigraphy in the assessment of sleep and sleep disorders: an update for 2007. *Sleep, 30*(4), 519-529.
- Morin, C. M., Belleville, G., Belanger, L., & Ivers, H. (2011). The Insomnia Severity Index: psychometric indicators to detect insomnia cases and evaluate treatment response. *Sleep, 34*(5), 601-608.

- Naylor, E., Penev, P. D., Orbeta, L., Janssen, I., Ortiz, R., Colecchia, E. F., et al. (2000). Daily social and physical activity increases slow-wave sleep and daytime neuropsychological performance in the elderly. *Sleep, 23*(1), 87-95.
- Naylor, E., & Zee, P. C. (2006). Circadian rhythm alterations with aging. *Sleep Medicine Clinics, 1*(2), 187-196.
- Newman, A. B., Enright, P. L., Manolio, T. A., & Haponik, E. F. (1997). Sleep disturbance, psychosocial correlates, and cardiovascular disease in 5201 older adults: The cardiovascular health study. *Journal of the American Geriatrics Society, 45*(1), 1-7.
- NIH. (2005, June 13-15). *National Institutes of Health State-of-the-Science Conference Statement of Manifestations and Management of Chronic Insomnia in Adults*. Paper presented at the National Institutes of Health State-of-the-Science Conference.
- Ohayon, M. M. (2002). Epidemiology of insomnia: what we know and what we still need to learn. *Sleep Medicine Reviews, 6*(2), 97-111.
- Ohayon, M. M., Carskadon, M. A., Guilleminault, C., & Vitiello, M. V. (2004). Meta-analysis of quantitative sleep parameters from childhood to old age in healthy individuals: developing normative sleep values across the human lifespan. *Sleep, 27*(7), 1255-1273.
- Ong, J. C., Huang, J. S., Kuo, T. F., Manber, R., Ong, J. C., Huang, J. S., et al. (2007). Characteristics of insomniacs with self-reported morning and evening chronotypes. *Journal of Clinical Sleep Medicine, 3*(3), 289-294.
- Pandi-Perumal, S. R., Spence, D. W., & Sharma, V. K. (2010). Aging and circadian rhythms: general trends. In J. M. Pandi-Perumal, J. M. Monti & A. A. Monjan (Eds.),

- Principles and Practice of Geriatric Sleep Medicine* (Vol. New York): Cambridge University Press.
- Perlis, M. L., Smith, L. J., Lyness, J. M., Matteson, S. R., Pigeon, W. R., Jungquist, C. R., et al. (2006). Insomnia as a risk factor for onset of depression in the elderly. *Behavioral Sleep Medicine*, 4(2), 104-113.
- Pigeon, W. R., Hegel, M., Unutzer, J., Fan, M.-Y., Sateia, M. J., Lyness, J. M., et al. (2008). Is insomnia a perpetuating factor for late-life depression in the IMPACT cohort? *Sleep: Journal of Sleep and Sleep Disorders Research*, 31(4), 481-488.
- Pollak, C. P., & Perlick, D. (1991). Sleep problems and institutionalization of the elderly. *Journal of Geriatric Psychiatry & Neurology*, 4(4), 204-210.
- Randler, C. (2009). Validation of the full and reduced Composite Scale of Morningness. *Biological Rhythm Research*, 40(5), 413-423.
- Raymann, R. J. E. M., Swaab, D. F., & Van Someren, E. J. W. (2007). Skin temperature and sleep-onset latency: changes with age and insomnia. *Physiology & Behavior*, 90(2-3), 257-266.
- Riemann, D., Berger, M., & Voderholzer, U. (2001). Sleep and depression--results from psychobiological studies: an overview. *Biological Psychology*, 57(1-3), 67-103.
- Rivkees, S. A. (2007). The Development of Circadian Rhythms: From Animals to Humans. *Sleep Medicine Clinics*, 2(3), 331-341.
- Rovner, B. W. (1993). Depression and increased risk of mortality in the nursing home patient. *American Journal of Medicine*, 94(5A), 19S-22S.

- Rovner, B. W., & Katz, I. R. (1993). Psychiatric disorders in the nursing home: A selective review of studies related to clinical care. *International Journal of Geriatric Psychiatry*, 8(1), 75-87.
- Sack, R. L., Auckley, D., Auger, R., Carskadon, M. A., Wright, K. P., Jr., Vitiello, M. V., et al. (2007). Circadian rhythm sleep disorders: Part II, advanced sleep phase disorder, delayed sleep phase disorder, free-running disorder, and irregular sleep-wake rhythm: An American academy of sleep medicine review. *Sleep: Journal of Sleep and Sleep Disorders Research*, 30(11), 1484-1501.
- Saliba, D., & Buchanan, J. (2008). Development and validation of a revised nursing home assessment tool: MDS 3.0. Retrieved from <http://www.cms.hhs.gov/NursingHomeQualityInits/downloads/MDS30FinalReport.pdf>
- Samis, H. (1968). Aging: The loss of temporal organization. *Perspectives in Biology and Medicine*, 12(1), 95-102.
- Schmidt, C., Collette, F., Cajochen, C., & Peigneux, P. (2007). A time to think: Circadian rhythms in human cognition. *Cognitive Neuropsychology*, 24(7), 755-789.
- Schnelle, J. F., Alessi, C. A., Al-Samarrai, N. R., Fricker, R. D., Jr., & Ouslander, J. G. (1999). The nursing home at night: Effects of an intervention on noise, light, and sleep. *Journal of the American Geriatrics Society*, 47(4), 430-438.
- Schnelle, J. F., Cruise, P. A., Alessi, C. A., Al-Samarrai, N., & Ouslander, J. G. (1998). Individualizing nighttime incontinence care in nursing home residents. *Nursing Research*, 47(4), 197-204.

- Shah, S. N., Schoenbachler, B., Streim, J., & Meeks, S. (in press). Antidepressant Prescribing Patterns in the Nursing Home: Second-Generation Issues Revisited. *Journal of the American Medical Directors Association*.
- Sharma, M., Palacios-Bois, J., Schwartz, G., Iskandar, H., & et al. (1989). Circadian rhythms of melatonin and cortisol in aging. *Biological Psychiatry*, 25(3), 305-319.
- Shen, G. H., Alloy, L. B., Abramson, L. Y., & Sylvia, L. G. (2008). Social rhythm regularity and the onset of affective episodes in bipolar spectrum individuals. *Bipolar Disorders*, 10(4), 520-529.
- Shochat, T., Martin, J. L., Marler, M., & Ancoli-Israel, S. (2000). Illumination levels in nursing home patients: effects on sleep and activity rhythms. *Journal of Sleep Research*, 9(4), 373-379.
- Sokolove, P. G., & Bushell, W. N. (1978). The chi square periodogram: its utility for analysis of circadian rhythms. *Journal of Theoretical Biology*, 72(1), 131-160.
- Song, Y., Dowling, G. A., Wallhagen, M. I., Lee, K. A., Strawbridge, W. J., & Hubbard, E. M. (2009). Rest-activity patterns in institutionalized Korean older adults with dementia: a pilot study. *Journal of Gerontological Nursing*, 35(12), 20-28; quiz 30-21.
- Souetre, E., Salvati, E., Belugou, J.-L., Pringuey, D., & et al. (1989). Circadian rhythms in depression and recovery: Evidence for blunted amplitude as the main chronobiological abnormality. *Psychiatry Research*, 28(3), 263-278.
- Spira, A. P., Covinsky, K., Rebok, G. W., Stone, K. L., Redline, S., & Yaffe, K. (2012). Objectively measured sleep quality and nursing home placement in older women. *Journal of the American Geriatrics Society*, 60(7), 1237-1243.

- Stratmann, M., & Schibler, U. (2006). Properties, Entrainment, and Physiological Functions of Mammalian Peripheral Oscillators. *Journal of Biological Rhythms*, 21(6), 494-506.
- Suhner, A. G., Murphy, P. J., & Campbell, S. S. (2002). Failure of timed bright light exposure to alleviate age-related sleep maintenance insomnia. *Journal of the American Geriatrics Society*, 50(4), 617-623.
- Sullivan, S. C., & Richards, K. C. (2004). Predictors of circadian sleep-wake rhythm maintenance in elders with dementia. *Aging & Mental Health*, 8(2), 143-152.
- Szuba, M. P., Yager, A., Guze, B. H., Allen, E. M., & Baxter, L. R. (1992). Disruption of social circadian rhythms in major depression: A preliminary report. *Psychiatry Research*, 42(3), 221-230.
- Taylor, D. J., Lichstein, K. L., Durrence, H. H., Reidel, B. W., & Bush, A. J. (2005). Epidemiology of insomnia, depression, and anxiety. *Sleep*, 28(11), 1457-1464.
- Tsuno, N., Besset, A., & Ritchie, K. (2005). Sleep and Depression. *Journal of Clinical Psychiatry*, 66(10), 1254-1269.
- van den Berg, J. F., Miedema, H. M., Tulen, J. H., Hofman, A., Knuistringh Neven, A., & Tiemeier, H. (2009). Sex differences in subjective and actigraphic sleep measures: A population-based study of elderly persons. *Sleep: Journal of Sleep and Sleep Disorders Research*, 32(10), pp.
- Van Someren, E. J. (1997). Actigraphic monitoring of movement and rest-activity rhythms in aging, Alzheimer's disease, and Parkinson's disease. *IEEE Transactions on Rehabilitation Engineering*, 5(4), 394-398.
- Van Someren, E. J. (2000). Circadian rhythms and sleep in human aging. *Chronobiology International*, 17(3), 233-243.

- Van Someren, E. J. (2003). Thermosensitivity of the circadian timing system. *Sleep & Biological Rhythms*, 1(1), 55-64.
- Van Someren, E. J. (2007). Improving actigraphic sleep estimates in insomnia and dementia: how many nights? *Journal of Sleep Research*, 16(3), 269-275.
- Van Someren, E. J., Hagebeuk, E. E., Lijzenga, C., Scheltens, P., de Rooij, S. E., Jonker, C., et al. (1996). Circadian rest-activity rhythm disturbances in Alzheimer's disease. *Biological Psychiatry*, 40(4), 259-270.
- Van Someren, E. J., Kessler, A., Mirmiran, M., & Swaab, D. F. (1997). Indirect bright light improves circadian rest-activity rhythm disturbances in demented patients. *Biological Psychiatry*, 41(9), 955-963.
- Van Someren, E. J., Lijzenga, C., Mirmiran, M., & Swaab, D. F. (1997). Long-term fitness training improves the circadian rest-activity rhythm in healthy elderly males. *Journal of Biological Rhythms*, 12(2), 146-156.
- Van Someren, E. J., & Riemersma-Van Der Lek, R. F. (2007). Live to the rhythm, slave to the rhythm. *Sleep Medicine Review*, 11(6), 465-484.
- Van Someren, E. J., Riemersma, R. F., & Swaab, D. F. (2002). Functional plasticity of the circadian timing system in old age: light exposure. *Progress in Brain Research*, 138, 205-231.
- Van Someren, E. J., Swaab, D. F., Colenda, C. C., Cohen, W., McCall, W. V., & Rosenquist, P. B. (1999). Bright light therapy: improved sensitivity to its effects on rest-activity rhythms in Alzheimer patients by application of nonparametric methods. *Chronobiology International*, 16(4), 505-518.

- Voyer, P., Verreault, R., Mengue, P. N., & Morin, C. M. (2006). Prevalence of insomnia and its associated factors in elderly long-term care residents. *Arch Gerontol Geriatr*, 42(1), 1-20.
- Walker, M. P. (2010). Sleep, memory and emotion. *Progress in Brain Research*, 185, 49-68.
- Welsh, D. K., & Ptacek, L. J. (2010). Circadian rhythm dysregulation in the elderly: advanced sleep phase syndrome. In J. M. Pandi-Perumal, J. M. Monti & A. A. Monjan (Eds.), *Principles and Practice of Geriatric Sleep Medicine* (Vol. New York, pp. 131-142): Cambridge University Press.
- Wever, R. A. (1988). Order and disorder in human circadian rhythmicity: Possible relations to mental disorders *Biological rhythms and mental disorders* (pp. 253-346). New York, NY: Guilford Press; US.
- Whitehead, D. L., Davies, A. D. M., Playfer, J. R., & Turnbull, C. J. (2008). Circadian rest-activity rhythm is altered in Parkinson's disease patients with hallucinations. *Movement Disorders*, 23(8), 1137-1145.
- Williams, R. T., Heinemann, A. W., Bode, R. K., Wilson, C. S., Fann, J. R., & Tate, D. G. (2009). Improving measurement properties of the Patient Health Questionnaire-9 with rating scale analysis. *Rehabilitation Psychology*, 54(2), 198-203.
- Wirz-Justice, A., & Van den Hoofdakker, R. H. (1999). Sleep deprivation in depression: What do we know, where do we go? *Biological Psychiatry*, 46(4), 445-453.
- Witting, W., Kwa, I., Eikelenboom, P., Mirmiran, M., & et al. (1990). Alterations in the circadian rest-activity rhythm in aging and Alzheimer's disease. *Biological Psychiatry*, 27(6), 563-572.

- Yoo, S. S., Gujar, N., Hu, P., Jolesz, F. A., & Walker, M. P. (2007). The human emotional brain without sleep--a prefrontal amygdala disconnect. *Current Biology, 17*(20), R877-878.
- Young, K. W., & Greenwood, C. E. (2001). Shift in diurnal feeding patterns in nursing home residents with Alzheimer's disease. *Journal of Gerontology: Series A Biological Sciences, 56*(11), M700-706.
- Zisberg, A., Gur-Yaish, N., & Shochat, T. (2010). Contribution of routine to sleep quality in community elderly. *Sleep: Journal of Sleep and Sleep Disorders Research, 33*(4), 509-514.
- Zohar, D., Tzischinsky, O., Epstein, R., & Lavie, P. (2005). The Effects of Sleep Loss on Medical Residents' Emotional Reactions to Work Events: a Cognitive-Energy Model. *Sleep: Journal of Sleep and Sleep Disorders Research, 28*(1), 47-54.

APPENDIX

The Insomnia Severity Index (Interviewer – T1)

The following questions relate to any problems you may have had with sleep before you came to the nursing home.

1. Please rate the severity of any insomnia problems that may have occurred over the past month before you came to the nursing home.

	None	Mild	Moderate	Severe	Very
a. Difficulty falling asleep:	0	1	2	3	4
b. Difficulty staying asleep:	0	1	2	3	4
c. Problem waking up too early:	0	1	2	3	4

2. How satisfied/dissatisfied were you with your sleep pattern?

<u>Very Satisfied</u>	<u>Satisfied</u>	<u>Neutral</u>	<u>Dissatisfied</u>	<u>Very Dissatisfied</u>
0	1	2	3	4

3. To what extent do you consider your sleep problem interfered with your daily functioning (e.g. daytime fatigue, ability to function at work/daily chores, concentration, memory, mood, etc.).

<u>Not at all interfering</u>	<u>A little</u>	<u>Somewhat</u>	<u>Much</u>	<u>Very much interfering</u>
0	1	2	3	4

4. How noticeable to others do you think your sleep problem was in terms of impairing the quality of your life?

<u>Not at all noticeable</u>	<u>A little</u>	<u>Somewhat</u>	<u>Much</u>	<u>Very much noticeable</u>
0	1	2	3	4

5. How worried/distressed were you about your sleep problem?

<u>Not at all worried</u>	<u>A little</u>	<u>Somewhat</u>	<u>Much</u>	<u>Very Much worried</u>
0	1	2	3	4

PHQ-9 Mood Questionnaire (Interviewer – T1)

1. Over the last 2 weeks before you came to the nursing home, how often were bothered by any of the following problems? Please consider to each item carefully and refer to the four response choices.

Not at all (0-1 days)	Several days (2-6 days)	More than half of days (7-11 days)	Nearly every day (12-14 days)
--------------------------	----------------------------	---------------------------------------	----------------------------------

a. Little interest or pleasure in doing things

<u>Not at all</u>	<u>Several days</u>	<u>More than half of days</u>	<u>Nearly every day</u>
0	1	2	3

b. Feeling down, depressed, or hopeless

<u>Not at all</u>	<u>Several days</u>	<u>More than half of days</u>	<u>Nearly every day</u>
0	1	2	3

c. Trouble falling asleep, staying asleep, or sleeping too much

<u>Not at all</u>	<u>Several days</u>	<u>More than half of days</u>	<u>Nearly every day</u>
0	1	2	3

d. Feeling tired or having little energy

<u>Not at all</u>	<u>Several days</u>	<u>More than half of days</u>	<u>Nearly every day</u>
0	1	2	3

e. Poor appetite or overeating

<u>Not at all</u>	<u>Several days</u>	<u>More than half of days</u>	<u>Nearly every day</u>
0	1	2	3

f. Feeling bad about yourself, or that you are a failure, or have let yourself or your family down

<u>Not at all</u>	<u>Several days</u>	<u>More than half of days</u>	<u>Nearly every day</u>
0	1	2	3

g. Trouble concentrating on things such as reading the newspaper or watching television

<u>Not at all</u>	<u>Several days</u>	<u>More than half of days</u>	<u>Nearly every day</u>
0	1	2	3

h. Moving or speaking so slowly that other people could have noticed. Or the opposite, being so fidgety or restless that you have been moving around a lot more than usual

<u>Not at all</u>	<u>Several days</u>	<u>More than half of days</u>	<u>Nearly every day</u>
0	1	2	3

i. Thoughts that you would be better off dead or of hurting yourself in some way

<u>Not at all</u>	<u>Several days</u>	<u>More than half of days</u>	<u>Nearly every day</u>
0	1	2	3

2. If you checked off any problem on this questionnaire so far, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people?

<u>Not difficult at all</u>	<u>Somewhat difficult</u>	<u>Very Difficult</u>	<u>Extremely Difficult</u>
0	1	2	3

Pittsburgh Sleep Quality Index (Interviewer – T1)

The following questions relate to your usual sleep habits during the last month before you came to the nursing home. Your answers should indicate the most accurate reply for the majority of days and nights in the past month preceding your stay in the nursing home. If you were in the hospital for a period of time before you came to the nursing home, please consider your routine for the last month *before* you were hospitalized.

Interviewer: Please make sure that the time period coincides with the resident’s typical routine before they were hospitalized or came to the nursing home. In other words, refer to the last month that the resident was at home or in a residential facility (not hospitalized or in this nursing home).

Were you hospitalized for an extended period of time before admission to the facility?

Yes No

How long (days or weeks) since you were last home? _____

Did your typical sleep timing change while you were in the hospital? Yes No
If yes, how did it change? _____

1. For the last month at home, what time have you usually gone to bed at night?
Bed time _____

2. For the last month at home, how long (in minutes) did it usually take you to fall asleep each night?
Number of minutes _____

3. For the last month at home, what time have you usually gotten up in the morning?
Getting up time _____

4. For the last month at home, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spent in bed.)
Hours per night of sleep _____

5. For the last month at home, how often did you have trouble sleeping because you:

a. Could not get to sleep within 30 minutes

Not during <u>the past month</u>	Less than <u>once a week</u>	Once or twice <u>a week</u>	Three or more <u>times a week</u>
0	1	2	3

b. Woke up in the middle of the night or early morning

Not during <u>the past month</u>	Less than <u>once a week</u>	Once or twice <u>a week</u>	Three or more <u>times a week</u>
0	1	2	3

- c. Had to get up to use the bathroom**
- | | | | |
|-------------------------------------|---------------------------------|--------------------------------|--------------------------------------|
| Not during
<u>the past month</u> | Less than
<u>once a week</u> | Once or twice
<u>a week</u> | Three or more
<u>times a week</u> |
| 0 | 1 | 2 | 3 |
- d. Could not breathe comfortably**
- | | | | |
|-------------------------------------|---------------------------------|--------------------------------|--------------------------------------|
| Not during
<u>the past month</u> | Less than
<u>once a week</u> | Once or twice
<u>a week</u> | Three or more
<u>times a week</u> |
| 0 | 1 | 2 | 3 |
- e. Coughed or snored loudly**
- | | | | |
|-------------------------------------|---------------------------------|--------------------------------|--------------------------------------|
| Not during
<u>the past month</u> | Less than
<u>once a week</u> | Once or twice
<u>a week</u> | Three or more
<u>times a week</u> |
| 0 | 1 | 2 | 3 |
- f. Felt too cold**
- | | | | |
|-------------------------------------|---------------------------------|--------------------------------|--------------------------------------|
| Not during
<u>the past month</u> | Less than
<u>once a week</u> | Once or twice
<u>a week</u> | Three or more
<u>times a week</u> |
| 0 | 1 | 2 | 3 |
- g. Felt too hot**
- | | | | |
|-------------------------------------|---------------------------------|--------------------------------|--------------------------------------|
| Not during
<u>the past month</u> | Less than
<u>once a week</u> | Once or twice
<u>a week</u> | Three or more
<u>times a week</u> |
| 0 | 1 | 2 | 3 |
- h. Had bad dreams**
- | | | | |
|-------------------------------------|---------------------------------|--------------------------------|--------------------------------------|
| Not during
<u>the past month</u> | Less than
<u>once a week</u> | Once or twice
<u>a week</u> | Three or more
<u>times a week</u> |
| 0 | 1 | 2 | 3 |
- i. Had pain**
- | | | | |
|-------------------------------------|---------------------------------|--------------------------------|--------------------------------------|
| Not during
<u>the past month</u> | Less than
<u>once a week</u> | Once or twice
<u>a week</u> | Three or more
<u>times a week</u> |
| 0 | 1 | 2 | 3 |
- j. Other reason(s), please describe** _____
- k. How often did you have trouble sleeping because of this?**
- | | | | |
|-------------------------------------|---------------------------------|--------------------------------|--------------------------------------|
| Not during
<u>the past month</u> | Less than
<u>once a week</u> | Once or twice
<u>a week</u> | Three or more
<u>times a week</u> |
| 0 | 1 | 2 | 3 |
- 6. For the last month at home, how would you have rated your sleep quality overall?**
- | | | | |
|------------------|--------------------|-------------------|-----------------|
| <u>Very good</u> | <u>Fairly good</u> | <u>Fairly bad</u> | <u>Very bad</u> |
| 0 | 1 | 2 | 3 |

7. For the last month at home, how often did you take medicine to help you sleep (prescribed or "over the counter")?

Not during <u>the last month</u>	Less than <u>once a week</u>	Once or twice <u>a week</u>	Three or more <u>times a week</u>
0	1	2	3

8. For the last month at home, how often did you have trouble staying awake while driving, eating meals, or engaging in social activity?

Not during <u>the last month</u>	Less than <u>once a week</u>	Once or twice <u>a week</u>	Three or more <u>times a week</u>
0	1	2	3

9. For the last month at home, how much of a problem was it for you to keep up enough enthusiasm to get things done?

No problem <u>at all</u>	Only a very <u>slight problem</u>	Somewhat <u>of a problem</u>	A very big <u>problem</u>
0	1	2	3

10. Did you have a bed partner or roommate?

- No bed partner or room mate
- Partner/roommate in other room
- Partner in same room, but not same bed
- Partner in same bed

11. For the last month at home, did your partner or roommate engage in activities at night that kept you awake or awakened you after you fell asleep?

- Yes
- No

Describe _____

Modified Social Rhythm Metric (Interviewer – T1)

I am going to read you a list of activities that some people do as part of a regular daily routine. Let’s review each item carefully and decide whether that activity usually happened at a regular time during the past month just before you came to the nursing home. In order for an activity to be part of a regular routine, it must have happened at approximately the same time each day, or within 45 minutes of an average (usual) time.

Check “Yes” if the activity happened at approximately the same time each day (± 45 minutes) for 3 or more days per week. If “Yes”, circle the number of days per week that it happened, and check the appropriate box to indicate if the activity took place alone or with someone else. If the activity did not occur at least 3 times per week for the past month at approximately the same time (± 45 minutes), check “No” and continue to the next item.

	Did this activity regularly?		Number of times per week (circle)	Time of day	Alone	Spouse	Friend	Parent	Other relative
	<input type="checkbox"/> No	<input type="checkbox"/> Yes							
1. Get out of bed	<input type="checkbox"/> No	<input type="checkbox"/> Yes	Yes circle # at right. If no, next item 3 4 5 6 7	<input type="checkbox"/> am <input type="checkbox"/> pm					
2. First contact (in person or by phone) with another person	<input type="checkbox"/> No	<input type="checkbox"/> Yes	Yes circle # at right. If no, next item 3 4 5 6 7	<input type="checkbox"/> am <input type="checkbox"/> pm					
3. Have morning beverage	<input type="checkbox"/> No	<input type="checkbox"/> Yes	Yes circle # at right. If no, next item 3 4 5 6 7	<input type="checkbox"/> am <input type="checkbox"/> pm					
4. Have breakfast	<input type="checkbox"/> No	<input type="checkbox"/> Yes	Yes circle # at right. If no, next item 3 4 5 6 7	<input type="checkbox"/> am <input type="checkbox"/> pm					
5. Go outside (of room or building) for the first time	<input type="checkbox"/> No	<input type="checkbox"/> Yes	Yes circle # at right. If no, next item 3 4 5 6 7	<input type="checkbox"/> am <input type="checkbox"/> pm					
6. Start activities	<input type="checkbox"/> No	<input type="checkbox"/> Yes	Yes circle # at right. If no, next item 3 4 5 6 7	<input type="checkbox"/> am <input type="checkbox"/> pm					

7. Have lunch	<input type="checkbox"/> No	<input type="checkbox"/> Yes	Yes circle # at right. If no, next item	3 4 5 6 7	<input type="checkbox"/> am <input type="checkbox"/> pm						
8. Take an afternoon nap	<input type="checkbox"/> No	<input type="checkbox"/> Yes	Yes circle # at right. If no, next item	3 4 5 6 7	<input type="checkbox"/> am <input type="checkbox"/> pm						
9. Have dinner	<input type="checkbox"/> No	<input type="checkbox"/> Yes	Yes circle # at right. If no, next item	3 4 5 6 7	<input type="checkbox"/> am <input type="checkbox"/> pm						
10. Engage in physical exercise	<input type="checkbox"/> No	<input type="checkbox"/> Yes	Yes circle # at right. If no, next item	3 4 5 6 7	<input type="checkbox"/> am <input type="checkbox"/> pm						
11. Have an evening snack/drink	<input type="checkbox"/> No	<input type="checkbox"/> Yes	Yes circle # at right. If no, next item	3 4 5 6 7	<input type="checkbox"/> am <input type="checkbox"/> pm						
12. Watch an evening TV program	<input type="checkbox"/> No	<input type="checkbox"/> Yes	Yes circle # at right. If no, next item	3 4 5 6 7	<input type="checkbox"/> am <input type="checkbox"/> pm						
13. Watch another TV program	<input type="checkbox"/> No	<input type="checkbox"/> Yes	Yes circle # at right. If no, next item	3 4 5 6 7	<input type="checkbox"/> am <input type="checkbox"/> pm						
14. Activity A	<input type="checkbox"/> No	<input type="checkbox"/> Yes	Yes circle # at right. If no, next item	3 4 5 6 7	<input type="checkbox"/> am <input type="checkbox"/> pm						
15. Activity B	<input type="checkbox"/> No	<input type="checkbox"/> Yes	Yes circle # at right. If no, next item	3 4 5 6 7	<input type="checkbox"/> am <input type="checkbox"/> pm						
16. Return home or retire to bedroom (for the last time)	<input type="checkbox"/> No	<input type="checkbox"/> Yes	Yes circle # at right. If no, next item	3 4 5 6 7	<input type="checkbox"/> am <input type="checkbox"/> pm						
17. Go to bed	<input type="checkbox"/> No	<input type="checkbox"/> Yes	Yes circle # at right. If no, next item	3 4 5 6 7	<input type="checkbox"/> am <input type="checkbox"/> pm						

Morningness-Eveningness Questionnaire (Interviewer – T1)

- Please listen to each question very carefully before answering.
- Each question should be answered independently of others.
- Do not go back and change your answers.
- Please answer each question as honestly as possible.

1. Considering your own “feeling best” rhythm, at what time would you get up if you were entirely free to plan your day?

Time _____

2. Considering only your own “feeling best” rhythm, at what time would you go to bed if you were entirely free to plan your evening?

Time _____

3. If there is a specific time you have to get up in the morning, to what extent are you dependent on being woken up by an alarm clock?

<u>Not at all dependent</u>	<u>Slightly dependent</u>	<u>Fairly dependent</u>	<u>Very dependent</u>
4	3	2	1

4. Assuming adequate environmental conditions, how easy do you find getting up in the mornings?

<u>Not at all easy</u>	<u>Not very easy</u>	<u>Fairly easy</u>	<u>Very easy</u>
1	2	3	4

5. How alert do you feel during the first half hour after having woken in the mornings?

<u>Not at all alert</u>	<u>Slightly alert</u>	<u>Fairly alert</u>	<u>Very alert</u>
1	2	3	4

6. How is your appetite during the first half hour after having woken in the mornings?

<u>Very poor</u>	<u>Fairly poor</u>	<u>Fairly good</u>	<u>Very good</u>
1	2	3	4

7. During the first half hour after having woken in the morning, how tired do you feel?

<u>Very tired</u>	<u>Fairly tired</u>	<u>Fairly refreshed</u>	<u>Very refreshed</u>
1	2	3	4

8. When you have no commitments the next day, at what time do you go to bed compared to your usual bedtime?

<u>Seldom or never later</u>	<u>Less than 1 hour later</u>	<u>1-2 hours later</u>	<u>More than 2 hrs later</u>
4	3	2	1

9. You have decided to engage in some physical exercise. A friend suggests that you do this one hour twice a week and the best time for him is between 7 and 8 a.m. Bearing in mind nothing else but your own “feeling best” rhythm how do you think you would perform?

Would be <u>in good form</u>	Would be <u>in reasonable form</u>	Would find it <u>difficult</u>	Would find it <u>very difficult</u>
4	3	2	1

10. At what time in the evening do you feel tired and as a result in need of sleep?

Time _____

11. You wish to be at your peak performance for a test which you know is going to be mentally exhausting and lasting for two hours. You are entirely free to plan your day and considering only your own “feeling best” rhythm which one of the four testing times would you choose?

8 to 10 a.m.	11 a.m. to 1 p.m.	3 to 5 p.m.	7 to 9 p.m.
6	4	2	0

12. If you went to bed at 11 p.m. at what level of tiredness would you be?

<u>Not at all tired</u>	<u>A little tired</u>	<u>Fairly tired</u>	<u>Very tired</u>
0	2	3	5

13. For some reason you have gone to bed several hours later than usual, but there is no need to get up at any particular time the next morning. Which one of the following events are you most likely to experience?

- (4) Will wake up at usual time and will NOT fall asleep
- (3) Will wake up at usual time and will doze thereafter
- (2) Will wake up at usual time but will fall asleep again
- (1) Will NOT wake up until later than usual

14. One night you have to remain awake between 4 and 6 a.m. in order to carry out a night watch. You have no commitments the next day. Which one of the following alternatives will suit you best?

- (1) Would NOT go to bed until watch was over
- (2) Would take a nap before and sleep after
- (3) Would take a good sleep before and nap after
- (4) Would take ALL sleep before watch

15. You have to do two hours of hard physical work. You are entirely free to plan your day and considering only your own “feeling best” rhythm which one of the following times would you choose?

8 to 10 a.m.	11 a.m. to 1 p.m.	3 to 5 p.m.	7 to 9 p.m.
4	3	2	1

16. You have decided to engage in hard physical exercise. A friend suggests that you do this for one hour twice a week and the best time for him is between 10 to 11 p.m. Bearing in mind nothing else but your own “feeling best” rhythm how well do you think you would perform?

Would be
in good shape
1

Would be
in reasonable shape
2

Would find it
difficult
3

Would find it
very difficult
4

17. Suppose that you can choose your own work hours. Assume that you worked a FIVE hour day (including breaks) and that your job was interesting and paid by results. Which five consecutive hours would you select?

Hours _____

18. At what time of the day do you think that you reach your “feeling best” peak?

Time _____

19. One hears about “morning” and “evening” types of people. Which one of these types do you consider yourself to be?

- (6) Definitely a morning type
- (4) More a morning than evening type
- (2) More an evening than morning type
- (0) Definitely an evening type

CURRICULUM VITAE

Irene Marie Kostiwa

EDUCATION

Vanderbilt University-Department of Veterans Affairs APA Accredited Internship in Professional Psychology	2012- 2013
University of Louisville APA Accredited Clinical Psychology Ph.D. Program M.A. Clinical Psychology (2007), GPA: 4.0 Faculty Mentor: Suzanne Meeks, Ph.D.	2013
Northern Illinois University B.A. Psychology, Summa Cum Laude with Honors in Psychology Honor's Thesis: <i>The role of self-compassion in traumatic stress</i>	2005
Southern Illinois University B.S. Journalism major, Visual Communications minor	2002

CLINICAL EXPERIENCE

Women Veterans Health Care Clinic <i>Veterans Administration, Nashville, Tennessee</i> Provide psychological services in co-located mental health/primary care setting to female veterans. Conduct diagnostic intake interviews and provide individual psychotherapy for veterans with anxiety, panic disorder, depression, insomnia, military sexual trauma, and other physical or sexual abuse history. Primary therapeutic modalities include ACT and CPT. <i>Supervisor: Michele Panucci, Ph.D.</i>	January - June 2013
Primary Care Mental Health Integration <i>Veterans Administration, Nashville, Tennessee</i> Provide psychological services within a primary care setting. Conduct diagnostic intake interviews, brief cognitive and mental health screenings, and conduct short-term individual therapy for variety of mental health and health-related concerns including pain, substance abuse, depression, anxiety, insomnia, and obesity. <i>Supervisor: Rhonda Venable, Ph.D.</i>	January - June 2013

Pain Management Rotation

Veterans Administration, Murfreesboro, Tennessee

Provide consultation services to Pain Clinic, conduct diagnostic interviews, stress assessments, individual and group therapy for self-management of chronic pain. Guide patients in biofeedback training utilizing sensors measuring blood volume pulse, skin conductance, muscle tension, respiration, and temperature. *Supervisor: Lori Vehring, Psy.D.*

October 2012 -
January 2013

Compensation and Pension Examinations

Veterans Administration, Murfreesboro, Tennessee

Assist in neuropsychological evaluations to determine eligibility for benefits. Report writing for C&P exams for veterans presenting with problems related to TBI, PTSD, and psychiatric conditions. *Supervisor: Randall Petersen, Ph.D.*

October -
December 2012

Geropsychology Inpatient Therapy and Assessment Rotation

Community Living Center, Veterans Administration, Murfreesboro, Tennessee

Conduct diagnostic interviews, brief cognitive assessments, capacity assessments, and individual and group therapy with veterans and caregivers in a skilled nursing care facility. Actively participated in Interdisciplinary Treatment Team meetings and coordinated patient care with team. Formal presentation given to Geriatrics and Extended Care Staff on sleep and aging issues pertinent to the nursing home setting. *Supervisor: Erin Patel, Psy.D.*

July - October
2012

Nursing home therapy and research practicum

BE-ACTIV Treatment Study, Aging and Mental Health Lab, University of Louisville

Investigation of a 10-week intervention for depression in nursing home residents that involves behavioral activation. Responsible for weekly individual therapy sessions, coordination of care and consultation with staff regarding treatment progress, chart reviews, and regular assessments of mood, pleasant events, working alliance, memory, and behavior problems. Weekly supervision included review of audio recorded sessions. *Supervisor: Suzanne Meeks, Ph.D.*

2007-2010

Outpatient clinic therapy practicum

Noble H. Kelley Psychological Services Center, University of Louisville

Provided time-limited dynamic therapy and interpersonal therapy to individuals and couples presenting with relationship problems and personality disorders. Responsible for intakes, case conceptualizations, monitoring of patient progress through use of self-report measures of symptoms, working alliance, and interpersonal relationships. Video recordings of sessions were used for weekly group supervision. *Supervisor: Stanley A. Murrell, Ph.D.*

2007-2009

Outpatient clinic assessment practicum

Noble H. Kelley Psychological Services Center, University of Louisville

Assessments of adults and children for Attention-Deficit Hyperactivity Disorder, learning disability, and intellectual functioning. Assessments included a full diagnostic battery for ADHD, semi-structured and structured interviews, tests of intelligence, achievement, personality and other

2006-2009

diagnostic measures. Conducted assessments for school-age children for advanced placement in public school system. Responsible for administering, scoring, and interpreting tests, report writing, and feedback to clients. *Supervisors:* Bernadette Walter, Ph.D., Stanley Murrell, Ph.D., Paul Bock, Ph.D.

Disability assessment practicum

2007-2008

Private Practice of Steven J. Simon, Louisville, Kentucky

Neuropsychological evaluations using a flexible test battery to determine eligibility for disability benefits for clients referred by the Kentucky Division of Disability Determinations. Responsible for administration, scoring, interpretation of tests, and written reports. *Supervisor:* Steven J. Simon, Ph.D.

Prison nursing home therapy and research practicum

Summer 2007

Kentucky State Reformatory, LaGrange, Kentucky

Responsible for recruitment of inmates for BE-ACTIV study, psychological evaluation using the Structured Clinical Interview for the DSM-IV, administration of 10-week individual therapy depression intervention and coordination of ongoing treatment with staff. *Supervisors:* Suzanne Meeks, Ph.D., Robin Sublett, Ph.D.

Home-based primary care (HBPC) clinical health psychology practicum

2005-2007

Louisville Veterans Administration, Geriatrics Division, HBPC Team

Responsible for evaluation and treatment of home-bound veterans with multiple chronic health conditions and psychological disorders. Participated in interdisciplinary team meetings and didactic training on aging and chronic health conditions. Treatment modalities included cognitive behavioral therapy, acceptance and commitment therapy, mindfulness, and supportive therapy. *Supervisor:* Barbara Stetson, Ph.D.

Nursing home assessment and therapy practicum

2006-2007

Wedgewood Healthcare Center, a rehabilitation and long-term care facility

Neuropsychological assessments and individual therapy with nursing home residents. Responsible for written reports and administration, scoring, and interpretation of assessments including dementia, mental status, language, visuospatial, memory, attention, motor skills, and other cognitive functions. Provided feedback to assessment clients and individual therapy to residents for depression, grief, and adjustment to functional limitations and the nursing home environment using behavioral and cognitive behavioral intervention strategies. *Supervisors:* Suzanne Meeks, Ph.D., Benjamin Mast, Ph.D.

Inpatient therapy and assessment practicum

2006-2007

Central State Hospital, a 192-bed adult psychiatric hospital

Responsible for individual and group therapy with patients on acute care units, assessment of risk and symptomatology, and participation in treatment team meetings. Treatments included cognitive behavioral therapy, dialectical behavior therapy, mindfulness, and supportive therapy. *Supervisors:* Kathryn Hoover, Ph.D., Karen Lenhoff, Ph.D.

RESEARCH EXPERIENCE

- Research Assistant, Vanderbilt University Medical Center* 2012-2013
ICU Delirium & Cognitive Impairment Study Group
Responsible for administration and scoring of a variety of neuropsychological assessment batteries with patients who experienced delirium or pneumonia during their stay at the Vanderbilt Intensive Care Unit. Conduct assessments via phone and in-person with patients and caregivers. Projects involve large-scale multi-site investigations of treatments (early cognitive training, Omega3, antipsychotics) and long-term outcomes related to delirium. Responsible for research and writing for peer-reviewed journals. *Supervisor:* James Jackson, Ph.D.
- Project Coordinator, Dissertation Study, University of Louisville* 2011-2013
Circadian Rhythm, Sleep, and Mood Disturbances in Nursing Home Residents
Investigating relationship between social rhythms, sleep timing, sleep quality, mood, and circadian rhythm upon admission to the nursing home. Study involves original data collection from residents within 30 days of admission. Received a Research Initiation Grant from the University of Louisville to fund a research assistant on the project. Conducted literature review, generated hypotheses, designed study, conducted power analyses, recruited nursing homes, trained research assistants, recruited participants, and supervised data collection. *Supervisor:* Suzanne Meeks, Ph.D.
- Graduate Research Assistant (funded)* 2011-2012
Mental Health and Aging Lab, University of Louisville
Responsible for support on various research projects within the lab, including data collection, literature research and writing for articles in progress. *Supervisor:* Suzanne Meeks, Ph.D.
- Graduate Research Assistant (funded)* 2007-2010
BE-ACTIV nursing home depression treatment, University of Louisville
NIMH-funded randomized control trial investigating BE-ACTIV therapy. Responsible for data collection including medical chart reviews, interviews of patients and staff using self-report measures, individual therapy, and coordination of patient care with staff and family. *Primary Investigator:* Suzanne Meeks, Ph.D.
- Research Assistant* 2008-2009
Cognitive Behavioral Therapy for Insomnia, Sleep Medicine Specialists
Responsible for data analysis, database organization, retrieval of data from patient charts, and data entry on projects investigating outpatient treatment using Cognitive Behavioral Therapy for Insomnia. *Supervisor:* Ryan Wetzler, Psy.D.. *Location:* Louisville, Kentucky
- Graduate Research Assistant* 2005-2007
Organizational Culture in Nursing Homes, University of Louisville
Investigation of organizational culture, job satisfaction, and quality of life in nursing homes. Responsible for recruitment of nursing homes and residents, and collection and analysis of data from residents and staff. *Primary Investigator:* Suzanne Meeks, Ph.D.

- Undergraduate Research Assistant* 2004-2005
The role of self-compassion in traumatic stress, Northern Illinois University
 For an honor's thesis, used existing data from a sample of college students to investigate self-compassion as a moderator between abuse history and mental health outcomes. *Advisor:* Holly Orcutt, Ph.D.
- Undergraduate Research Assistant* 2003-2005
Study of the Consequences of Trauma Exposure, Northern Illinois University
 Investigation of PTSD, abuse and trauma history in college students. Responsible for participant screening and data collection, coding and entry of data. *Primary Investigator:* Holly Orcutt, Ph.D.
- Primary Investigator* 2004-2005
The Aging Game Workshop, Northern Illinois University
 The Aging Game is a workshop designed to educate students on effective ways of caring for and interacting with disabled older persons. Designed and implemented a study to measure changes in students' attitudes and anxiety toward aging resulting from participation in the activity. *Advisor:* Carolinda Douglass, Ph.D., School of Public Health
- Undergraduate Research Assistant* 2004-2005
Age expectations in mentoring relationships, Northern Illinois University
 Assisted in the initial study conceptualization, construction of a measurement tool, IRB submission, and data collection. *Primary Investigator:* Lisa Finkelstein, Ph.D.
- Undergraduate Research Assistant (funded), Department of Medicine, Section of Geriatrics* 2004
Decision-making in prostate cancer, University of Chicago
 Investigation of decision-making in prostate cancer; anxiety related to screening, diagnosis, and treatment. Responsible for consent and screening of prostate cancer patients in urology clinic, development of follow-up questionnaire and phone script, follow-up calls to patients after diagnosis, literature research and review, development of survey, IRB submission, assisted in preparing protocol document. *Advisor:* William Dale, M.D., Ph.D.
- Undergraduate Research Assistant* 2003
Effects of abuse on psychological functioning, Northern Illinois University
 Responsibilities included participant screening and data collection, coding and entry of data, and transcription of interviews. *Primary Investigator:* Tom McCanne, Ph.D.

PUBLICATIONS

- Meeks, S., Van Haitsma, K., **Kostiwa, I.**, Murrell, S. (2012) Positivity and Well-being Among Community-Residing Elders and Nursing Home Residents: What Is the Optimal Affect Balance? *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, 1-8
- Kostiwa, I.**, & Meeks, S. (2009). The Relation between Psychological Empowerment, Service Quality, and Job Satisfaction among Certified Nursing Assistants. *Clinical Gerontologist: The Journal of Aging and Mental Health*, 32, 276-292.
- Meeks, S., Sublett, R., **Kostiwa, I.**, Rodgers, J., & Haddix, D. (2008). Treating depression in the prison nursing home: Demonstrating Research-to-Practice Translation. *Clinical Case Studies*, 7 (6), 555-574.
- Douglass, C., Henry, B.W., & **Kostiwa, I.** (2008). An aging game simulation activity for allied health students. *Educational Gerontology: An International Journal*, 34 (2), 124-135.
- Henry, B.W., Douglass, C., & **Kostiwa, I.** (October 2007) Effects of participation in an Aging Game simulation activity on the attitudes of allied health students toward older adults, *Internet Journal of Allied Health Sciences and Practice*.

PRESENTATIONS

- Meeks, S., **Kostiwa, I.**, & Antimisiaris, D. (November 2012) Depression, Pain, and Polypharmacy in Nursing Homes. *Poster presented at the Gerontological Society of America Annual Meeting*.
- Kostiwa, I.** (September 2012) Circadian Rhythms, Sleep, and Aging. *Presented to the Geriatrics and Extended Care Staff on sleep issues pertinent to the nursing home setting*.
- Kostiwa, I.**, Wetzler, R., Schwarz, R., Fulkerson, E., Winslow, D. (2009) Sleep Improves in Patients Discontinuing Medication Use With CBT-I. *Journal of Sleep and Sleep Disorders Research. Poster presented at the Annual Meeting of the Associated Professional Sleep Societies*.
- Wetzler, R., Linfield, K., Fulkerson, E., Schwarz, R., **Kostiwa, I.**, Price, D., Winslow, D. (2009). Effectiveness of a Cognitive Behavioral Treatment Program for Insomnia. *Journal of Sleep and Sleep Disorders Research. Poster presented at the Annual Meeting of the Associated Professional Sleep Societies*.
- Wetzler, R., Fulkerson, E., Linfield, K., **Kostiwa, I.**, Schwarz, R., Price, D., Winslow, D. (2009). Could Depression be Over-Diagnosed in a Sleep Disordered Population? Differential Diagnosis and Treatment Considerations *Journal of Sleep and Sleep Disorders Research. Poster presented at the Annual Meeting of the Associated Professional Sleep Societies*.
- Fulkerson, E., Wetzler, R., Linfield, K., **Kostiwa, I.**, Schwarz, R., Price, D., Winslow, D. (2009). Personality Characteristics of Patients Seeking Treatment at a Behavioral Sleep Medicine Clinic *Journal of Sleep and Sleep Disorders Research (abstract supplemental). Poster presented at the Annual Meeting of the Associated Professional Sleep Societies*.
- Schuster, S. and **Kostiwa, I.** "The Cost of Inaction: A Profession in Peril" (2009). Presentation concerning the importance of advocacy in the field of psychology

presented at the Kentucky Psychological Association Student Academic Conference.

- Meeks, S., Van Haitsma, K., **Kostiwa, I.**, & Murrell, S.A. (2008). Positivity Ratios and Flourishing among Community-Residing Elders and Nursing Home Residents: What is the Optimal Affect Balance in Late Life? *Poster presented at the Annual Gerontological Society of America Meeting in Washington DC.*
- Kostiwa, I.** Chair of symposium: "The context of caregiving: Patient and environmental variables related to caregiver burden" (2007). *Symposium and paper presented at the Annual Gerontological Society of America Meeting in San Francisco, CA.*
- Kostiwa, I.**, Meeks, S. (2007). The Nursing Home as Work Environment: The Relation between Psychological Empowerment, Perceived Service Quality and Job Satisfaction. *Symposium and paper presented at the Annual Gerontological Society of America Meeting in San Francisco, CA.*
- Kostiwa, I.**, McEntarfer, C. K., Meeks, S., Mast, B. T., Azar, A. R. (2007). A taxometric analysis of depression in nursing home and older primary care samples. *Poster presented at the Annual Gerontological Society of America Meeting and Kentucky Psychological Association Annual Student Mentoring Conference.*
- Stetson, B., O'Malley, K., Rothschild, C., **Kostiwa, I.**, Rodgers, J., Bonner, J. (2006). Environmental and affective associations with physical function in veterans receiving interdisciplinary home based primary care. *Poster presented at the Annual Convention of the Association for the Advancement of Behavioral and Cognitive Therapies in Chicago, IL.*
- Finkelstein, L., Zimmerman, A., **Kostiwa, I.**, Matarazzo, K. (2006). Who Is Your Ideal Mentor? *Poster presented at the Annual Society for Industrial and Organizational Psychology Conference in Dallas, TX.*
- Rodgers, J. R., Chaneb, B. J., **Kostiwa, I.**, Shah, S. N., Meeks, S. (2006). Organizational culture and resident outcomes in nursing homes. *Poster presented at the Annual Southeastern Regional Student Mentoring Conference in Gerontology and Geriatrics in Lexington, KY.*
- Shah, S. N., Chaneb, B. J., **Kostiwa, I.**, Rodgers, J. R., Meeks, S. (April 2006). An evaluation of depression and quality of life for nursing home residents in relation to staff-resident relationships, social interaction, and organizational culture. *Poster presented at the 17th Annual Southeastern Regional Student Mentoring Conference in Gerontology and Geriatrics in Lexington, KY.*
- Orcutt, H. K., & **Kostiwa, I.** (November 2004). Self-compassion as a moderator of the relation between childhood abuse history and current mental health symptoms. *Poster presented at the 38th Annual Meeting of Association for Advancement of Behavioral Therapy, New Orleans, LA*

TEACHING EXPERIENCE

In-service trainer, Rolling Hills Health Care Center

March 2007

Behavioral Management: Needs-based Assessment

Provided training for nursing care staff on assessment of and interventions for problematic behaviors in residents.

Community educator, Stephen Foster Senior Living Center February 2007
Understanding Our Changing Needs for Sleep as We Age
 Presented and led discussions with seniors about sleep in the context of aging.

Teaching Assistant, University of Louisville 2005-2006
Introduction to Psychology
 Delivered weekly lectures for three lab sections; developed presentations materials;
 implemented in-class learning experiments

Project Coordinator and Facilitator 2004-2005
The Aging Game Workshop, Northern Illinois University
 Organized and implemented the Aging Game, a workshop designed to educate students on effective ways of caring for and interacting with disabled older persons. Led discussions concerning students attitudes and anxiety about aging.

PROFESSIONAL SERVICES

American Psychological Association of Graduate Students 2008-2010
APAGS State Advocacy Coordinator, Kentucky
 Responsible for recruitment and oversight of APAGS campus representatives in Kentucky, and for the organization and dissemination of information and actions pertaining to local, state, and national legislation directly affecting the training, post-graduate employment, and practice of psychology. Served as a liaison to the state psychological association and attended quarterly board meetings.

2006-2008
APAGS Campus Representative, University of Louisville
 Responsible for mobilization of campus response to legislative alerts pertaining to the training and practice of psychology, recruitment of APAGS members, and other functions.

2008-2009
 Kentucky Psychological Association
Co-chair of the KPA Student Academic Conference (2009)
Communications committee member (2008-2009)

2008-2009
 University of Louisville, Department of Psychological and Brain Sciences
Graduate Student Peer Mentor
 Served as a mentor to incoming first year graduate student.

2006
 Psychologists in Long-Term Care (PLTC)
Ad-hoc reviewer for PLTC student research award

2003-2005
 Gerontology Student Organization
President (2004-2005), Secretary (2003-2004)
 Organized educational activities and fundraising events; sponsored community service projects in support of older adults in the DeKalb area; participated in programs and discussions related to topics in aging; developed and designed website content

2004-2005
 Psi Chi National Honor Society in Psychology, Northern Illinois University
Secretary

VOLUNTEER EXPERIENCE

<i>Elderly Program Mentor and Volunteer</i> , Kentucky Refugee Ministries Tutor refugees for English language and citizenship test, provide socialization opportunities, help connect refugees to social services	2008-2009
<i>Volunteer</i> , Bethany Healthcare and Rehabilitation Center, Dekalb, Illinois Conduct group and individual activities, engage in friendly visits, assist with resident needs	2004-2005
<i>Volunteer</i> , Rosewood Nursing Care Center, St. Charles, Illinois Conduct group and individual activities, engage in friendly visits, assist with resident needs	2003
<i>Elder Care</i> , Elburn, Illinois Provided direct daily care, health care and financial decision-making for immediate family member diagnosed with vascular dementia	1997-2003

AWARDS/HONORS

Research Initiation Grant, Intramural Research Incentive Grants, University of Louisville	January 2012 March 2009
Excellence in Leadership Award, American Psychological Association of Graduate Students	2003-2005
Psi Chi Honor Society	

PROFESSIONAL MEMBERSHIPS

American Association of Sleep Medicine
Gerontological Society of America
Psychologists in Long-Term Care
American Psychological Association (APA)
APA Division 12, Section II: Clinical Geropsychology
APA Division 20: Adult Development and Aging
Kentucky Psychological Association