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Sleep Disturbances in Alzheimer's Disease and Caregiver Mood: A Diary Study

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**SLEEP DISTURBANCES IN ALZHEIMER'S DISEASE AND CAREGIVER
MOOD: A DIARY STUDY**

A Dissertation Presented

by:

ANNA M.K ÅKERSTEDT

Submitted to the Graduate School of the
University of Massachusetts-Amherst in partial fulfillment
of the requirements for the degree of

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DEDICATION

To Ingrid and Torbjörn Åkerstedt, my wonderful parents. You were my biggest source of support and encouragement during this process. I could not have done it without you!

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ABSTRACT

SLEEP DISTURBANCES IN ALZHEIMER'S DISEASE AND
CAREGIVER MOOD: A DIARY STUDY
FEBRUARY 2012

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Sleep disturbances are common in persons with Alzheimer's disease (AD) (Hart et al., 2003) and pose a great strain on their family caregivers (Hope, Keene, Gedling, Fairburn, & Jacoby, 1998) including their emotional functioning (Schulz & Martire, 2004). The current study is the first to examine the impact of daily sleep and mood in persons with AD on their caregiver's sleep and emotional functioning. The study examined sleep and mood across eight days in 40 family caregivers of persons with AD. It was hypothesized that poor sleep in the person with AD would have a negative impact on caregiver emotional functioning the next day. Furthermore, it was hypothesized that sleep disruption or the mood in the person with AD would mediate the association between AD person sleep and caregiver mood. The results demonstrated a direct link between poor sleep in persons with AD and caregiver negative affect (NA), but not positive affect (PA). The results also indicated that poor caregiver sleep and NA in the person with AD partially mediated the relationship between AD person sleep and caregiver NA. The results suggest that addressing AD person and caregiver sleep and AD person affect may improve caregiver emotional functioning. Improving AD person sleep and mood, and

caregiver emotional functioning has important implications that may prolong the time until institutionalization.

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CHAPTER 1

INTRODUCTION

Alzheimer's disease (AD) is a growing problem in the United States with approximately 5.1 million individuals diagnosed with the disease (Plassman, et al., 2007). It is estimated that as many as 16 million individuals will be diagnosed with AD by 2050 (Herbert, Beckett, Sherr, & Evans, 2001). Alzheimer's disease not only affects the person, but also has a great impact on their caregivers (Glozman, 2004; Schultz & Martire, 2004; Clyburn, Stones, Hadjistavropoulos, & Tuokko, 2000). Because it is often one or more family members who assume the role as caregiver (Alzheimer's Association, 2011), it is important to understand factors that adversely impact this vulnerable caregiver population. In fact, family caregiving constitutes a large portion of the care of AD persons, with as many as 70 percent of AD persons being cared for at home (Alzheimer's Association, 2011). The caregiving process is associated with negative consequences, including psychological and emotional distress (Belle et al., 2006; Schulz & Martire, 2004). LoGuidice and colleagues (1998) found that 52 percent of caregivers of persons with dementia experience significant anxiety and depression.

One of the most problematic stressors for family caregivers is sleep disturbance in the person with AD (Hope, Keene, Gedling, Fariburn, & Jacoby, 1998; Lawlor, 1994; Pollack & Perlick, 1991). It is well established that disturbed sleep is a common problem among persons with AD (McCurry et al., 2007; Vitiello & Borson, 2001) and its impact on negative emotions in caregivers have been identified. For example, caregivers of persons with AD who have disturbed sleep report increased distress (McCurry et al., 1999), burden (e.g., Allegri et al., 2006), and depressive symptoms (McCurry & Teri,

1995). In addition, research suggests that negative mood tends to increase in response to daily stressors (e.g., Almeida, 2005).

In contrast, less is known about the impact of AD person sleep disturbance on caregivers' positive emotions. Positive emotions are important to consider with this population because of the stressors associated with caregiving. In particular, research on stress reactivity and affect has found that positive emotions may serve as a buffer against stress (Ong, Bergeman, Bisconti, & Wallace, 2006) and protect against detrimental effects of negative emotions (Zautra, Affleck, Tennen, Reich, & Davis, 2005). Positive emotions also are important for coping and resilience (Folkman, 1997; Folkman & Moskowitz, 2000). Furthermore, experiencing low levels of positive mood in the context of high levels of negative mood is associated with depressive symptoms (Teachman, Siedlecki, & Magee, 2007). It has been demonstrated that ongoing negative affect in a chronic stressful condition without the experience of positive affect could result in clinical depression (Gross & Munoz, 1995). The impact of stress on positive affect is not entirely clear, but there is some indication that positive affect can decrease in response to stress (Chepenik et al., 2006). Thus, it may be particularly relevant to understand the impact of a stressor, such as sleep disturbance in the person with AD, on caregiver affect.

A unique aspect of the current study is that it will examine sleep disturbance in the person with AD and caregiver emotions prospectively, using a diary method. To date, research has shown that AD person sleep disturbance is associated with retrospective measures of caregiver emotional functioning (McCurry, Logsdon, Teri, & Vitiello, 2007; Schulz & Martire, 2004; Hart et al., 2003). Thus, while disturbed sleep in the person with AD is a common stressor that, on average, has negative consequences for the caregivers,

little is known about how their sleep problems impact caregivers on a day-to-day level. The current study will add to the literature by examining the association between sleep in the AD person and caregiver mood prospectively. Examining this association on a daily basis provides an avenue for understanding the potential mechanism underlying the association between sleep disturbance in the person with AD and caregiver emotions. Understanding the underlying mechanism, in turn, could potentially guide interventions aiming at improving emotional functioning in AD caregivers.

One possible underlying mechanism for poor emotional outcomes in caregivers of persons with AD who experience sleep disturbance is through disruption of the caregiver's own sleep. In fact, persons with AD frequently awaken their caregivers at night (e.g., McCurry & Teri, 1995), which results in sleep disruption and subsequent daytime fatigue for the caregiver. These findings are important, because of the findings from a large body of research demonstrating an association between sleep and emotional functioning (e.g., Kahn-Greene, et al., 2007; Willette-Murphy, Toderro, & Yeaworth, 2006; Tsuno, Besset, & Ritchie, 2005). In particular, poor sleep is associated with increased negative mood and decreased positive mood the following day (McCrae et al., 2008). Furthermore, it appears as though sleep deprivation can have a profound impact on a person's mood on a day-to-day basis (Pilcher & Huffcutt, 1996). Thus, it seems likely that these findings would apply to AD caregivers as they typically experience nightly awakenings and other components of poor sleep.

Another potential explanation for poor caregiver emotional functioning on a day-to-day basis may be how they perceive the mood in the AD person. While not investigated specifically in AD person-caregiver dyads, there is past research that has

shown that the mood in one person can influence the mood of another (e.g., Schoebi, 2008; Butner, Diamond, & Hicks, 2007; Jeglic et al., 2005). Thus, it is possible that if the person with AD exhibits NA during the day, the caregiver will also experience increased NA. Conversely, it is possible that caregivers of AD persons that generally experience high PA also will report greater PA during the day. As it has been demonstrated that poor/disturbed sleep impacts PA and NA it is likely that this association can occur in AD persons (McCrae et al., 2008). Thus, the present study will also examine AD person PA and NA as potential mediators between poor sleep in the person with AD and caregiver affect.

The goals of the current study are to examine the relationship between the daily variation in caregivers' perception of sleep in AD persons and caregiver PA and NA the next day. In addition, another aim is to explore whether disruption of the caregiver's sleep or mood in the person with AD mediate this relationship. This research has practical implications. Improving sleep in the AD person could prove to be a beneficial target for treatment that could have a positive impact on caregivers' daily mood and well-being, and ameliorate some of the stress of the caregiving process. The present study will thus pave the way toward the development of interventions that might dually improve sleep in the AD person and caregiver mood.

Sleep Disturbances in AD Persons

It has been suggested that the sleep problems in AD are a magnification of the natural changes in sleep that occur with aging (Vitiello et al., 1990). Thus, in order to understand sleep in AD, it is useful to identify the normal changes in sleep that accompany increasing age. Age-related changes in sleep architecture are well

documented (Campbell & Murphy, 2007; Ohayon, Carskadon, Guilleminault, & Vitiello, 2004). Older age (i.e., 65 years and older) is associated with early morning awakening, decreased rapid eye movement (REM) sleep, longer sleep latency (time to fall asleep), decreased total sleep time, decreased sleep efficiency (ratio of time in bed divided by time spent sleeping), decreased slow-wave sleep (deep sleep), and an increase in time spent awake after sleep onset during the night (Ohayon, Carskadon, Guilleminault, & Vitiello, 2004). In other words, older age is related to a shorter, lighter, and more disturbed sleep.

Sleep disturbance is common in persons with AD (Carpenter, Strauss, & Patterson, 1995). It appears as though approximately forty to fifty percent of those being cared for by their family members experience sleep disturbances as determined by caregiver reports (e.g., Hart et al., 2003; Carpenter, Strauss, & Patterson, 1995). Caregivers of persons with AD report a wide variety of sleep problems in these individuals (McCurry et al., 1999). Some of the most common sleep disturbances include difficulty falling asleep, nighttime awakenings, early morning awakenings, and sleeping in the daytime (Hart et al., 2003; McCurry et al., 1999; Carpenter, Strauss, & Patterson, 1995). Thus, many of the sleep difficulties experienced by AD persons mimic sleep disturbances that occur in normal aging, but are worse in severity compared to non-demented elders as determined by polysomnography (Vitiello et al., 1990). Polysomnography (PSG) refers to the use of electroencephalography (recording of brain waves), electrooculography (recording of eye movements), and electromyography (recording of muscle movements) to describe physiological sleep (Rechtschaffen & Kales, 1968). Moreover, persons with AD may also experience sleep-wake disorders,

such as developing a reversed day-night rhythm or an irregular sleep-wake rhythm (Okawa et al., 1991). For instance, Vitiello and colleagues (1991) found that the sleep-wake rhythm in persons with AD was partially reversed, with patients spending up to 40 percent of their nighttime laying awake and spending much of their daytime asleep (Vitiello, Poceta, & Prinz, 1991).

Persons with AD may also experience more than one type of sleep disturbance at the same time (Carpenter, Strauss, & Patterson, 1995). For example, when interviewing caregivers, Carpenter and colleagues (1995) found that approximately 40 percent of their mild-stage AD persons experienced at least one symptom of sleep disturbance during the past year. Among their sleep-disturbed care recipients, 40 percent experienced difficulties in one area, 25 percent experienced difficulties in two areas, and the remaining individuals experienced difficulties in three or more areas of sleep. Furthermore, their results indicated that 30 percent of the persons with AD had experienced a sleep disruption during the past week (Carpenter, Strauss, & Patterson, 1995). In addition, Hart and colleagues (2003) found that 54 percent of their sample of individuals with moderate to severe AD experienced some form of sleep disturbance, as reported by their caregiver. Thus, these results suggest that sleep disturbance occurs frequently among persons with AD and that it is not uncommon that they experience more than one problem concurrently.

It is also important to understand the type and severity of sleep disturbance at different stages of the disease because the impact on caregivers may be different across the disease process. The types of sleep disturbance are fairly similar throughout the course of the disease; however, the severity of disturbance may increase as the disease

progresses (Bliwise, 1993). For example, the number of awakenings and decreased sleep efficiency are closely parallel to the severity of dementia, and more severely demented persons may spend more time sleeping during the day compared to mildly demented individuals (Bliwise, 1993). A review of three studies by Vitiello and colleagues (1991) compared sleep disturbance in individuals with AD varying in level of severity with control participants. All participants underwent PSG. The most common sleep disturbances experienced across all persons with AD included spending more time awake during nighttime and awakening more frequently than age-matched controls. The individuals with AD also spent less time in deep sleep and REM sleep and more time napping than controls. Furthermore, the severity of sleep problems increased with dementia severity. Overall, compared to controls, all persons with AD experienced more sleep disturbance.

The severity of sleep disturbances in individuals with mild-stage AD are also greater compared to non-demented elders when using PSG measures (Vitiello, Prinz, Williams, Frommlet, & Ries, 1990). The results from Vitiello and colleagues (1990) indicated that compared with controls, AD persons awakened after sleep onset more frequently, spent significantly more time in bed, and had less deep sleep. That these sleep disturbances occur even in mild-stage AD is an important finding because the majority of these persons are most likely being cared for by their families (Alzheimer's Association, 2004). Awakening during the nighttime was a common problem even in the mild-stage group and it is likely that this had a negative effect on the caregivers.

Although persons with AD experience a wide range of sleep disturbances, there appear to be particular problems that are experienced as more troublesome by caregivers.

A study by McCurry and colleagues (1999), utilizing caregiver-reported sleep, investigated which specific sleep problems in AD persons were perceived as the most problematic by caregivers. Whereas sleeping more than usual and having early morning awakenings were the most common sleep problems among the persons with AD, these sleep problems were not the most distressing to the caregivers. Instead, they found that caregivers rated nighttime awakenings as the most problematic sleep disturbance in the person with AD. Thus, one of the major problems with disturbed sleep in the AD person might be when their nighttime awakenings impact the caregiver's own sleep. This issue will be discussed in more detail below.

Effects of Sleep Disturbance in the Person with AD on Caregiver Emotional Functioning

There is evidence from the literature on retrospective reports of emotional functioning in caregivers that AD person sleep disturbance has adverse effects on caregiver mood. These findings suggest that there may be day-to-day effects of sleep in the person with AD on caregiver mood that underlie the more global outcomes on emotional functioning. In particular, past research has found that sleep disturbances in the AD person are associated with global measures of caregiver emotional functioning, such as distress (Schulz & Martire, 2004) and burden (Allegri et al., 2006). In a review of non-cognitive disturbances in AD, Lawlor (1994) found that typical sleep disturbances such as decreased REM and slow-wave sleep (SWS)/deep sleep were important factors associated with caregiver distress. Specifically, the reduction in deep sleep and REM sleep found in persons with AD was associated with increased daytime napping and nighttime wandering behavior and these two behaviors were related to increased caregiver distress. Furthermore, caregiver distress increased as the frequency of AD

person's sleep disturbances increased (McCurry et al., 1999). Research on sleep in persons with AD and caregiver burden also provides some evidence for the impact of AD person sleep on caregiver mood because the definition of caregiver burden includes the emotional problems experienced by family caregivers (George & Gwyther, 1986). Allegri and colleagues (2006) found that greater sleep disturbance in the person with AD was significantly correlated with greater perceived caregiver burden.

By examining sleep in persons with AD and daily mood prospectively, it is possible to better understand the mechanism behind the aforementioned relationship between poor sleep in persons with AD and caregiver emotional functioning. For example, a prospective study could answer whether there are direct linkages between sleep problems in the person with AD on a given night and the caregiver's mood the following day, or whether the association is indirect. Furthermore, research to date has largely focused on negative emotional outcomes in caregivers and little is known about the impact of sleep disturbance in the person with AD on the caregivers' positive mood. Robertson and colleagues (2007) suggested that the experience of positive affect can be adaptive for caregivers, both in terms of the caregiver-AD person relationship, as well as the caregiver's ability to take care of the person with AD, and the caregiver's own well-being. Additionally, the experience of positive affect could be important for caregivers in terms of rebounding after stressful experiences (Robertson, Zarit, Duncan, Rovine, & Femia, 2007). Thus, understanding the effects of sleep in persons with AD on caregiver positive *and* negative mood could have implications for intervention that aims to improve the caregiver's situation.

It is also important to include a measure of daily mood in the person with AD when investigating the association between their sleep disturbance and caregiver mood. Because poor sleep has been linked to worse mood the next day (McCrae et al., 2008), it is reasonable to assume that mood in AD persons will be related to their nightly sleep. Although not investigated on a day-to-day level, sleep disturbance in persons with AD is highly correlated with emotional outcomes, such as depression (Vitiello & Borson, 2001), and approximately 20 percent of persons with AD are depressed, as rated by their caregivers (Lyketsos et al., 2000). It is possible that caregivers who take care of a person with sleep problems and subsequent poor mood will report worse mood outcomes, in part because of patient mood. For example, it has been found that individuals living with a depressed person have higher levels of depression (Jeglic et al., 2005). Thus, because mood in the person with AD could potentially impact caregiver mood on a day-to-day basis, the present study will also examine whether daily mood in the AD person affects the association between patient sleep and caregiver mood.

Sleep in AD Caregivers

Caregivers can suffer sleep disturbances due to the AD person's nighttime behavior (Creese et al., 2007) or due to other reasons associated with caregiving (McCurry & Teri, 1995). Experiencing disturbed sleep can have both immediate impact on the next day's functioning but also have long-term implications. In fact, it has been suggested that being frequently awakened at night may lead to chronic difficulties with initiating and maintaining sleep (McCurry & Teri, 1995). Nighttime awakening is frequently experienced by caregivers. Yaffe and colleagues (2002) found that approximately 45 percent of the individuals in their sample of over 5500 persons with

dementia frequently awakened their caregivers at night. Thus, being awakened by their care recipient may be both a common and particularly significant problem for caregivers.

McCurry and Teri (1995) found that 68 percent of caregivers had experienced some type of sleep problem three or more nights per week for the past month. The particular problems experienced in their sample included: difficulty with sleep initiation, not feeling rested upon awakening, and awakening because of the person with dementia. Furthermore, awakening at night for reasons other than the person with AD awakening them, as well as an inability to fall back asleep quickly were common problems experienced by the caregivers (McCurry & Teri, 1995). McCurry and Teri (1995) also reported that elderly caregivers experienced increased frequency of daytime napping. After controlling for caregiver age, results indicated that caregiver depressive symptoms were significantly associated with caregiver sleep difficulties.

Other research indicates that compared to non-caregiving peers, caregivers of persons with AD appear to experience more sleep disturbance. McKibbin and colleagues (2005) compared sleep in AD caregivers with non-caregiving peers using polysomnography. Compared with non-caregiving peers, caregivers of persons with AD experienced worse overall sleep quality and more daytime dysfunction. For example, the caregivers in this study reported that daytime sleepiness interfered with their ability to socialize with friends, being productive, and being active. With regards to daytime dysfunction, the results also indicated that caregivers of persons with severe AD experienced greater impairment in daytime activities than both caregivers of mild-stage AD persons and controls. Thus, the effects of caregiving appeared to be particularly salient for those caregivers who are responsible for persons with moderate to severe AD,

as compared with caregivers of mild-stage AD and non-caregivers. Regardless of disease severity, the results suggest that disrupted sleep in caregivers of persons with AD may lead to more daytime impairment, which most likely will affect the caregiving role.

Indirect Effects of Sleep in Persons with AD on Caregiver Mood

While sleep disturbances in persons with AD appear to directly impact caregiver emotional functioning, the aforementioned findings on caregiver sleep quality suggest an indirect link through caregiver sleep (Figure 1). Thus, AD person sleep disturbance may have a direct effect on caregiver positive and negative affect (c), but there may also be an indirect link between sleep disturbance in the person with AD and caregiver moods through disruption of the caregiver's sleep (a-b) (Baron & Kenny, 1986). It is also possible that the AD person's daily mood will influence the caregiver's mood, and thus, the present study will run separate models with AD person PA and NA as mediators.

In terms of indirect effects, persons with AD experience a wide range of sleep problems and these problems, as reviewed above, frequently result in the caregiver's own sleep being disrupted (McCurry, Logsdon, Teri & Vitiello, 2007; McCurry & Teri, 1995). This is an important finding because there is a well-established link between disturbed sleep and depressive symptoms (Tsuno, Besset, & Ritchie, 2005; Rao et al., 2005; Buysse, 2004). Disturbed sleep in the caregiver could thus have implications for the caregiver's daily mood and possible long-term detrimental effects on emotional and psychological functioning. McCurry and colleagues (2007) have suggested that the sleep disturbance in the person with AD may result in sleep problems in the caregiver that may persist even after the AD person's sleep disturbances are no longer present. There is evidence that disturbed caregiver sleep is associated with retrospective measures of

depressive symptoms (McCurry & Teri, 1995) and burden (Willette-Murphy, Todero, & Yeaworth, 2006). Moreover, research with other caregiving populations has found poor caregiver sleep quality to be associated with worse emotional functioning. For example, caregivers of cancer patients have been found to experience long sleep latency and daytime dysfunction which are components of sleep quality (Cho, Dodd, Lee, Padilla, & Slaughter, 2006). Furthermore, Cho and colleagues (2006) found that dysfunction in these dimensions of sleep quality in caregivers was associated with depression and fatigue. Thus, the results suggest that poor caregiver sleep quality is related to worse emotional functioning.

To our knowledge, this is the first project to prospectively study the impact of caregiver perceptions of sleep problems in persons with AD on caregiver daily mood. Research with other populations indicates that daily mood is susceptible to the impact of poor sleep (McCrae et al., 2008; Pilcher & Huffcutt, 1996). A recent diary study that examined the daily association between sleep and affect in older adults suggest that poor sleep on a given day has an impact on the following day's positive and negative mood (McCrae et al., 2008). Specifically, McCrae and colleagues (2008) found that nights with more time spent awake and lower self-reported sleep quality were associated with an increase in negative affect and decreased positive affect the next day as measured by the PANAS. The McCrae et al (2008) study also compared self-reported sleep with objective measures of sleep (actigraphy) and the results indicated that only the subjective sleep measures were significantly associated with mood.

Moreover, research on the effects of sleep deprivation has demonstrated that complete or partial sleep loss can increase negative mood and depressive symptoms

(Kahn-Greene, et al., 2007; Pilcher & Huffcutt, 1996). Pilcher and Huffcutt (1996) found that partial sleep loss was significantly associated with poor emotional, cognitive, and psychomotor outcomes. Partial sleep deprivation is suggested to be analogous to fragmented sleep, in that the person receives at least some sleep during the night (Pilcher & Huffcutt, 1996). Because the sleep patterns of caregivers can be irregular and include prolonged awakenings during the nighttime (McCurry, Logsdon, Teri, & Vitiello, 2007), it is useful to understand the impact of sleep loss on mood. In fact, sleep loss can impact brain regions that are involved in affect regulation (Kahn-Greene et al., 2007). Kahn-Greene and colleagues (2007) suggest that sleep deprivation can be particularly relevant for mood because it impacts the prefrontal cortex, which is involved in affect regulation (Thomas et al., 2000).

Further, healthy persons who experience sleep deprivation across two nights had increased ratings on the depression scale of the Personality Assessment Inventory compared to their baseline ratings (Kahn-Greene, Killgore, Kamimori, Balkin, & Killgore, 2007). Interestingly, it was not the physical symptoms of depression that increased on the depression scale, but rather the depressive thinking (cognitive subscale) and the subjective experience of sadness (affective subscale). While the scores did not reach clinically significant levels, the results suggest that prolonged wakefulness is associated with a non-pathological increase in affective symptoms of psychopathology (Kahn-Greene, Killgore, Kamimori, Balkin, & Killgore, 2007).

In addition, research on mothers with young children can serve as a useful framework for understanding the impact of disturbed sleep on a caregiver's emotional functioning. Mothers caring for children with sleep disturbances are particularly

vulnerable to poor emotional outcomes (Meltzer & Mindell, 2007). Specifically, Meltzer and Mindell (2007) found that child sleep disruption was a significant predictor of the mother's sleep quality. In turn, poor maternal sleep quality was a significant predictor of depression. Interestingly, Meltzer and Mindell (2007) indicated that bedtime, wake time, or total sleep time did not differ between mothers of children with sleep disturbances and mothers of children without sleep problems. In contrast, the number of times the mothers awoke during the nighttime to care for the child was significantly greater for those who identified their child as having sleep problems. Thus, it is possible that it was the amount of awakenings that accounted for the poorer sleep quality in this group of mothers. This finding could be of importance when studying caregivers of persons with AD, because frequent awakenings are a common problem in this group (Yaffe et al., 2002). This issue will be addressed below.

Sleep Disturbance in Persons with AD as Target for Intervention

Disturbed sleep in persons with AD could prove to be a suitable target for intervention in order to improve caregiver mood and sleep. In fact, there are recent studies that have shown that sleep disturbances can be alleviated in persons with AD. A study by McCurry and colleagues (2005) compared a sleep education program (NITE-AD) to community supportive treatment and found that the sleep education program improved sleep in the AD persons. Specifically, the NITE-AD participants experienced a 32 percent reduction in time spent awake at night two months posttest. These improvements held up at the six-month follow-up. In addition, the NITE-AD participants had significantly fewer awakenings per hour and were awake for less time at each awakening compared with the control group. Future studies should extend this line of

research and investigate the impact of improved sleep in individuals with AD on caregiver's mood and sleep.

Significance

Since sleep problems are common in persons with AD and a large portion of these individuals are cared for by their family members, it is relevant to understand how their sleep impacts their caregiver's emotional functioning. This work is important because poor emotional functioning in caregivers has implications for the caregiver-patient relationship and quality of care (McCurry et al., 2007; Meltzer & Mindell, 2007). For instance, McCurry and colleagues (2007) have suggested that caregivers of persons with AD who experience sleep problems may be more irritable with the care-recipient and experience more difficulty with quick problem solving related to behavioral disturbances in their care recipient. Thus, it is apparent that sleep disturbance in persons with AD has implications for caregiver emotional functioning, which in turn, may influence the caregiver-patient relationship. The current study will further the understanding of the association between AD person sleep and caregiver mood by simultaneously examining negative and positive mood. A unique aspect of the present study is the examination of positive affect, which may be a particularly important resource for caregivers who are faced with stressors, such as sleep disturbance in the person with AD. This study will thus guide future research towards developing effective interventions to improve caregiver emotional functioning.

Poor sleep in the person with AD may also impact the caregiver's own sleep, which may be the mechanism through which the negative impact on emotional functioning has been delivered. Additionally, disruption of the caregiver's own sleep may

result in daytime impairment in their ability to manage the duties of caregiving. Daytime fatigue, for example, is associated with decreased ability of the caregiver to perform duties associated with caregiving (Teel & Press, 1999). Thus, sleep in persons with AD may have direct and indirect effects on caregiver emotional functioning that could have tremendous implications for the caregiving process that may result in early institutionalization. In fact, research has shown that sleep disturbance in persons with AD is one of the most common factors influencing the caregiver's decision to institutionalize the person with AD (Yaffe et al., 2002; Hope, Keene, Gedling, Fairburn, & Jacoby, 1998; Lawlor, 1994; Pollack & Perlick, 1991). It has been suggested that alleviation of sleep problems in persons with AD may prolong the time an ill elderly relative can remain at home (Pollack & Perlick, 1994) which often is a goal for these individuals and caregivers alike.

Early institutionalization is associated with tremendous economic and psychological ramifications (Sloane, et al., 2002). In fact, because the number of individuals diagnosed with AD is expected to increase substantially over the next few decades (Herbert, Beckett, Sherr, & Evans, 2001), it has been suggested that an increase in persons requiring institutionalization will have a major impact on public health (Sloane et al., 2002). To date, informal caregivers in the U.S., such as family members, provide approximately two thirds of the cost of caring for the AD population (Sloane, et al., 2002). Thus, research on factors that are associated with early institutionalization is of great importance in the search for intervention and the possible delay of formal care. Finding means to improve the situation for caregivers, by improving their mood and

sleep, could not only benefit the caregiver and caregiving process, but may also prolong the time a person with AD can remain at home.

The Current Study

The current study will be the first to prospectively examine the impact of sleep disturbance in persons with AD on the daily positive and negative mood of their family caregivers. Sleep problems in the persons with AD will be measured by caregiver report. The current study will utilize a diary method, so it will be possible to determine prospective associations between caregiver perceptions of sleep in the person with AD and caregiver mood. The benefit of utilizing diary methods rests on data that it is the *perceptions* of sleep that are more important for next day's mood compared with objective measures of good and poor sleep (McCrae et al., 2008). Additionally, subjective estimates of sleep problem have been found to be more important for diagnosing insomnia, as compared to objective estimates (Edinger et al., 2005). Furthermore, caregivers perceived particular sleep disturbance as more problematic than others even though these particular problems occurred less frequently in the persons with AD (McCurry et al., 1999). Thus, by utilizing caregiver reports of that sleep of the person with AD, it is possible to get a useful understanding of the sleep disturbance – caregiver affect relationship.

The current study conceptualizes sleep disturbance in persons with AD as a stressor that is associated with worse emotional functioning in the caregiver (Allegri et al., 2006; McCurry et al., 1999). Additionally, there is a robust link between stress and increased negative affect (e.g., Almeida, 2005). It is thus hypothesized that sleep disturbance in the person with AD will be associated with caregiver negative affect on the

following day. Furthermore, there is evidence that positive affect decreases in response to stress (Chepenik, et al., 2006) and it is thus hypothesized that sleep disturbance in persons with AD will be associated with decreased positive affect the following day in caregivers.

As discussed above, links between sleep in the persons with AD and caregiver mood could be direct or indirect. Thus, the present study will examine caregiver sleep as a mediator between poor sleep in persons with AD and caregiver daily mood. In other words, it is hypothesized that caregiver sleep will mediate the relationship between sleep disturbance in AD persons and caregiver daily mood (Figure 1). The discussion above suggests that the particular sleep variables to choose for caregivers in the present study should include reduced and interrupted sleep. This would include total sleep time (TST) or sleep period time (SPT), and sleep efficiency (TST/Time in bed). Additionally, sleep latency is a central variable in the diagnosis of insomnia (Edinger et al, 2005) and is thus included as an estimate of disturbed sleep. Finally, the time of awakening may be of interest since early awakenings by AD persons would be likely to be seen as a problem by the caregiver. It will also be important to include the total number of awakenings (both in caregiver and patient), as well as the number of times the person with AD leaves the bed, as these variables influence the caregiver's nightly sleep. In addition to sleep interruption or sleep reduction, global estimates of sleep quality are of interest in relation to mood, as demonstrated by McCrae et al (2008). Another related variable reflecting the global effect of sleep is being well rested (Roth et al., 2010; Sarsour et al., 2010; Harvey, Tang, & Browning, 2005).

The caregiver will report on similar sleep variables for their care-recipient. However, it should be noted that because TST requires keeping track of wake after sleep onset (WASO), it cannot be used for the persons with AD in the present study because caregiver sleep would prevent that kind of observation. The same goes for related measures, such as sleep efficiency. Instead, the caregivers will report on their care-recipient's SPT and the sleep latency. The caregivers will also indicate how well-rested the person with AD appears in the morning, as well as how they perceived their care-recipient's sleep quality. In addition, ratings of the caregiver's perception of the AD person's sleep quality, as well as whether they appear rested in the morning will be included as global estimates of disturbed sleep.

In addition to sleep problems, it is possible that caregiver affect is impacted by the AD person's mood. It is possible that disturbed sleep in the person with AD affects their daily mood, which in turn may influence the caregiver's mood. Past research has shown that mood in one person may influence mood in another person within close relationships (Schoebi et al., 2008; Butner, Diamond, & Hicks, 2007). In other words, it is possible that it is the mood in the person with AD that mediates the relationship between sleep in AD persons and their caregiver's mood. Thus, the current study will explore PA and NA in the AD person as potential mediating variables (Figure 1).

Apart from the daily association between the sleep of the person with AD and caregiver affect, there is also a possibility that background variables, for example, the level of dementia, or level of caregiver burden influences the association. Additionally, there may be day-to-day variables, such as daily stress the influence the association. Such

links have not been tested before, and if significantly related to caregiver affect, will be included as potential control variables in the models described above.

CHAPTER 2

METHODS

Participants

The sample included 40 family caregivers of persons with possible or probable AD, per physician diagnosis as reported by the caregiver. The participants were recruited via flyers, press releases, at senior centers and talks at local organizations including support groups for caregivers of AD patients and the Alzheimer's Association Massachusetts and New York City chapters. For caregiver inclusion criteria, the current study utilized part of the eligibility criteria from the Resources for Enhancing Alzheimer's Caregiver Health (REACH II) study (Belle et al., 2006). These inclusion criteria require the caregiver to have provided care for a relative with diagnosed AD for at least 4 hours per day for at least the past 6 months (Belle et al., 2006). Additional inclusion criteria for the present study required the caregiver to be a family member who was currently living with the person with AD and was able to report on his/her sleep. Furthermore, caregivers had to be available for a one-hour initial in-person interview and phone interviews across eight consecutive days. Exclusion criteria included cognitive impairment and/or a diagnosis of a primary sleep disorder apart from insomnia (e.g., narcolepsy, sleep apnea). All caregivers were compensated a \$10 gift certificate to a location of their choice. Additionally, all caregivers were entered in a lottery to win one out of four \$50 prizes. The winners of the \$50 prizes were drawn from the pool of participants who completed the study.

Procedures

Recruitment and Screening

Potential participants were contacted by the principal investigator, and informed of the nature of the study. If they agreed to participate, verbal consent for screening was obtained. Interested participants were then screened for cognitive impairment using the Telephone Interview for Cognitive Status-modified (Lines, McCarroll, Lipton, & Block, 2003). If the caregiver met inclusion criteria and there was no evidence of cognitive impairment, he or she was invited to participate in the study and an initial meeting was scheduled. The caregiver was informed that the diary portion of the study would begin the morning after the initial meeting. The initial meeting was conducted by the principal investigator in the home of the caregiver, or at the Memory, Mood and Aging lab at UMass if the caregiver so desired. All caregivers signed an IRB approved consent form before participating in the study.

Background and Clinical Data Collection

The caregiver was interviewed concerning burden of caregiving, and the severity of the person with AD's symptoms of dementia. Caregivers also filled out a set of self-report measures about their health, depressive symptoms, overall sleep quality, and their patient's neuropsychiatric symptoms and activities of daily living (see below for details).

The **diary-portion** of the study began in the morning following the initial meeting and was repeated over eight consecutive days. The principal investigator interviewed the caregiver over the phone about his/her sleep the night before, as well as about the sleep of the person with AD. In the early evening the caregiver was interviewed about his/her affect and stress during the day, as well as about the positive and negative affect of the

person with AD. The benefit of conducting the daily interviews at two time points was that the caregivers were more able to accurately report on their sleep and mood. That is, caregivers were less likely to forget the past night's sleep if interviewed shortly after rising. Furthermore, asking about their daily mood by the end of the day allowed for an examination of the impact of sleep on their mood across the day.

Screening Measure

The Telephone Interview for Cognitive Status – modified (TICS-m) is a telephone interview comprising of 13 items that are divided into three factors assessing language, attention/orientation, and memory (Lines, McCarroll, Lipton, & Block, 2003). Higher scores indicate better cognitive functioning. The TICS-m has no clearly distinguished cut-off point, but a score of <19 is suggested to indicate possible dementia (van Uffelen et al., 2007; Moylan et al., 2004; Lines, McCarroll, Lipton, & Block, 2003). The TICS-m has demonstrated good test-retest reliability across two administrations separated by 15 months in non-demented and demented older adults (Plassman, Newman, Welsh, & Helms, 1994). The TICS-m demonstrates convergent validity because it is significantly correlated ($r = .57$) with the MMSE, another screening tool for cognitive functioning (de Jager, Budge, & Clarke, 2003). The delayed recall component of the memory factor has been found to discriminate well between individuals with and without amnesic mild cognitive impairment (aMCI) (Lines, McCarroll, Lipton, & Block, 2003).

Baseline Measures

Activities of Daily Living

This Activities of Daily Living Scale Questionnaire (ADLQ) scale assesses patient functional abilities (Johnson, Barion, Rademaker, Rehkemper, & Weintraub,

2004). The caregiver was instructed to “score each item according to the current level of ability relative to his/her customary performance prior to the onset of dementia symptoms” (Johnson, Barion, Rademaker, Rehkemper, & Weintraub, 2004). The ADLQ measures functioning in six areas: self-care, household care, employment and recreation, shopping and money, travel, and communication (Johnson, Barion, Rademaker, Rehkemper, & Weintraub, 2004). Each area contains between three to six items. Each item is rated on a 4-point scale from 0 (no problem) to 3 (no longer capable of performing activity). There is also an option to indicate if the activity has never been performed by the patient or was stopped prior to the onset of dementia. The ADLQ yields a total score as well as scores for each of the subscales. The total score ranges from 0 to 100, with higher scores indicating a higher degree of functional impairment. The total score will be used in the present study. The test-retest reliability separated by one week for the total ADLQ score was .96, and ranging from .65 (Employment) to .94 (Self-care) for the subscales (Johnson, Barion, Rademaker, Rehkemper, & Weintraub, 2004). The ADLQ also has demonstrated good convergent validity with the MMSE ($r = -.42$), a measure of cognitive impairment, and the CDR ($r = .50$), a measure of dementia severity. Furthermore, the ADLQ was found to be a valid measure of disease progression, as demonstrated by a decline in scores at the 1-year follow-up and its correlation with the MMSE ($r = -.38$) and the CDR ($r = .55$) (Johnson, Barion, Rademaker, Rehkemper, & Weintraub, 2004). Lastly, the ADLQ total score has demonstrated good concurrent validity ($\alpha = .46$) with the total score of the Record of Independent Living (RIL), another measure of dependency in daily living activities (Johnson, Barion, Rademaker, Rehkemper, & Weintraub, 2004).

Depression

The Center for Epidemiological Studies Depression Scale (CESD) assessed caregivers' depressive symptoms. The CESD was designed for research purposes and it is a self-report index of depressive symptoms (Radloff, 1977). It consists of 20 items that assess depressed mood, feelings of guilt and worthlessness, feelings of helplessness and hopelessness, loss of energy, and sleep and appetite disturbances (Radloff & Teri, 1986). The CESD is designed to assess a participant's current symptoms and asks how often each symptom occurred during the past week. Responses are rated on a 4-point scale (0 = rarely or none of the time, less than 1 day; 3 = most or all of the time, 5-7 days). The CESD has been found to measure four factors of depression; depressed affect, positive affect, somatic complaints, and interpersonal problems (Kohut, Berkman, Evans, & Cornoni-Huntley, 1993). The CESD has high internal consistency reliability (.85 to .92) (Radloff, 1977). The average two-week test-retest reliability is .57; this moderate to low score is expected because the scale measures a current state (past two weeks) and depression is thought to fluctuate over time (Radloff, 1977). The CESD correlates well with other scales designed to measure depression (e.g., Radloff, 1977).

Dementia Severity

The Clinical Dementia Rating Scale (CDR) is a global rating of dementia severity (Hughes, Berg, Danziger, Coben, & Martin, 1982). The rating covers six domains of the patient's cognitive and functional performance including, memory, orientation, judgment and problem solving, community affairs, home and hobbies, and personal care (Hughes, Berg, Danziger, Coben, & Martin, 1982). The necessary information to make each rating is obtained through a semi-structured interview of the person with AD and a reliable

informant, such as a family member. The person with AD is rated on a five-point scale (0 = healthy, 0.5 = very mild, 1 = mild, 2 = moderate, 3 = severe dementia) with higher values indicating increased severity of dementia (Morris, 1993). The CDR has been demonstrated to have good inter-rater reliability of .62 (Rockwood, Strang, MacKnight, Downer, & Morris, 2000).

The NPI-Q is a brief questionnaire about patient neuropsychiatric symptoms adapted from the Neuropsychiatric Inventory (NPI), which is a comprehensive interview (Cummings, et al., 1994). The NPI-Q is a self-report questionnaire that is completed by the caregiver person with dementia (Kaufer, et al., 2000). The questionnaire incorporates screening questions for 12 neuropsychiatric symptoms (delusions; hallucinations; agitation/aggression; depression/dysphoria; anxiety; elation/euphoria; apathy/indifference; disinhibition; irritability/lability; motor disturbance; nighttime behaviors; and appetite/eating). If the caregiver answers “yes” to a screening question, he or she is asked to rate the symptoms present during the last four weeks. The symptoms are rated on a three-point scale for severity (1 = mild; 2 = moderate; 3 = severe) and on an anchored six-point scale for caregiver distress (0 = not distressing at all; 5 = extreme or very severe). The NPI-Q yields a total severity score that represents the sum of individual symptom scores and ranges from 0 to 36, and a total distress score that ranges from 0 to 60, with higher values indicating more severe symptoms and distress. The test-retest reliability measured across a few hours was 0.80 for total symptom severity, and 0.94 for total distress (Kaufer et al., 2000). The NPI-Q demonstrated good convergent validity and has been found to correspond well with the original NPI; the correlation between the NPI-Q and the NPI has been estimated at 0.91 for total severity and 0.92 for

total distress (Kaufer et al., 2000). The NPI-Q has also been significantly (inversely) correlated with the MMSE, another screening tool for cognitive functioning (Kaufer et al., 2000).

Stress

The Perceived Stress Scale (PSS) is a global measure of perceived stress. The items were designed to measure the degree to which situations in a person's life are perceived as stressful including how individuals perceive their lives as unpredictable, uncontrollable, and overloading (Cohen, Kamarck, & Mermelstein, 1983). The PSS includes 14 items covering stressful events that have occurred in the past month that are rated on a 4-point scale (0 = never to 4 = very often) with higher values indicating higher degree of perceived stress (Cohen, Kamarck, & Mermelstein, 1983). The PSS has demonstrated good test-retest reliability of .85 over a two-day interval (Cohen, Kamarck, & Mermelstein, 1983). The PSS has also demonstrated fair to moderate concurrent validity with a measure of negative life events assessed across three samples (Cohen, Kamarack, & Mermelstein, 1983).

Physical Functioning

The Physical Symptom Checklist (PSC) is a 44-item instrument that assesses a broad spectrum of physical symptoms (Cameron, Leventhal, & Leventhal, 1993, 1995). Caregivers rate the extent to which they experienced each symptom over the past week. The scale yields an overall global score, which will be used in the present study.

Sleep

Caregivers completed the Pittsburgh Sleep Quality Index (PSQI) to assess their baseline sleep quality. The PSQI is a self-report measure of sleep quality. The scale was

developed to discriminate between “good” and “poor” sleepers, to be easily interpreted by clinicians and researchers, and to assess a variety of sleep disturbances that are thought to affect sleep quality. The scale asks about participants’ sleep during the past month and the participant estimates his/her average bedtime, sleep latency, time of rising in the morning, and number of hours slept. Responses to the remaining questions regarding sleep disturbances and daytime functioning are rated on a 4-point scale (0 = not during the past month; 3 = three or more times per week). The PSQI generates seven component scores: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction. The PSQI also yields a global score thought to reflect overall sleep quality. The possible range of scores is 0-21 with higher scores indicating more disturbances (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). A cut-off score of five points has been found to distinguish between good and poor sleepers (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The seven component scores of the PSQI have overall high internal consistency reliability ($\alpha = .83$) with the global sleep quality score, indicating that each of the seven components measure a particular aspect of the same overall construct (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The global PSQI score has high test-retest reliability across a 28-day time period ($r = .85$), and the test-retest of component scores ranged from .65 (medication use) to .84 (sleep latency) (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). Furthermore, the PSQI discriminates well between sleep disturbed patients and controls.

Burden

The Zarit Burden Interview (ZBI) is a self-report inventory that measures caregiver burden in the past week (Zarit, Anthony, & Boutselis, 1987; Zarit, Reever, & Bach-Peterson, 1980). The revised version evolved from the original 29-item version and contains 22 items that assess the degree to which caregivers perceive the responsibilities associated with caregiving to have a negative impact on their health, emotional functioning, finances, and personal and social life (Zarit, Orr, & Zarit, 1985). The items consist of a wide range of statements such as “do you feel your relative is dependent on you” and “do you feel that you don’t have as much privacy as you would like, because of your relative?” (Zarit, Orr, & Zarit, 1985). Each item is rated for the amount of discomfort on a five-point scale (0 = never; 4 = nearly always) and four items are reverse-scored and are subtracted from the total (Zarit, Reever, & Bach-Peterson, 1980). The ZBI has been found to have good internal consistency reliability ($\alpha = 0.89$) (Zarit, Anthony, & Boutselis, 1987). Furthermore, the ZBI demonstrates good convergent validity ($>.6$) with measures of caregiver life quality, depression, and patient’s functional abilities (Visser-Meily, Post, Lindeman, & Riphagen, 2004).

Daily Diary Measures

Sleep

The Morin sleep diary (Morin, 1993) was adapted to provide information about the AD patient and the caregiver sleep patterns for the duration of the diary study. There were separate diaries for patient and caregiver. The Morin sleep diary includes questions about bedtime, wake time, sleep-onset latency, number and duration of awakenings, time of last awakening, naps, medication intake, and overall sleep quality. In addition to the

Morin-items, the caregivers were also asked about their and their care-recipient's caffeine and alcohol intake during the previous day. Furthermore, to better understand the impact of sleep in the AD person on caregiver sleep, the caregivers were asked to report whether sleep variables such as bedtime/wake up time were due to the patient or other factors. The caregivers were given a set of sleep diaries for themselves and for their patient to fill out upon awakening in order to increase the accuracy of their recall when they were interviewed in the morning. During the evening interview, the caregivers were asked to rate their anticipation for the coming night's sleep on the following item "*how well do you anticipate you will sleep tonight?*" The caregivers were asked to rate this item on a five-point Likert-type scale (1 = very well to 5 = very poorly), with a higher rating indicating poorer sleep predictions. The independent variables in the sleep diary for the caregiver were: bedtime, time of awakening, time to fall asleep (sleep latency), time being awake after sleep onset (WASO – wake after sleep onset), number of times being awakened by the patient, number of other awakenings, sleep quality (1-5, "very poor" to "very good"), being well rested from sleep (1-5, "not at all" to "very much").

For the person with AD, the caregiver rated the same items, but with some changes. Thus the caregiver noted how many times the person with AD woke up, but also how many times he/she woke the caregiver and left the bed. The ratings of sleep quality and being rested were estimates based on the caregiver perception of the person with AD in the morning.

Mood

The caregivers were interviewed about their mood and mood in the AD person during the past day using the Positive and Negative Affect Schedule (PANAS). The

PANAS consists of two 10-item mood scales that measures positive and negative affect (Watson, Clark, & Tellegen, 1988). The positive affect (PA) scale items include: *attentive, interested, alert, excited, enthusiastic, inspired, proud, determined, strong, and active*. The negative affect (NA) scale items include: *scared, afraid, upset, distressed, jittery, nervous, ashamed, guilty, irritable, and hostile*. The individual is asked to rate to what extent they have felt these emotions for the past day on a five-point scale (1 = very slightly or not at all; 2 = a little; 3 = moderately; 4 = quite a bit; 5 = extremely). The correlation between the PA and NA scales is low, ranging from -.12 to -.23 across different time frames (Watson, Clark, & Tellegen, 1988). In other words, the two affect dimensions are thought to be independent of one another. The PANAS has demonstrated high internal consistency reliability, with .90 for PA and .87 for NA for different *today* ratings. The PANAS test-retest reliability across an 8-week period for the *today* ratings for PA was .47, and the reliability for NA was .39 (Watson, Clark, & Tellegen, 1988). The PANAS NA scale is positively correlated (.74) with the Hopkins Symptom Checklist, another measure of distress and dysfunction, and with the Beck Depression Inventory (.56) (Watson, Clark, & Tellegen, 1988).

Possible Between-Subject Control Variables

Daily Stress

The Daily Inventory of Stressful Events (DISE) is a semi-structured, interview-based inventory of daily stressors (Almeida, Wethington, & Kessler, 2002). The caregivers were asked about any daily stressful experiences by using the seven stem questions from the DISE (Almeida, Wethington, & Kessler, 2002). The stem questions ask whether particular kinds of stressors (e.g., interpersonal, work-related) have occurred

in the past 24 hours and the responses are coded “yes” or “no” (Almeida, Wethington, & Kessler, 2002). The number of “yes” responses will be tallied up to form a total daily stress score with higher numbers indicating more stressful experiences.

Physical Activity

The caregivers will be asked about the level of intensity of their daily physical activity (light, moderate, and vigorous).

Analytic Strategy

The hypothesis that sleep disturbances in persons with AD would increase daily NA and decrease PA levels, and that this association might be mediated by caregiver sleep or AD person affect, was evaluated with a series of models using Hierarchical Linear Modeling (HLM). In the proposed analyses, the repeated measurements of sleep in the person with AD, caregiver sleep, and daily PA and NA were all nested within the individual caregivers. HLM was selected because these repeated measurements are likely to be correlated within each caregiver and thus, the assumption of independence of measurement errors may be violated (Raudenbush & Bryk, 2002). Therefore, traditional linear regression models are inappropriate to analyze diary data. HLM addresses the challenges inherent in the analysis of dependent data from repeated measurements of the observed variables (Bauer, Preacher, & Gil, 2006). By using HLM it is possible to examine 1) how sleep disturbance in the person with AD predicts caregiver affect and 2) how the relationship between sleep disturbance of the person with AD and caregiver affect might be mediated by caregiver sleep or affect of the person with AD.

In order to carry out a mediation analysis, the link between the independent variable (AD person sleep) and the mediator (NA or PA in persons with AD or caregiver

sleep variables) needs to be significant (the “a” pathway, Figure 1), as well as the link between the mediator and the dependent variable (the “b” pathway, Figure 1) (Baron and Kenney, 1986). For the mediation models examining caregiver sleep as a potential mediator, only the AD person sleep variables that are significantly associated with caregiver NA (path “c”), and also with the mediating variable (link “a”), will be included in the final models. Additionally, only the caregiver sleep variables that are significantly associated with the dependent variable (link “b”) will be included in the mediation analyses.

Similarly, for the models examining AD person PA or NA as mediators, only the sleep variables in the person with AD that are significantly associated with caregiver PA or NA (link “c”), and AD person affect (link “a”) will be included. Likewise, AD person NA and PA can only be included as mediators if they are significantly associated with the outcome variable (link “b”).

The *independent* variables are sleep characteristics of the person with AD. These include sleep period time (SPT), sleep latency, number of awakenings, number of times leaving the bed, sleep quality, and appearing rested. The potential *mediators* are positive and negative affect of the person with AD, as well as the sleep variables of the caregiver. Caregiver sleep variables include: sleep latency, SPT, total sleep time (TST), WASO, sleep efficiency, number of awakenings due to the person with AD, sleep quality, and feeling rested after sleep. All variables are used since that is commonly done in sleep studies, despite the fact that TST is derived from SPT – WASO and that sleep efficiency is derived from Time in bed – TST, and thus are highly correlated.

There are two *dependent* variables in the present study, caregiver PA and NA. Below are the models, using NA as the example. The same set of models was fit using caregiver PA as the outcome variable. First, an unconditional model (intercept only) defines the variance to be explained. The unconditional model for NA yields the estimated average level of NA and the residuals. The intercept is equal to the predicted average of NA across caregivers. The residuals indicate the average amount of change in NA across eight days. The day component is included to control for any overall temporal trends in the data, which may spuriously create time-varying relationships between predictors and the affect outcome. The Level 1 equation for the unconditional model is:

$$\text{Level 1: } \quad \text{NA}_{ij} = \beta_{0j} + \beta_{1j} (\text{day}) + r_{ij}$$

$$\text{Level 2: } \quad \beta_{0j} = \gamma_{00} + u_{0j}$$

$$\beta_{1j} = \gamma_{10} + u_{1j}$$

Where γ_{00} is the average negative affect score across all caregivers and u_{0j} is the deviation of an individual person from the average. Furthermore, γ_{10} represents the intercept, centered at initial day of study, with u_{1j} , indicating whether there is significant variability over time. If we do not find that there is significant change over time, the day component will be excluded from future analyses.

The hypothesis that sleep disturbance of the person with AD is associated with increased daily caregiver NA will be evaluated. The equations are:

$$\text{Level 1: } \quad \text{NA}_{ij} = \beta_{0j} + \beta_{1j} (\text{AD person sleep}) + r_{ij}$$

$$\text{Level 2: } \quad \beta_0 = \gamma_{00} + u_{0j}$$

$$\beta_1 = \gamma_{10} + u_{1j}$$

Where γ_{00} is the average NA across caregivers, u_{0j} is the individual caregivers deviation from the average, γ_{10} is the average relationship between patient sleep and caregiver NA, and u_{ij} is the variability around the average relationship between AD person sleep and caregiver NA. It is expected that NA will have a significant and negative association with patient sleep.

Assuming this expected association is found, several analyses will be conducted to evaluate whether AD person sleep is associated with caregiver sleep variables (path “a”). The caregiver sleep variables that are significantly associated with AD person sleep will then be included in analyses to determine whether they are significantly associated with caregiver NA (path “b”). The variables that remain significant in both path “a” and “b” will be included in subsequent mediation analyses. The same series of analyses to determine significant paths for “a” and “b” will be conducted with AD person NA and PA.

Next, a model will be fit to evaluate whether caregiver sleep disturbance (or affect of the person with AD) mediates the relationship between AD person sleep and caregiver affect (Figure 1). In other words, if there is mediation, the direct effect between AD person sleep and caregiver NA or PA (path “c”) will be significantly reduced by the indirect effect (path “a” x “b”) of caregiver sleep disturbance (or AD person affect) on caregiver NA or PA. To evaluate the hypothesis that caregiver sleep disturbance mediates the association between patient sleep disturbance and caregiver NA, a mediator model will be fit as outlined below. The Level 1 equation for the mediation model is:

$$NA_{ij} = \beta_{0j} + \beta_{1j} (\text{AD person sleep}) + \beta_{2j} (\text{caregiver sleep}) + r_{ij}$$

Although not a primary aim of the present study, following the advice of Curran and Bauer (2011), the mean level of each AD person's and caregiver's sleep will be entered at Level 2 in order to control for any potential effect of their average tendency on the outcome variable (caregiver NA or PA). Thus, for all the potential mediation models, all predictors will be averaged for each person and included in the model at Level 2.

It is important to note that all variables included in the mediation model are measured on a daily basis for each caregiver. Because the mediator variable, caregiver sleep disturbance, is measured repeatedly for each person across eight days, the proposed models evaluate "lower level," or Level 1 mediation (Kenny, Bolger, & Korchmaros, 2003). Thus, all of the effects occur at Level 1 and all of the variables are nested within the caregiver (Level 2). According to Kenny and colleagues (2003), lower level effects may vary across Level 2 units. Thus, with regards to the current study, the mediation of the association between AD person sleep and caregiver NA might be different for different caregivers (Kenny, Bolger, & Korchmaros, 2003). Thus, there will be "a," "b," and "c" paths for everyone, as well as each person's variability from the overall average. The mediator model will be evaluated using MPlus statistical software (Muthén & Muthén, 2007). This software allows for the individual variability in the mediation relationship across all caregivers, and can thus provide accurate standard errors and produce the test statistics to determine whether the model is significant. Therefore, a mediation model (Figure 2) is simultaneously fit to each individual, taking into account the variability in this relationship across all caregivers.

The mediator model is designed following the statistical advice of Bauer, Preacher, and Gil (2006). This provides a statistical test of mediation and provides a standard error to test if the indirect (mediated) effect is significantly different from zero.

Exploratory Analyses

Variables that are not of primary interest, but that could potentially predict caregiver PA and NA were assessed during the initial interview (e.g., level of dementia of the person with AD, caregiver burden, caregiver depression, patient functional status), as well as caregiver daily stress. Some correlation analyses will be conducted to investigate if any of these variables are significantly associated with caregiver affect. Those variables that are found to be significantly associated with PA and NA in this sample will be statistically controlled, by being entered as Level 2 variables in the potential mediation models.

CHAPTER 3

RESULTS

Preliminary Analyses

Background Variables

The final sample was comprised of 40 dyads. The ethnic make up of the caregivers was Caucasian (67.5%), African-American (10%), Hispanic (15%), Native American (2.5%), and other ethnicities (5%). All of the caregivers were living with their family member with AD. Twenty-three caregivers were spouses of the person with AD and 17 were adult children of the person with AD (Table 1). More than half of the caregivers shared a bedroom with the person with AD. Approximately half of the caregivers had formal help with caregiving duties (e.g., home health aides), and two-thirds had help from family members and friends. Approximately 58 percent of caregivers were classified as having poor sleep quality on the PSQI (scores > 5). Almost half of the caregivers reported significant levels of depressive symptoms (CESD Total score ≥ 16).

The internal consistency of background measures was generally good. Specifically, overall internal consistency for the ZBI was strong (overall Cronbach's $\alpha = .91$). The internal consistency reliabilities for the CESD ($\alpha = .88$), and the PSS ($\alpha = .85$) were good. The internal consistency for the PSQI was somewhat lower compared to previous samples ($\alpha = .73$).

Spousal caregivers were significantly more likely to share bedroom with the person with AD compared to adult children caregivers ($\chi^2 = 12.03$, $p < .01$). Similarly, older age was significantly associated with sharing a bedroom with the AD person ($t(38)$

= 2.95, $p < .01$). Thus, it was also of interest to determine whether caregivers who shared a bedroom with the person with AD would report worse overall sleep quality on the PSQI, as it may influence the day-to-day variation in perceived sleep quality across the diary measures. Independent samples t-test revealed that there was no significant difference in Global PSQI scores between caregivers who shared a bedroom with the person with AD ($M = 7.77$, $SD = 4.37$) compared to those who slept in a different bedroom ($M = 6.00$, $SD = 4.01$) ($t = -1.32$, $p > 0.5$). Similarly, there was no significant differences in Global PSQI scores between spouses ($M = 6.43$, $SD = 3.87$) compared to children of AD persons ($M = 7.58$, $SD = 4.68$) ($t = -.85$, $p > 0.5$). When examined against the diary data, the results indicated that there was not a significant association between sharing a bedroom or type of relationship on caregiver daily sleep quality (all $p > 0.5$).

The severity of dementia amongst the persons with AD was questionable (2.50%), mild (32.50%), moderate (52.50%), and severe (12.50%). The average number of years since diagnosis was five (range 1-15 years). On average, persons with AD required help with approximately two-thirds of their ADLs (Table 2).

Correlations were computed between the major baseline variables for caregivers and persons with AD. The results indicated that the PSC, ZBI, PSQI, CESD, and PSS were significantly intercorrelated (Table 3).

Diary Variables

Means Across the Eight Days

To give an overall impression of the sleep data for persons with AD and their caregivers across the eight days, the mean and standard deviation of AD person and caregiver sleep variables was computed for each individual across days. Results were

then averaged across individuals (Table 4 and 5). The averaged SD represents the mean variation across the eight days (across individuals), which constitutes the basis for the subsequent analyses of day-to-day co-variability.

There was variation in the caregiver's sleep duration across the eight days (range 4.7-9.1 hours) (Table 4). On average, the caregivers demonstrated normal sleep efficiency slightly above the cut-off for poor sleep (85 percent) according to the PSQI (Buysse, et al., 1989). The person with AD caused approximately 43 percent of caregiver nightly awakenings.

On average, persons with AD had longer sleep duration than the caregivers. For the AD persons, only the sleep period time (SPT) could be estimated with any reliability since caregiver's own sleep would prevent them from estimating WASO for the person with AD, and thus from calculating an accurate total sleep time (TST) (because WASO is subtracted from SPT to calculate TST). The AD person SPT indicated an average of 8.7 hours ($SD = 1.5$ hrs), again with considerable variation across time. Persons with AD woke once per night on the average, left bed $\frac{3}{4}$ of the nights and, as indicated above, woke their caregiver more than half the nights of the week. As mentioned above, the persons with AD had longer SPT compared to the caregivers. Thus, caregivers also reported on the number of times persons with AD left their bed even if they had not yet gone to bed themselves.

Similarly, to give an overall impression of the mood data for persons with AD and their caregivers across the eight days, the mean and standard deviation for PA and NA across days was computed for each individual. The results were then averaged across individuals (Table 4 and 5), where the averaged SD represents the mean variation across

the eight days (across individuals). Caregivers reported significantly higher PA compared to the persons with AD ($t = 8.15, p < .01$). There was not a significant difference between the caregivers' average level of NA compared with persons with AD ($t = 1.75, p > .05$).

Correlations for Caregiver and AD Person Baseline and Diary Variables

To gain an initial understanding of the relationship between AD persons sleep and affect and their caregivers' sleep and affect, we conducted a series of correlations between the diary variables (Table 6). The results showed that the average caregiver NA was significantly correlated with the average ratings of the AD person appearing rested and their average NA. No other variables were significantly correlated with caregiver NA. Average caregiver PA was only significantly correlated with the average PA in the person with AD.

As mentioned above, in order for the mediation analyses to be conducted, paths "a" and "b" need to be significant (indirect effect) in addition to path "c" (direct effect). Thus, we conducted a series of correlations between the average values of the diary variables to better understand the potential "a" and "b" paths. With regards to the link between AD person sleep and caregiver sleep (path "a"), the results indicated that AD person sleep latency, number of awakenings, appearing rested, and sleep quality were significantly correlated with caregiver sleep variables (Table 6). In particular, AD person sleep latency was significantly correlated with caregiver sleep quality and feelings of being rested, such that longer AD person sleep latency was associated with the caregiver reporting worse sleep quality and feeling less rested in the morning. The number of AD person awakenings was significantly associated with number of times the caregiver was awakened by the AD person, as well as their WASO. The ratings for AD person

appearing rested was significantly, and negatively correlated with the caregiver being awakened, and positively correlated with caregiver WASO, feeling rested, and sleep quality. The ratings for AD person sleep quality was significantly, and negatively correlated with the number of times the caregiver was awakened and their WASO, and positively correlated with caregiver sleep quality.

Next, we evaluated mean caregiver affect and sleep variables to understand which variables were significantly associated with caregiver affect (path “b”). Mean level of caregiver stress was also included as it was hypothesized to have an effect on caregiver affect. The results indicated that caregiver NA was significantly correlated with feeling rested, and overall sleep quality (Table 7). Caregiver sleep quality and feelings of being rested in the morning were both negatively correlated with caregiver NA, indicating that worse sleep quality and feeling less rested were associated with higher levels of NA. In addition, caregiver NA was significantly correlated with stress, indicating that higher levels of stress were associated with higher levels of NA. There were no significant correlations between any of the caregiver sleep variables and their PA.

A second mediation hypothesis was that the association between AD person sleep and caregiver affect was mediated through the NA or PA of the person with AD. Thus, a correlation analysis was conducted amongst the mean levels of AD person affect and sleep variables across the week (Table 8). The results indicated that AD person NA was significantly correlated with number of awakenings and number of times they left the bed during the nighttime. Thus, greater amounts of awakenings and number of times leaving bed were associated with higher levels of NA in persons with AD. AD person NA also was significantly, and negatively, correlated with appearing rested in the morning. Thus,

the less rested the AD person appeared, the higher their NA. There were no significant correlations between AD person sleep variables and AD person PA.

With regards to path “b,” the results indicated that AD person NA was significantly and positively correlated with caregiver NA (Table 6). Similarly, AD person PA was significantly and positively correlated with caregiver PA.

Baseline Variables and Mean Diary Variables

To investigate whether the baseline variables were related to mean levels of the AD person and caregiver diary variables across the week, caregiver and AD person NA, PA, and sleep variables were correlated with the total scores for the ADL, PSC, ZBI, PSQI, CESD (Table 9). There were no significant correlations between caregiver affect and any of the baseline variables (Table 9). With regards to caregiver PA, only PSC total score was significantly correlated, indicating that lower physical symptoms was associated with higher levels of PA, suggesting this as a possible control variable in potential mediation analyses. No other baseline variables were significantly correlated with caregiver PA.

HLM Analyses

As described in the analytic strategy section, several HLM models were run to determine the variables to be included in the mediation models. The HLM models were run in three steps to establish the “a,” “b,” and “c” paths (Figure 2). Step 1 included the analyses to establish the direct effect of AD person sleep variables on caregiver NA and PA. The sleep variables that were significant provided evidence for a direct effect between AD person sleep and caregiver affect (path “c”) and would therefore be included in the mediation models. Step 2 included the analyses to evaluate whether these sleep

variables were significantly associated with the hypothesized mediators (caregiver sleep or AD person affect) in order to establish path “a.” Step 3 included analyses to determine if the significant variables from Step 2 were associated with caregiver affect, thus providing evidence for path “b.”

Testing the Unconditional Model

Prior to addressing the primary research questions, the first step was to fit an unconditional model with no predictors to determine the variance to be explained. The unconditional model for NA will yield the estimated average level of NA and the residuals. That is, the intercept is equal to the predicted average level of NA across caregivers. The unconditional model will also yield the residuals, which indicates the average amount of change in NA across the eight days. A “day” component was included in order to control for any overall temporal trends in the data, which may spuriously create time-varying relationships between predictors and negative affect.

Analyses revealed, on average, that caregiver level of NA was significantly different from zero at the initial day ($\beta = 15.03, p < .01$). Furthermore, there was significant variability in the deviation of individual caregivers from the average score ($u_{0j} = 12.52, p < .01$). The slope for days was not significant ($\beta = -0.16, p > .05$), indicating that there was not a significant linear change in the NA scores across time. Thus, the day component was not included in subsequent analyses with caregiver NA as outcome.

A similar unconditional model was fit with caregiver PA as outcome. Analyses revealed, on average, that caregiver PA was significantly different from zero at the initial day ($\beta = 33.90, p < .01$). Furthermore, there was significant variability in the deviation of individual caregivers from the average score ($u_{0j} = 47.14, p < .01$). The slope for days

was not significant ($\beta = 0.16, p > .05$), indicating that there was not a significant linear change in the PA scores across time. Thus, the day component was not included in subsequent analyses with caregiver PA as outcome.

Association between Sleep Variables in Persons with AD and Caregiver NA and PA (“c” pathway)

In order to determine whether patient daily sleep variables had an effect on caregiver daily mood, several HLM models were fit. If there are no significant associations between AD person sleep variables and caregiver PA and NA, no subsequent mediation models can be fit with AD person sleep variables as predictors. The present models were fit to examine the “c” pathway for the subsequent mediation models. The models examined how well these sleep variables predicted caregiver affect within-persons (Level-1). Thus, Level-1 analyses addressed questions such as “On days when a caregiver reports worse than average sleep quality in their companion with AD, does he/she also report higher levels of negative affect?”

As mentioned in the introduction, the following sleep variables for persons with AD were examined in relation to daily caregiver NA and PA: sleep quality, appearing rested, number of awakenings, getting out of bed, SPT, and sleep latency. These variables were examined one by one and will be described below first with caregiver NA and then with caregiver PA as the outcome. All sleep variables were centered around the grand mean to provide a meaningful intercept (i.e., the intercept represents the average value for that particular variable). Furthermore, all HLM models were run using full maximum likelihood estimations.

As hypothesized, the results indicated that the average ratings for the person with AD appearing rested in the morning were significantly associated with caregiver NA

(Table 10). Specifically, as the person with AD was rated as less rested, caregivers reported more NA. Thus, caregiver NA was high when the person with AD did not appear well-rested. Similarly, as person with AD was rated as having poor sleep quality, caregivers reported more NA. Furthermore, the number of times the person with AD left the bed during nighttime was significantly associated with lesser caregiver NA. These variables were thus kept for further evaluation to determine if they would be included in the final mediation models. None of the other sleep variables for AD persons (SPT, latency, number of awakenings) were significantly associated with caregiver NA. These variables were thus excluded as predictors in subsequent mediation models with caregiver NA as outcome.

The same sleep variables in persons with AD (SPT, latency, number of awakenings, leaving bed, sleep quality, appearing rested) were examined for their association with caregiver PA as outcome. The results indicated that there were no significant associations between the aforementioned sleep variables and caregiver PA (Table 11). Thus, we did not test a mediation model with caregiver PA as outcome.

Associations between Sleep Variables in Persons with AD and Caregiver Sleep Variables ("a" pathway)

The next step was to examine the daily association between sleep variables in persons with AD and caregiver sleep variables. In accordance with Baron and Kenny (1986), only the significant sleep variables from the "c" pathway (AD person appearing rested, sleep quality, and leaving bed) were included in the following analysis. Hence, we examined the associations between AD person appearing rested, their sleep quality, and leaving bed for their associations with caregiver sleep variables. Significant associations between these three variables and caregiver sleep variables would provide evidence for a

significant “a” pathway in the subsequent meditation analyses. As explained in the introduction, the following caregiver sleep variables were included as potential mediators: sleep latency, sleep quality, feeling rested in the morning, being awakened by the person with AD, sleep efficiency, WASO, SPT, and TST. Again, SPT, TST, WASO, and sleep efficiency are all used since that is commonly done in sleep studies, despite the fact that these variables were highly correlated.

Overall, the results indicated that AD person appearing rested was significantly associated with caregiver sleep quality, feeling rested, and being awakened by the person with AD (Table 12). Specifically, increases in ratings of the person with AD appearing rested were associated with increased caregiver sleep quality, and increased ratings of the caregiver feeling rested in the morning. Furthermore, AD person appearing rested was negatively associated with number of times the caregiver was awakened by the person with AD during the nighttime. None of the other caregiver sleep variables (SPT, TST, WASO, and sleep efficiency) were significantly associated with the patient appearing rested, and were thus excluded from subsequent mediation analyses with AD person appearing rested as initial predictor.

Next, associations between caregiver sleep variables and the number of times the person with AD left the bed were investigated (Table 13). AD person leaving bed was significantly associated with caregiver being awakened by the person with AD, WASO, sleep efficiency, and sleep quality, and feelings of being rested in the morning. In other words, the number of times the AD person left the bed was associated with the caregiver being awakened. Furthermore, the more times the AD person left the bed during the night, the caregiver’s ratings of feeling rested upon awakening decreased. Similarly, AD

person leaving bed was significantly associated with lesser caregiver sleep quality, and increased caregiver WASO. There were no significant associations between AD person leaving bed and caregiver SPT and TST, and these variables were thus excluded from subsequent mediation analyses with AD person leaving bed as initial predictor.

AD person sleep quality also was significantly associated with caregiver sleep. AD person sleep quality was positively associated with caregiver sleep efficiency, sleep quality, and feeling rested. Furthermore, AD person sleep quality was negatively associated with caregiver being awakened by the person with AD, and caregiver WASO (Table 14). There were no significant associations between AD person sleep quality and caregiver SPT and TST, and these variables were thus excluded from subsequent mediation analyses with AD person sleep quality as initial predictor.

Associations between Caregiver Sleep Variables and Caregiver NA (“b” pathway)

Similar to analyses described above, only the significant potential mediator variables (from the “a” pathway) were included in the subsequent analyzes to determine path “b” (Baron & Kenny, 1986). Thus, caregiver feeling rested, sleep quality, sleep efficiency, being awakened by the person with AD and WASO were examined for potential association with caregiver NA. Caregiver sleep quality was significantly, and negatively, associated with caregiver daily NA (Table 15). Thus, when caregivers experienced better sleep quality, they tended to report less NA. Similarly, caregivers’ ratings of feeling rested in the morning were significantly associated with their daily NA. Therefore, when caregivers were well-rested in the morning they reported less daily NA. Caregiver being awakened by the person with AD also was significantly associated with caregiver NA, indicating that the more times the caregiver was awakened during the

nighttime, the higher they reported their NA during the course of the day Caregiver sleep efficiency and WASO were not significantly associated with their daily NA and were thus excluded from subsequent mediation models.

Final Model: Indirect Effects of Caregiver Sleep

Based on the results from the aforementioned analyses, three separate mediation models were run with caregiver sleep quality, feeling rested, and being awakened by the AD person as potential mediators between AD person sleep quality and caregiver NA. As described in the analytic strategy section, caregiver age, the average of the AD person sleep quality, as well as the average of each of the potential mediating variables (caregiver ratings of feeling rested, their sleep quality, and number of times they were awakened by the AD person) was included as between-subject variables at level 2 in its corresponding mediation model. This was done in order to determine whether the average tendency of the AD person appearing rested, in addition to each caregiver's average tendency of being awakened by the person with AD, feeling rested, and their sleep quality also were significantly associated with caregiver NA, in addition to the variability in the same variables across the eight days. The results indicated that caregiver sleep quality partially mediated the association between AD person sleep quality and caregiver NA (Figure 3). Specifically, on days when the person with AD was rated as having poor sleep quality, the caregivers also tended to rate their sleep quality low, which in turn was associated with higher levels of NA in the caregiver. The total effect that was mediated was $-.76$ ($SE = .36, p < .05$), which represents the sum of the indirect ($a \times b$), and the direct effect when the mediator is present (c'). The indirect effect was $-.42$ ($SE = .16, p < .01$), and mediated 55 percent of the total effect. The results from the mediation model

indicated that the association between AD person sleep quality and caregiver NA varied within caregivers across the week, and that this relationship was partially mediated by caregiver sleep quality, controlling for caregiver age, and the average tendency of AD person sleep quality, caregiver sleep quality and caregiver stress.

Caregiver feeling rested also was found to partially mediate the association between AD person sleep quality and caregiver NA (Figure 4). The total effect that was mediated was $-.68$ ($SE = .37$, $p=.06$), and the indirect effect was $-.32$ ($SE = .14$, $p<.05$), and mediated 47 percent of the total effect. The results from the mediation model indicated that the association between AD person sleep quality and caregiver NA varied within caregivers across the week, and that this relationship was partially mediated by caregiver feeling rested in the morning, controlling for caregiver age, and the average tendency of AD person sleep quality, caregiver feeling rested and caregiver stress. Thus, on days when the person with AD was rated as having good sleep quality, the caregivers also tended to rate their sleep quality well, which in turn was associated with lower levels of NA in the caregiver.

Next, three separate mediation models were run with caregiver sleep quality, feeling rested, and being awakened by the AD person as potential mediators between AD person appearing rested and caregiver NA. Similar to the mediation models described above, caregiver age, the average level of stress, and the average values of all the predictors were included as between-subject variables at level 2 in its corresponding mediation model. This was done in order to determine whether the average tendency of the AD person appearing rested, in addition to each caregiver's average tendency of being awakened by the person with AD, feeling rested, and their sleep quality also were

significantly associated with caregiver NA, in addition to the variability in the same variables across the eight days. The results showed that there was no significant mediation effect of any of the caregiver sleep variables on the association between the AD person appearing rested and caregiver NA (all $p > .05$).

Similarly, three separate mediation analysis were run with each of the significant caregiver sleep variables (awakened by person with AD, feeling rested, and sleep quality) as potential mediators between AD person leaving bed and caregiver NA. As described above, caregiver age, and the average of each predictor were included as between-subject variables at level 2 in its corresponding mediation model. The results showed that there was no significant mediation effect of any of the caregiver sleep variables on the association between the AD person leaving bed and caregiver NA (all $p > .05$).

In sum, we found support for the hypothesis that poor caregiver sleep mediated the association between sleep in AD persons and caregiver NA. Specifically, we found that caregiver sleep quality mediated the association between AD person sleep quality and caregiver NA. Furthermore, we found that caregiver feelings of being rested in the morning mediated the association between AD person sleep quality and caregiver NA. Next, we turn to the second hypothesis including AD person mood as the mediator between their sleep and caregiver mood.

Associations between Sleep Variables in Persons with AD on Their Daily PA and NA ("a" pathway)

As mentioned above, the current study also hypothesized AD person NA and PA as mediators between sleep in the person with AD and caregiver affect. As a reminder, because we failed to find any AD person sleep variables to significantly predict caregiver PA, there were no mediation models run with caregiver PA as outcome.

We conducted a series of analyses to determine whether the “a” and “b” paths were significant when AD person NA was used as the mediator. Thus, similar to the analysis for the “a” pathway with caregiver sleep variables, the next step was to examine the associations between sleep in persons with AD and their daily levels of PA and NA. Again, significant associations between these variables will provide evidence for a significant “a” pathway in the subsequent mediational analyses where daily mood in persons with AD serve as the potential mediator between AD persons’ sleep and caregiver mood. Based on the analyses examining the “c” pathway described above, AD person leaving bed, appearing rested, and sleep quality were the AD person sleep variables that were included.

The results indicated that AD person appearing rested in the morning was significantly associated with their NA during the day (Table 16). In other words, when caregivers rated the person with AD as appearing less rested their ratings for the AD person’s NA increased. Similarly, AD person sleep quality was significantly associated with their NA, indicating that lower sleep quality was associated with higher NA. In contrast, the number of times the person with AD left the bed during the nighttime was not significantly associated with their NA the following day.

There were not any significant associations between AD person sleep variables and their PA. Thus, the results did not provide evidence for PA in the person with AD as a potential mediating variable between AD person sleep and caregiver NA (Table 16).

Associations between NA in the Persons with AD and Caregiver NA (“b” pathway)

Similar to the analyses for the “b” pathway with caregiver sleep variables, the next step was to examine the associations between NA in persons with AD and caregiver

daily NA. Daily NA in persons with AD was significantly, and positively, associated with caregiver NA ($\beta_1 = .39$, $se = .05$, $p < .001$). In other words, as the NA in persons with AD increased, caregiver NA also increased. As there was not a significant association between any of the sleep variables in persons with AD and their daily PA, this variable was not included further as it was not supported as a potential mediator.

Final Model: Indirect Effects of NA in the Person with AD

Based on the aforementioned analyses, a mediation analysis was run with AD person NA as mediator between AD person appearing rested and caregiver NA. In addition, the average for each AD person's NA, AD person's average rating of appearing rested were included as between-subject variables in the mediation model. This was done to determine whether each AD person's average tendency of NA or appearing rested also were significantly associated with caregiver NA, in addition to the variability in the AD person appearing rested and AD person NA variables across the eight days. Furthermore, caregiver age and their average level of stress were included to determine whether the mediation relationship would hold up in the presence of these variables.

The results also showed that AD person NA partially mediated the association between AD person sleep quality and caregiver NA (Figure 5). The total effect that was mediated was -1.19 ($SE = .38$, $p < .01$), and the indirect effect was $-.53$ ($SE = .21$, $p < .01$), and mediated 44 percent of the total effect. The results from the mediation model indicated that the association between AD person sleep quality and caregiver NA varied within caregivers across the week, and that this relationship was partially mediated by NA in the person with AD, controlling for caregiver age, and the average tendency of AD person sleep quality and NA, and caregiver stress. Thus, on days when the ratings for

sleep quality in the person with AD were poor, they also tended to display higher levels of NA, which, in turn, was associated with higher levels of NA in the caregiver.

The results also showed that NA in the person with AD partially mediated the association between AD person appearing rested and caregiver NA (Figure 6). The total effect that was mediated was -1.30 (SE = .35, $p < .01$). The indirect effect was -.61 (SE = 2.10, $p < .01$), and mediated 46 percent of the total effect. The results from the mediation model indicated that the association between AD person appearing rested and caregiver NA varied within caregivers across the week, and that this relationship was partially mediated by NA in the person with AD, controlling for caregiver age, and the average tendency of AD person rested and NA, and caregiver stress. Thus, on days when the person with AD appeared less rested, they also tended to display higher levels of NA, which, in turn, was associated with higher levels of NA in the caregiver.

CHAPTER 4

DISCUSSION

To date, the majority of the studies investigating sleep and emotional functioning in dementia family caregivers have been retrospective (e.g., McCurry, Logsdon, Teri, & Vitiello, 2007; Schulz & Martire, 2004; Hart et al., 2003). Thus, little is known about the mechanism through which poor sleep in persons with AD affects their caregiver's emotional functioning. The current study addressed this issue by examining the association between poor/disturbed sleep in persons with AD and caregiver PA and NA prospectively. The current study determined whether sleep disturbances in persons with AD influenced their caregiver's emotional functioning the next day, and whether there was a direct or indirect link via disruption of the caregiver's sleep or the AD person's emotional functioning. The goals of the current study were 1) to examine the relationship between sleep in AD persons and caregiver PA and NA the next day, and 2) to explore whether disruption of the caregiver's sleep or mood in the person with AD mediated this relationship.

The present study found a significant association between AD person sleep and caregiver NA, but not PA. Furthermore, we found that the association between AD person sleep and caregiver negative mood was partially mediated by caregiver sleep variables, and also by AD person negative mood.

Caregiver Sleep as Mediator

The current study demonstrated that AD persons appearing rested in the morning, their sleep quality, and if they left the bed during the night were significant predictors of caregiver negative mood the following day. Specifically, we found that caregivers

reported higher levels of NA on days when the AD person appeared less rested, had poorer sleep quality, or had left the bed during the nighttime. In contrast, we did not find any significant associations between AD person sleep variables and caregiver positive mood. The significant relationship between AD person sleep quality and caregiver NA was partially mediated by the caregiver feeling rested in the morning and their sleep quality. Thus, the hypothesis that daily variations in caregiver sleep impairment would mediate the link between AD person sleep and caregiver NA, was supported.

Our results suggest that it was the more global estimates of caregiver sleep that partially mediated the impact of AD person sleep on caregiver daily affect as compared to the more specific variables (e.g., being awakened by the person with AD, amount of time awake after initially falling asleep). It is unclear why these global estimates turned out to predict caregiver NA whereas more specific indicators of poor/disturbed sleep (such as WASO) did not have a significant impact. However, it is possible that the global estimates simply capture any impact that the more specific variables may have had on caregiver NA. These findings suggest that it is important to target the caregivers global perceptions of their and their care-recipients' sleep as a potential means to alleviate their mood. Past research support this idea as it has been found that global ratings of sleep (i.e., sleep quality and feeling rested) are associated with higher ratings of depressive symptoms (Sarsour et al., 2010). Therefore, our results provide further evidence that these variables are important for emotional functioning.

Interestingly, the link between AD patient leaving bed and caregiver NA was not mediated by caregiver sleep or AD person NA. The reason for this is not clear, but one interpretation is that the link between the two is either direct or indirect via some, yet

unknown, mediator. One possible explanation may be that the AD person leaving bed is an irritant that is directly reflected in the NA of the caregiver without any mediation by caregiver sleep or AD person mood. The NA variable includes items such as being upset, irritated, etc, and it might well be the case that no mediation occurred because AD person leaving the bed represented a strong direct effect to the NA variable in the caregiver.

We did not find any significant associations between either poor sleep in the person with AD, disrupted/poor sleep in the caregiver and caregiver PA. The finding that caregiver sleep variables were not significantly associated with next day's PA is not consistent with previous findings (McCrae et al., 2008). McCrae and colleagues (2008) found that WASO on a given night was associated with lowered PA the next day in older adults. However, the McCrae study measured sleep and affect simultaneously in the morning. Thus, it is possible that the negative impact of poor sleep on PA was due to the two variables being measured shortly after awakening when the memory of the past night's sleep remained fresh. Thus, when compared to the results from the current study, it is possible that PA is more affected by immediate effects of poor sleep but that this effect does not persist throughout the day. In other words, it is possible that the reason for our findings is that caregiver PA is less vulnerable to poor sleep and that it is easier to rebound from a decrease in PA over the course of a day as opposed to NA. Future research could determine whether this explanation is accurate by measuring mood multiple times throughout the day.

In contrast to the frequently studied within-person link between disturbed/reduced sleep and mood, the present study examined whether the daily association of altered sleep in one individual altered mood in another. It was

hypothesized that such an effect, if demonstrated, might be indirect such that disturbed sleep in one person impaired the sleep in another, thereby impacting daily mood.

Therefore, the present study examined whether the sleep in persons with AD was associated with sleep in the caregiver. If there was evidence that sleep in persons with AD impacted sleep in their caregiver, caregiver sleep might mediate the association. That disturbed sleep in one person may cause disturbed sleep in another is well established in cross-sectional studies of parents with small children (e.g., Meltzer & Mindell, 2007), or in Alzheimer patient caregivers (Ownby et al., 2010; McCurry & Terri, 1995) of persons with AD sleep and caregiver mood.

The present study supported previous cross-sectional findings that poor sleep in one person is associated with poor sleep in another individual (Ownby et al., 2010; Meltzer & Mindell, 2007; McCurry & Terri, 1995), and demonstrated this association on a day-to-day basis in AD person-caregiver dyads. Our results suggest that caregiver perceptions of their care-recipient's sleep are important for their own sleep, probably because the former reflects a level of disturbance during the night that may have affected the caregiver's sleep. Such links between global ratings of sleep quality and more specific items of poor sleep (restless sleep or awakenings) are well established (Harvey et al 2008). In particular, we found that that day-to-day variability in caregiver WASO, sleep efficiency, sleep quality, and feelings of being rested were significantly decreased when the AD person appeared less rested, showed poorer sleep quality, and if the AD person had left the bed during the nighttime. Thus, the results from the current study demonstrated that, not surprisingly, being awakened by another person reduces sleep efficiency and increased the time spent awake after falling asleep. More interestingly, we

found that caregiver feelings of being rested and quality of sleep were associated with their perceptions of the AD person's sleep quality and how rested that person appeared. It is important to note that the current study is not able to determine whether these findings reflect a true impact of poor AD person sleep on caregiver sleep quality and feeling rested. It is possible that the association is reversed so that poor caregiver sleep quality and feelings of being rested influences how they rate their care-recipient's sleep. Nevertheless, the findings highlight the importance of improving sleep quality and feelings of being rested in both AD persons and caregivers as the association likely is bi-directional. Furthermore, improving feelings of being rested and sleep quality is important because they are indicators of whether sleep was restorative (Roth et al., 2010; Sarsour et al., 2010). Non-restorative sleep has been found to be as equally important to daytime functioning as symptoms of insomnia (such as trouble falling asleep or maintaining sleep) (Riemann, 2010). Additionally, non-restorative sleep is associated with poor emotional functioning, including depression in recent cross-sectional (Sarsour et al., 2010) and longitudinal studies (Roth et al., 2010).

As mentioned in the introduction, there are few studies that have examined *daily* co-variation of sleep problems in AD person-caregiver dyads, and it is therefore difficult to compare our findings to previous results. Furthermore, an understanding of co-variation of sleep problems in AD persons and their caregivers is complicated by differences in how sleep is measured across studies. Interestingly, one of the few studies that have examined co-variation of sleep between AD persons and their caregivers failed to find any significant associations (McCurry, Pike, Vitiello, Logsdon, & Terri, 2008). In fact, when studied on a day-to-day basis using objective sleep measures (e.g.,

actigraphy), McCurry and colleagues (2008) findings suggested that sleep problems were not necessarily correlated within an AD person-caregiver dyad (McCurry, Pike, Vitiello, Logsdon, & Terri, 2008). McCurry and colleagues (2008) examined the co-occurrence of sleep problems in AD persons and their caregivers across one week. Specifically, they examined bedtime, rise time, total time in bed, TST, number of awakenings, WASO, and sleep efficiency using actigraphy. Their results suggested that poor sleep in either the caregiver or the person with AD was not significantly linked to poor sleep in the other person.

It is difficult to determine the reason for the difference in our findings from the findings of the McCurry and colleagues' (2008) study, however, one possible explanation is the difference in how sleep was measured (objectively vs. subjectively). In fact, it has been demonstrated that subjective and objective sleep measures are not necessarily correlated within a person (McCrae et al., 2008). However, it remains to be demonstrated whether the same is true for correlations between the sleep of two individuals on objective and subjective measures. It could thus be useful to include both objective and subjective estimates of sleep in future studies to gain a more comprehensive understanding of how sleep in AD persons may influence their caregiver.

The present study also found a clear link between the caregiver's own sleep and their NA, which was a prerequisite for the mediating role of caregiver sleep between AD person sleep and caregiver NA. This within-subject link agrees with several previous studies that have examined sleep-mood associations on an intraindividual level (Talbot et al., 2010; Yoo et al., 2007). While the majority of studies that have examined poor sleep – mood relationships have focused on extended sleep deprivation (Talbot et al., 2010;

Yoo et al., 2007, VanDongen, et al., 2004; Harma et al., 1998), our findings suggest that even partial sleep loss (e.g., due to AD person leaving bed) or poor sleep quality and not being rested significantly impacts negative mood. This notion is supported by a study of daily variation of sleep and mood in older adults that found WASO and poor sleep quality to be significantly related to worse emotional outcomes (McCrae et al 2008).

AD Person Mood as Mediator

The current study had also proposed that the mood in the person with AD might mediate the association between his/her sleep and caregiver affect. We found that AD person NA partially mediated the association between their sleep and caregiver NA. Again, we had failed to find a significant association between AD person sleep and caregiver PA, and thus no mediation models were run with caregiver PA as outcome.

In addition to a direct effect of AD persons appearing rested and their sleep quality on caregiver NA, the results also found that AD person NA partially mediated these relationships. Specifically, the results showed that when caregivers perceived their care-recipient as less rested in the morning, they later in the day tended to report the AD person's daily NA higher than average, and consequently reporting their own NA higher. Similarly, when the caregivers perceived the AD persons sleep quality as poor, they also tended to report the AD person's NA higher later in the day. Thus, our results are consistent with past literature that poor sleep quality and not feeling rested is associated with worse mood the next day (Roth et al., 2010; McCrae et al, 2008), as well as studies that have suggested that mood in one person can influence the mood of another (Schoebi, 2008; Butner, Diamond, & Hicks, 2007).

In fact, previous research has demonstrated that negative mood in one person may result in negative mood in another person, such as a spouse (e.g., Schoebi, 2008; Butner, Diamond, & Hicks, 2007). It is important to note that the present study examined the caregiver's *perceptions* of the affect in the person with AD, and our findings are interpreted in the context of studies that incorporated self-rated mood. Schoebi (2008) examined the co-variation of self-rated mood in heterosexual married couples across seven days. The results from the Schoebi (2008) study suggest that there was a crossover effect in spousal relationships such that affect of one partner influenced the affect of the other. The Schoebi (2008) study found crossover effects between individuals' "hard" affect (i.e., angry - calm) and "soft" affect (i.e., sad/depressed – upbeat/content). This crossover effect was found for changes in husband's hard and soft affect as a result of their wife's affect, but not the other way around. In addition, Butner and colleagues (2007) examined whether romantic partners' positive and negative affect tended to vary in tandem on a day-to-day basis. Their results indicated that increases and decreases in PA and NA tended to be mirrored in romantic couples. In other words, fluctuations in PA and NA were significantly correlated between male and female romantic partners, even controlling for positive and negative interactions (Butner, Diamond, & Hicks, 2007).

In addition to studies examining positive and negative mood, there is evidence for the influence of one person's depressed mood on another person's depressed mood. There is a large body of research that has found that depressed mood is "contagious" (e.g., Benazon & Coyne, 2000; Joiner & Katz, 1999). In a meta-analytic review, Joiner and Katz (1999) found that the display of depressive symptoms in one person resulted in an increase in depressive symptoms in another person, such as a spouse, roommate, or

stranger. Similarly, Benazon and Coyne (2000) found that in couples where one partner was depressed, the spouse also tended to report increased levels of depressive symptoms. However, the results indicated that other factors, such as female gender and higher levels of burden might be more important predictors of the spouse's depressive symptoms rather than their depressed partner's mood per se.

While we did not find support for PA as a mediator between AD person sleep and caregiver mood, our results showed that the weekly mean of PA in the person with AD was significantly and positively correlated with caregiver PA. Previous research has shown that positive social and family relationships are associated with positive mood (Windsor & Anstey, 2010). In particular, the Windsor and Anstey (2010) study found that positive exchanges with family members were significantly associated with higher PA in middle-aged to older-age adults. As mentioned above, it also appears as though displays of PA in one person can influence the PA in another person within close relationships (Butner, Diamond, & Hicks, 2007). Thus, it is reasonable to think that caregivers who perceive their care-recipient's affect as positive during the day also tend to rate their own positive affect higher.

The Role of the Three Significant AD Person Sleep Predictors

In the discussion above the significant prediction of AD person sleep quality and being rested was discussed. These two showed different patterns, however. The former was partially mediated by caregiver sleep quality, feeling rested, as well as NA in the person with AD. AD person being rested was partially mediated by AD person NA and not by any of the caregiver sleep variables. It is not possible to judge if this difference is accidental or if it represents true different pathways. However, it might also be the case

that being rested is an indicator of restoration by sleep or of sufficient sleep. It therefore seems not unreasonable that being rested would be linked to affect, in line with the aforementioned discussions.

AD person leaving bed was not mediated by caregiver sleep or AD person NA and it is possible that another indirect link exists or that our findings reflect a true direct effect. As mentioned above, it is possible that the NA scale captured the nuisance of the AD person leaving the bed and thus no mediation exists because of a strong direct association. In contrast, it is also possible that the times when the AD person left the bed required the caregiver to assist the AD person in some way (e.g., help in the bathroom). In other words, it is possible that is not the AD person leaving the bed that is irritating per se, rather that the caregiver may have to help them out. We did not examine such variables and it could be useful to further examine the specific aspects of AD person nightly behavior on caregiver NA.

A final observation on AD person sleep quality and appearing rested is that it is unclear whether one variable is more important than the other in terms of their impact on caregiver NA. As of yet, there does not seem to be any established way to statistically determine which of the two predictors are most important. There is a need for future research to disentangle the different links between AD person sleep quality and appearing rested and caregiver NA. Nevertheless, our findings are consistent with previous studies that have suggested that both variables are important for emotional functioning (Roth et al., 2010; Sarsour et al., 2010)

Individual Characteristics

The current study also conducted a series of exploratory analyses to determine whether individual characteristics in the caregivers were influencing the association between AD persons sleep and caregiver mood. The results indicated that the average level of caregiver stress significantly predicted caregiver NA. These results are in line with previous findings that have demonstrated that daily stress leads to increased negative mood (Dowd, Zautra, & Hogan, 2010; Mroczek & Almeida, 2004; Bolger, DeLongis, Kessler, & Schilling, 1989). While past studies also have found stress to negatively impact PA (Dowd, Zautra, & Hogan, 2010), our results failed to demonstrate a significant association.

We also examined background and demographic variables for their potential influence on caregiver affect. However, we failed to find significant correlations between caregiver burden, depressive symptoms, and perceived stress and NA or PA. The lack of significant associations between these variables and affect is surprising in light of previous research that has found burden, distress, and depression to be related to emotional functioning in caregivers of persons with AD (e.g., Allegri et al., 2006; Schulz & Martire, 2004). The reason for this is not clear, but one possibility is that the caregiver group has rather high values on the negative sides of the scales. Thus, the variance is restricted, compared to a sample of the population as a whole. This restriction would make it more difficult to find significant correlations. It should also be emphasized that the focus of the present study was not habitual level of mood or sleep, it was the day-to-day variation of the two, and in two different persons.

Limitations

The present study has several limitations. Some limitations are related to the procedures in the current study. One such limitation was that the caregiver rated his/her own sleep and affect, as well as that of the AD person. This procedure involves the possible involvement of common method variance (Podsakoff, McKenzie, Podsakoff, & Lee, 2003). Typically, this mainly occurs in cross-sectional studies, with similar construction of questions, response alternatives or when the same rater judges both independent and dependent variables. Such influences should be reduced in studies with a longitudinal designs, however, since such influences are controlled for, that is, the questions and the rater are the same at all repetitions. The prospective design with sleep rated in the morning and affect in the evening should also reduce the risk of a mind-set of the rater affecting the results. Furthermore, it seems unlikely that attributing poor sleep to the AD person in the morning should affect the evening rating of caregivers affect and this constitutes the main result in the present study. There is, however, a certain risk that the evening rating of the affect of oneself and that of the AD person may involve some common variance. Still, considering the strong contagious effects of mood of one person on the mood of another person discussed above, emotional contagion seems a more logical conclusion of a demonstrated link rather than common method variance.

Another putative limitation related to the procedures of the current study is the use of subjective data instead of objective ones. However, sleep research has not been able to establish a clear link between objective and subjective sleep measures. In most studies there is a complete lack of correlation between the two types (Rosa & Bonnet, 2000) and the diagnosis of disturbed sleep, such as insomnia, is only based on subjective

information (AASM, 2005) and the recommendation from consensus groups is to use subjective data in clinical and hypnotics studies (Edinger et al 2005). Within the context of the present study it is doubtful if objective data would have been more conclusive than the subjective ones and the most similar previous study found no relation between affect and objective (actigraphy) data but did so for subjective data (McCrae et al 2008).

A further limitation is the exploratory nature of the current study and its associated use of many predictors. Thus, we ran the risk of increasing the probability of Type 1 error. The reason for the large number of variables / tests used in the current study was that previous studies examining day-to-day variability in sleep and mood have only examined a limited number of variables such as WASO and sleep quality (McCrae et al., 2008). The current study selected sleep variables based on findings both from cross-sectional studies as well as day-to-day studies in an attempt to deepen the understanding of the association between sleep and mood. While we could have attempted to reduce the number of variables through factor analysis and index construction, this approach may have obscured results. Furthermore, the significant predictors seem logical when links to caregiver mood and sleep are sought, that is, both more global measures of sleep (quality and being rested) and pronounced sleep interruption (AD person leaving bed) were identified.

Another potential confounder may be negative affectivity, that is, the disposition to experience adverse emotional states (Watson & Clarke, 1984) and thus give systematically negative responses to questions related to mood. This, however, constitutes an individual trait and should not play a role in a prospective daily relationship between two variables. Even if one could conceive of a daily variability in

negative affectivity, this should reasonably have affected the ratings of PA too. However, the results did not support this notion.

The self-selection of the sample is another potential limitation of the study. The current sample was a convenience sample, comprised of caregivers who had the opportunity and were willing to participate in an eight-day study. It is likely that those caregivers whose care-recipients experienced severe sleep disturbance or other behavioral problems were not volunteering to participate in the current study. Similarly, the majority of the caregivers were recruited through caregiver support groups, which may serve as an intervention in itself to alleviate poor emotional functioning in caregivers (Mittleman, Haley, Clay, & Roth, 2006). The implications of the selection of the sample are probably that the link between AD sleep disturbance and mood is underestimated.

Implications

Since impaired sleep in the caregiver is a key factor in the timing of the institutionalization of the AD person (Yaffe et al., 2002; Hope, Keene, Gedling, Fairburn, & Jacoby, 1998; Lawlor, 1994; Pollack & Perlick, 1991), improved caregiver sleep is important from a view of compassion with both the caregiver and the AD person. It is also an issue of cost to society and the afflicted persons. Currently, it is estimated that the annual cost to society of caring for individuals diagnosed with AD is over 180 billion dollars (Alzheimer's Association, 2011). Therefore, interventions to improve AD person sleep appear to be important since that would improve caregiver sleep. One means of intervention is light therapy, melatonin and increased physical activity, which may anchor the circadian rhythm and enhance sleep and cognition (Ying-Hui & Swaab, 2007). In severe cases hypnotic drugs may be used (Wilson and Nutt 2008).

The findings from the current study also suggest that treating caregiver sleep problems such as sleep quality and feelings of being rested will have beneficial implications for their emotional functioning. In fact, previous research has suggested that not being rested and having poor sleep quality are equally important sleep problems for daytime functioning as being unable to fall asleep and maintaining sleep, which are the major features of insomnia (Riemann, 2010). While the caregiver's role requires responding to the need of the patient, it may thus make disturbed sleep unavoidable. Therefore, targeting cognitions around sleep may serve useful, such as abbreviated cognitive behavioral therapy for sleep problems (Edinger & Sampson, 2003). Furthermore, it may also be fruitful to relieve the caregiver of responsibility a few times per week to permit undisturbed sleep and provide a chance to experience restorative sleep. It should be noted that there is not yet any established treatments for global indicators of poor sleep such as sleep quality and not feeling rested (Riemann et al., 2010), however, the results from the current study suggests that these will be important avenues to explore in future intervention studies.

Additionally, it could be beneficial to include psychoeducation around sleep and emotional functioning in caregiver support groups or other interventions targeting family members of AD persons. In fact, it has been shown that group-based interventions for caregivers of AD persons are associated with a prolonged time until institutionalization (Mittleman, Haley, Clay, & Roth, 2006). Similarly, interventions targeting behavior problems, such as aggressiveness and irritability in demented elderly has been shown to reduce caregiver stress and enhance problem-solving abilities (Logsdon, McCurry, & Teri, 2007).

Conclusion

The results extend the existing literature in important ways. First, we examined caregivers' perception of *both* AD persons sleep and affect, as predictors of caregiver daily mood. Previous research has generally examined these variables separately (e.g., McCurry et al., 1999; McCurry & Teri, 1995), and to our knowledge, there are no studies that have examined these two variables together in a caregiver – AD person dyad. Furthermore, we studied these variables on a day-to-day basis, thus extending previous research that has examined sleep-mood links in caregivers of AD persons retrospectively.

We found that global estimates of AD person sleep, including appearing rested and sleep quality, as well as whether they had left their bed during the night was associated with caregiver daily NA. Thus, our results provided evidence for a direct link between one person's poor sleep and another person's negative mood. While previous research has found that poor sleep in persons with AD is associated with global measures of caregiver emotional functioning such as burden and distress (Allegri et al., 2006; Shulz & Martire, 2004; McCurry et al., 1999), these studies have generally demonstrated these relationship using retrospective reports. To our knowledge this is the first study that has demonstrated a relationship between AD person sleep and caregiver affect on a daily basis. Thus, it is possible that the day-to-day effects of sleep in the person with AD on caregiver mood found in the present study, in part, underlie the more global outcomes of emotional functioning.

The results of the current study suggests that while poor sleep in the person with AD impacts caregiver NA, part of the mechanism through which sleep in the person with AD affects negative mood in the caregiver is through the disruption of the caregiver's

sleep and the AD person's own mood. This finding has important implications because it highlights the importance of improving sleep and improving negative moods in persons with AD. The current study suggests that poor sleep quality and non-restorative sleep in persons with AD may serve as an important target for intervention as it is associated with how the caregiver interprets their care-recipients, as well as their own mood.

Emotional functioning in the caregiver also is a behavior that is amenable to modification. The current study provides further understanding of variables that on a day-to-day basis partially influence caregiver mood. Thus, including an understanding of AD person affect in treatments targeting emotional functioning in caregivers of AD could prove to be beneficial for the caregiver. In addition, it may also have important implications for health care costs for society, as institutionalization is associated with tremendous costs for the health-care system. Thus, alleviating some of the burdens for family caregivers, including sleep problems and negative mood in the AD persons may aid in prolonging the time the person with AD can remain at home.

APPENDIX A

TABLES OF DESCRIPTIVE STATISTICS, BASELINE MEASURES, DAILY DIARY DATA, AND HLM MODELS

Table 1: Descriptive Statistics for Caregiver Demographic and Background Information

	<i>M</i>	<i>SD</i>	<i>%</i>
Age	66.35	11.83	
Females			82.50
Daily Caregiving (hrs)	18.95	7.97	
Share Bedroom			55.00
Spouse			52.50
Adult Child			48.50
CESD Total	16.00	10.67	
PSQI Total	6.98	4.26	
PSQI Sleep Efficiency	81.83	12.36	
PSC Total	10.05	11.90	
ZBI Total	35.85	15.81	

Note: CESD = Center for Epidemiological Studies Depression Scale; PSC = Physical Symptoms Checklist; PSQI = Pittsburgh Sleep Quality Index; Zarit Burden Interview.

Table 2: Descriptive Statistics for AD Person Demographic and Background Information

	<i>M</i>	<i>SD</i>	%
Age	81.58	7.80	
Females			65.00
CDR Total	1.76	.68	
Diagnosis (yrs)	4.96	2.89	
ADL Impairment	69.23	19.14	

Note: ADL = Activities of Daily Living Scale; CDR = Clinical Dementia Rating Scale

Table 3: Correlations between Background Measures for Caregivers and Persons with AD

	1	2	3	4	5	6	7
1. ADL Total	-						
2. CDR	.71**						
3. CESD Total	.13	.14					
4. Global PSQI	.02	.09	.60**				
5. PSC Total	-.00	.17	.65**	.37			
6. PSS Total	-.10	-.12	.72**	.61**	.59**		
7. ZBI Total	.13	.01	.65**	.50**	.36**	.57**	-

Note: ADL = Activities of Daily Living Scale; CDR = Clinical Dementia Rating Scale; CESD = Center for Epidemiological Studies Depression Scale; PSQI = Pittsburgh Sleep Quality Index; PSC = Physical Symptoms Checklist; PSS = Perceived Stress Scale; Zarit Burden Interview.

**p<.01

Table 4: Caregiver Mood and Sleep Variables Across Eight Days

	<i>M</i>	<i>SD</i>	<i>Msd</i>
Bedtime	23.26	1.07	.70
Time of Awakening	7.13	.98	.78
Sleep Latency	22.62	17.21	21.86
Sleep Efficiency	89.51	.08	.08
WASO	25.70	30.50	24.65
SPT	429.21	61.92	62.74
TST	405.05	70.51	69.19
Sleep Quality	3.64	.74	.92
Rested	3.34	.84	.93
Stress	.19	.13	.12
NA	14.88	3.89	3.84
PA	34.02	7.26	4.75

Note: Bedtime (hrs/min); Time of Awakening (hrs/min); Sleep Latency (min); Sleep Efficiency (%); WASO = Wake After Sleep Onset (min); SPT = Sleep Period Time (min); TST = Total sleep time (min); Sleep Quality = 1 = Very poor, 5 = Very good; Rested = 1 = Not at all, 5 = Very rested; NA = Negative affect; PA = Positive affect.

Table 5: AD Person Mood and Sleep Variables Across Eight Days

	<i>M</i>	<i>SD</i>	<i>Msd</i>
Bedtime	22.31	1.20	.59
Time of Awakening	7.82	1.12	.82
Sleep Latency	14.22	10.96	11.26
Awakenings	1.07	.89	.77
Leaving Bed	.80	.80	.54
SPT	547.38	87.53	63.04
Sleep Quality	3.96	.70	.70
Rested	3.67	.63	.82
NA	16.24	4.81	3.82
PA	25.17	5.49	4.6

Note: Bedtime (hrs/min); Time of Awakening (hrs/min); Sleep Latency (min); SPT = Sleep Period Time (min); Sleep Quality = 1 = Very poor, 5 = Very good; Rested = 1 = Not at all, 5 = Very rested; NA = Negative affect; PA = Positive affect

Table 6: Correlations between AD Persons and Caregiver Sleep and Mood Variables

Caregiver	AD Persons							
	Latency	Awakenings	Leaving Bed	Rested	Sleep Quality	SPT	PA	NA
Age	-.12	.20	.28	.10	.14	.40*	.05	.25
Stress	-.21	-.40*	.00	.27	.24	-.12	.04	.05
Latency	.14	.13	.06	-.06	-.02	.06	-.12	-.08
Awake AD	.29	.58**	.22	-.43**	-.52**	-.45	.14	.01
WASO	.14	.44**	-.02	.33*	-.32**	.16	-.06	-.01
Rested	-.40*	.02	.08	.54**	.27	.22	-.17	-.05
Sleep Quality	-.42**	-.24	-.12	.47**	.41**	.03	.05	-.07
SPT	-.30	.14	.22	.10	-.06	.37*	-.08	.06
TST	-.32	-.06	.21	.22	.07	.26	-.05	.05
Sleep Efficiency	-.21	-.40*	.00	.27	.24	-.09	.04	.05
PA	-.09	.04	.13	.23	.06	-.02	.41**	.17
NA	.26	.16	.25	-.43**	-.30	.13	.27	.40*

Note: Awake AD = Awakened by AD Person; WASO = Wake After Sleep Onset; SPT = Sleep Period Time; TST = Total Sleep Time; Sleep Quality = 1 = Very poor, 5 = Very good; Rested = 1 = Not at all, 5 = Very rested; NA = Negative affect; PA=Positive affect

*p<.05, **p<.01

Table 7: Correlations for Caregiver Daily Diary Variables

	1	2	3	4	5	6	7	8	9	10	11	12
1. Age	-											
2. Stress	-.01											
3. Latency	.11	.03										
4. Awake AD	.16	.26	-.06									
5. WASO	-.12	.19	.25	.62***								
6. Rested	.21	-.42**	-.15	-.35*	-.22							
7. Sleep Quality	.17	-.42	-.41	-.41*	-.51***	.69***						
8. SPT	.39*	-.24	-.14	-.22	-.08	.39*	.29					
9. TST	.38*	-.29	-.22	-.44	-.48***	.43**	.45**	.91***				
10. Efficiency	.07	-.18	-.64***	-.48**	-.88	.29	.61***	.26	.59***			
11. PA	-.08	-.05	-.31	-.01	-.11	.23	.28	-.23	-.16	.16		
12. NA	.19	.73***	-.08	.40	.19	-.34*	-.35*	-.10	-.17	-.14	.00	-

Note: Awake AD = Awakened by AD Person; WASO = Wake After Sleep Onset; Rested 1 = Not at all, 5 = Very rested; Sleep Quality 1 = Very poor, 5 = Very good; SPT = Sleep Period Time; TST = Total Sleep Time; Efficiency = Sleep Efficiency PA = Positive Affect; NA = Negative Affect

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 8: Correlations between Daily Diary Variables in AD Persons

	1	2	3	4	5	6	7	8
1. Latency	-							
2. Awakenings	.06							
3. Leaving Bed	.02	.73**						
4. Rested	-.37*	-.34*	.14					
5. Sleep Quality	-.41**	-.54**	-.36*	.70**				
6. SPT	-.16	.32*	.08	-.06	-.16			
7. PA	-.16	-.02	.19	-.01	.00	-.20		
8. NA	.05	.33*	.34*	-.34*	-.23	.36*	-.17	-

Note: Rested 1 = Not at all, 5 = Very rested; Sleep Quality 1 = Very poor, 5 = Very good; SPT = Sleep Period Time; PA = Positive Affect; NA = Negative Affect

* $p < .05$, ** $p < .01$

Table 9: Correlations between AD Person and Caregiver Diary and Background Variables

	CDR	ADL	PSC	ZBI	PSQI	CESD
<u>Caregiver</u>						
Age	-.17	-.20	-.04	.13	-.00	-.07
Stress	.03	.12	.20	.35*	.17	.28
Latency	-.08	.11	.02	-.04	.34*	-.10
Awake AD	.08	.35*	.00	-.15	-.18	.00
WASO	.41*	.37*	.19	.13	.15	.20
Rested	-.21	-.21	-.23	.20	-.28	-.29
Sleep Quality	-.14	-.18	-.10	-.18	-.25	-.09
SPT	-.26	-.23	.00	.20	-.07	.05
TST	-.44**	-.36**	-.10	.15	-.10	-.03
Sleep Efficiency	-.35*	-.27	.14	.01	-.24	-.09
PA	.16	.21	-.40**	-.26	-.16	-.22
NA	.02	.11	.20	.19	-.03	.18
<u>AD Person</u>						
Latency	.23	-.24	-.07	.10	.01	.00
Awakenings	.20	.31	-.11	-.03	-.05	.02
Leaving Bed	-.20	-.02	-.19	.11	.11	.07
Rested	-.19	-.41**	-.11	-.25	.01	-.26
Sleep Quality	-.25	-.45**	.11	-.06	.09	-.04
SPT	.15	.24	.12	.21	.08	.04
PA	-.21	-.19	-.05	-.16	.16	.23
NA	.31	.31	.21	-.29	-.03	.06

Note. ADL = Activities of Daily Living; PSC = Physical Symptoms Checklist; ZBI = Zarit Burden Interview; PSQI = Pittsburgh Sleep Quality Index; CESD = Center for Epidemiological Studies Depression Scale; Awake AD = Awakened by AD Person; WASO = Wake After Sleep Onset; Rested 1 = Not at all, 5 = Very rested; Sleep Quality 1 = Very poor, 5 = Very good; SPT = Sleep Period Time; TST = Total Sleep Time; PA = Positive Affect; NA = Negative Affect.

*p<.05, **p<.01

Table 10: Daily Association between AD Person Sleep and Caregiver NA (path “c”)

	β	SE	t	p
Latency				
Intercept	14.54***	.63	23.21	.00
Slope (γ_{10})	.00	.02	.02	.99
Awakenings				
Intercept	15.04***	.61	24.59	.00
Slope (γ_{10})	.47	.25	1.85	.06
Leaving Bed				
Intercept	15.04***	.60	25.09	.00
Slope (γ_{10})	.92**	.36	2.58	.01
Rested				
Intercept	15.04***	.59	25.68	.00
Slope (γ_{10})	-.92**	.29	-3.15	.00
Sleep Quality				
Intercept	15.04***	.60	25.05	.00
Slope (γ_{10})	-.72*	.33	-2.19	.03
SPT				
Intercept	15.04***	.62	24.23	.00
Slope (γ_{10})	-.00	.00	-.14	.89

Note: Rested 1 = Not at all, 5 = Very rested; Sleep Quality 1 = Very poor, 5 = Very good; SPT = Sleep Period Time
 * $p < .05$, ** $p < .01$, *** $p < .001$

Table 11: Daily Association between AD Person Sleep and Caregiver PA (path “c”)

	β	SE	t	p
Latency				
Intercept	33.86***	1.26	26.88	.00
Slope (γ_{10})	.03	.03	1.26	.21
Awakenings				
Intercept	33.88***	1.13	29.91	.00
Slope (γ_{10})	-.41	.30	-1.34	.18
Leaving Bed				
Intercept	33.88***	1.13	29.85	.00
Slope (γ_{10})	-.35	.44	-.79	.43
Rested				
Intercept	33.88***	1.21	30.29	.00
Slope (γ_{10})	.49	.35	1.41	.16
Sleep Quality				
Intercept	33.88***	1.13	30.07	.00
Slope (γ_{10})	-.32	.00	.81	.42
SPT				
Intercept	33.88***	1.13	30.02	.00
Slope (γ_{10})	-.00	.00	-.53	.59

Note: Rested 1 = Not at all, 5 = Very rested; Sleep Quality 1 = Very poor, 5 = Very good; SPT = Sleep Period Time

*** $p < .001$

Table 12: Daily Association between AD Person Appearing Rested and Caregiver Sleep (path “a”)

	β	SE	<i>t</i>	<i>p</i>
Latency				
Intercept	22.50***	2.80	8.05	.00
Slope (γ_{10})	-.48	1.98	-.24	.81
Awake AD				
Intercept	.71***	.11	6.47	.00
Slope (γ_{10})	-.22***	.06	-3.83	.00
WASO				
Intercept	25.80***	4.73	5.45	.00
Slope (γ_{10})	-.30	2.15	-.61	.55
Rested				
Intercept	3.35***	.12	28.12	.00
Slope (γ_{10})	.20***	.06	3.18	.00
Sleep Quality				
Intercept	3.64***	.11	33.39	.00
Slope (γ_{10})	.19**	.06	2.92	.01
SPT				
Intercept	435.38***	9.75	44.63	.00
Slope (γ_{10})	8.58	6.82	1.26	.21
TST				
Intercept	409.60***	11.06	37.04	.00
Slope (γ_{10})	11.22	7.25	1.55	.12
Sleep Efficiency				
Intercept	.89***	.01	68.17	.00
Slope (γ_{10})	.01	.01	.97	.33

Note: Awake AD = Awakened by AD Person; WASO = Wake After Sleep Onset; Rested 1 = Not at all, 5 = Very rested; Sleep Quality 1 = Very poor, 5 = Very good; SPT = Sleep Period Time; TST = Total Sleep Time
 *** $p < .001$

Table 13: Daily Association between AD Person Leaving Bed and Caregiver Sleep (path “a”)

	β	SE	<i>t</i>	<i>p</i>
Latency				
Intercept	22.50***	2.79	8.05	.00
Slope (γ_{10})	.33	2.25	.15	.88
Awake AD				
Intercept	.69***	.12	5.72	.00
Slope (γ_{10})	.48***	.07	7.40	.00
WASO				
Intercept	25.84***	4.90	5.28	.00
Slope (γ_{10})	7.64**	2.60	2.94	.01
Rested				
Intercept	3.35***	.13	24.92	.00
Slope (γ_{10})	.21***	.08	-2.69	.01
Sleep Quality				
Intercept	3.64***	.12	30.76	.00
Slope (γ_{10})	-.28***	.08	-3.72	.00
SPT				
Intercept	435.47***	9.68	45.00	.00
Slope (γ_{10})	10.51	7.66	1.37	.17
TST				
Intercept	409.68***	11.16	36.70	.00
Slope (γ_{10})	4.73	8.33	0.57	.57
Sleep Efficiency				
Intercept	.89***	.01	66.35	.00
Slope (γ_{10})	-.02*	.01	-1.94	.05

Note: Awake AD = Awakened by AD Person; WASO = Wake After Sleep Onset; Rested 1 = Not at all, 5 = Very rested; Sleep Quality 1 = Very poor, 5 = Very good; SPT = Sleep Period Time; TST = Total Sleep Time
 * $p < .05$, ** $p < .01$ *** $p < .001$

Table 14: Daily Association between AD Person Sleep Quality and Caregiver Sleep (path “a”)

	β	SE	<i>t</i>	<i>p</i>
Latency				
Intercept	22.50***	2.80	8.04	.00
Slope (γ_{10})	-.85	2.15	-.40	.69
Awake AD				
Intercept	.71***	.06	12.03	.00
Slope (γ_{10})	-.42***	.06	-7.18	.00
WASO				
Intercept	25.56***	2.41	10.59	.00
Slope (γ_{10})	-9.44***	2.38	-3.97	.00
Rested				
Intercept	3.36***	.13	26.52	.00
Slope (γ_{10})	.31***	.07	4.33	.00
Sleep Quality				
Intercept	3.66***	.11	33.62	.00
Slope (γ_{10})	.34***	.07	4.92	.00
SPT				
Intercept	435.85***	6.94	62.79	.00
Slope (γ_{10})	-3.27	6.84	-.48	.63
TST				
Intercept	410.28***	7.46	54.99	.00
Slope (γ_{10})	6.17	7.35	0.84	.40
Sleep Efficiency				
Intercept	.89***	.01	69.12	.00
Slope (γ_{10})	-.02**	.01	2.98	.01

Note: Awake AD = Awakened by AD Person; WASO = Wake After Sleep Onset; Rested 1 = Not at all, 5 = Very rested; Sleep Quality 1 = Very poor, 5 = Very good; SPT = Sleep Period Time; TST = Total Sleep Time
 * $p < .05$, ** $p < .01$ *** $p < .001$

Table 15: Association between Caregiver Sleep and Caregiver NA (path “b”)

	β	SE	t	p
Awake AD				
Intercept	15.04***	.60	25.21	.00
Slope (γ_{10})	.76**	.30	2.57	.01
WASO				
Intercept	14.91***	.61	24.43	.00
Slope (γ_{10})	.01	.01	1.62	.11
Rested				
Intercept	14.80***	.62	23.74	.00
Slope (γ_{10})	-.91***	.26	-3.45	.00
Sleep Quality				
Intercept	14.89***	.59	25.14	.00
Slope (γ_{10})	-.79**	.26	-3.10	.01
Sleep Efficiency				
Intercept	14.90***	.61	24.28	.00
Slope (γ_{10})	-3.75	2.39	-1.57	.12

Note: Awake AD = Awakened by AD Person; WASO = Wake After Sleep Onset; Rested 1 = Not at all, 5 = Very rested; Sleep Quality 1 = Very poor, 5 = Very good
 * $p < .05$, ** $p < .01$ *** $p < .001$

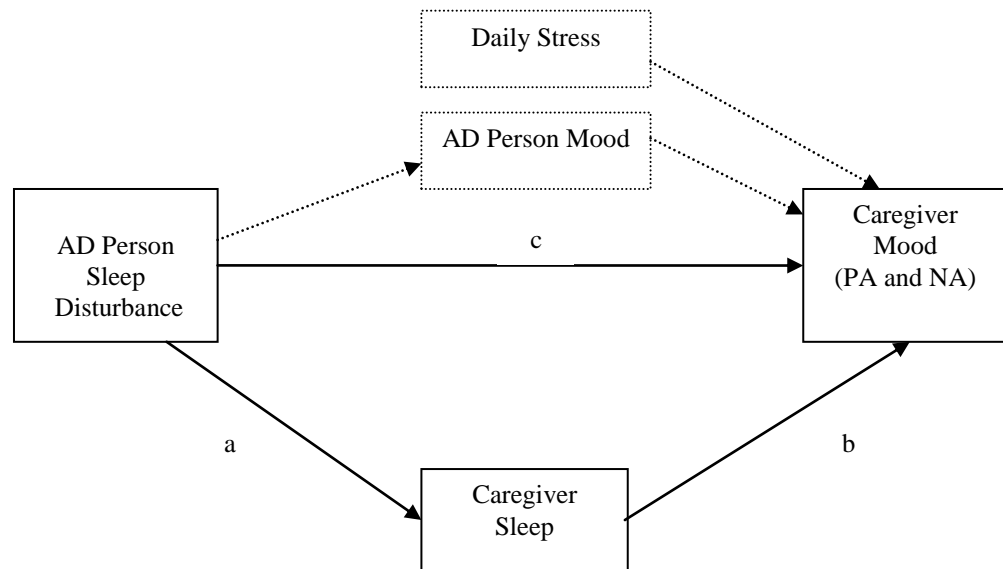
Table 16: Association between Sleep in AD Persons and AD Person NA and PA (path “b”)

	β	SE	t	p
NA				
Leaving Bed				
Intercept	16.30***	.73	22.48	.00
Slope (γ_{10})	.62	.37	1.68	.09
Rested				
Intercept	16.31***	.72	22.80	.00
Slope (γ_{10})	-1.27***	.29	-4.39	.00
Sleep Quality				
Intercept	16.31***	.73	22.37	.00
Slope (γ_{10})	-1.16***	.33	-3.51	.00
PA				
Leaving Bed				
Intercept	25.09***	.86	29.31	.00
Slope (γ_{10})	-.01	.42	-.03	.98
Rested				
Intercept	25.09***	.86	29.26	.00
Slope (γ_{10})	.52	.34	1.52	.13
Sleep Quality				
Intercept	25.09***	.86	29.32	.00
Slope (γ_{10})	.18	.39	.47	.64

Note: Sleep Quality 1 = Very poor, 5 = Very good; PA = Positive Affect; NA = Negative Affect
 * $p < .05$, ** $p < .01$, *** $p < .001$

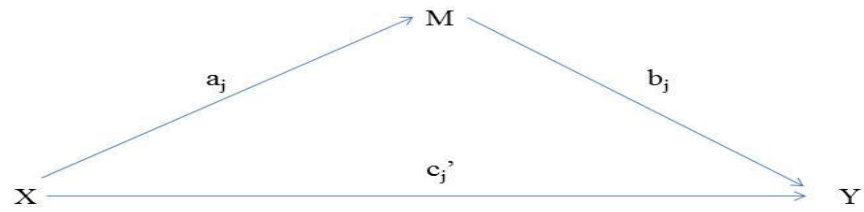
APPENDIX B

MEDIATION AND EXAMPLE MODEL FIGURES



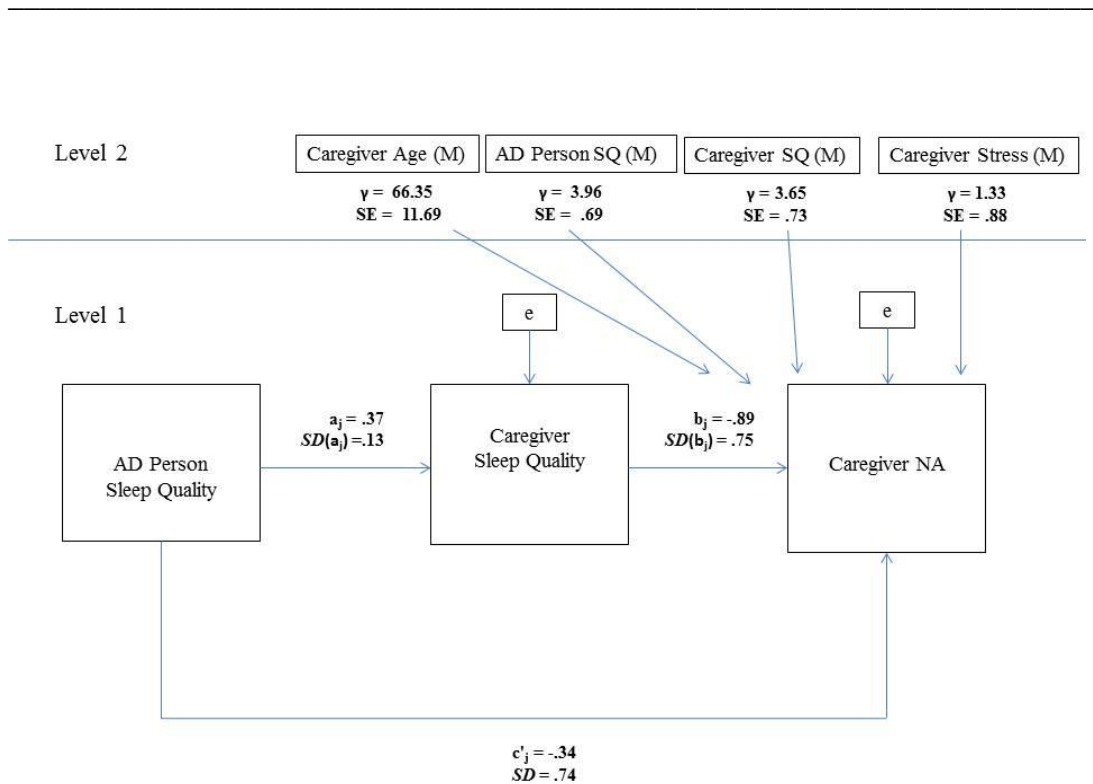
Note: Model testing the direct (c) and indirect (a-b) effects of AD patient sleep disturbance on caregiver positive and negative affect. Separate models will be run with AD person's mood as mediators. Caregiver daily stress will be examined as a separate predictor of caregiver PA and NA.

Figure 1: Mediation Model



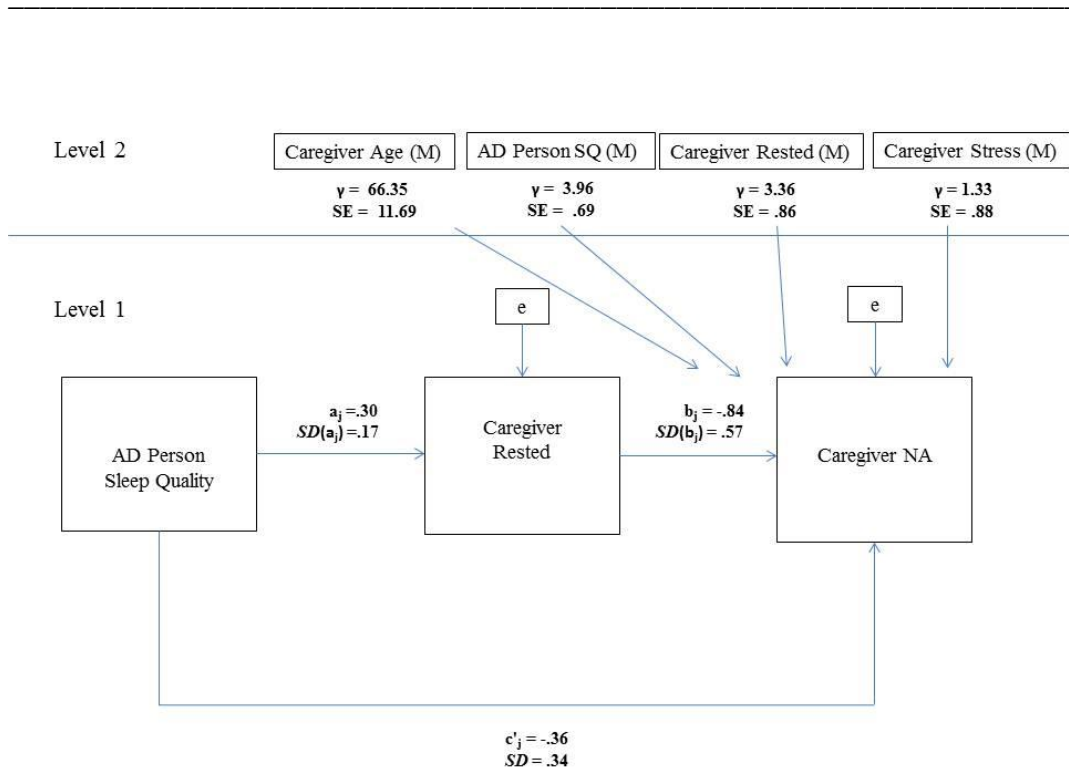
Note: The direct effect of X on Y is partially mediated by M (indirect effect). The subscript “ j ” refers to each unit (i.e., caregiver). Thus, for caregiver “ j ,” X causes M (path a_j), M causes Y (path b_j), and X causes Y (c_j'). Adapted from Kenny, Bolger, & Korchmaros, 2003.

Figure 2: Level 1 multilevel mediation model.



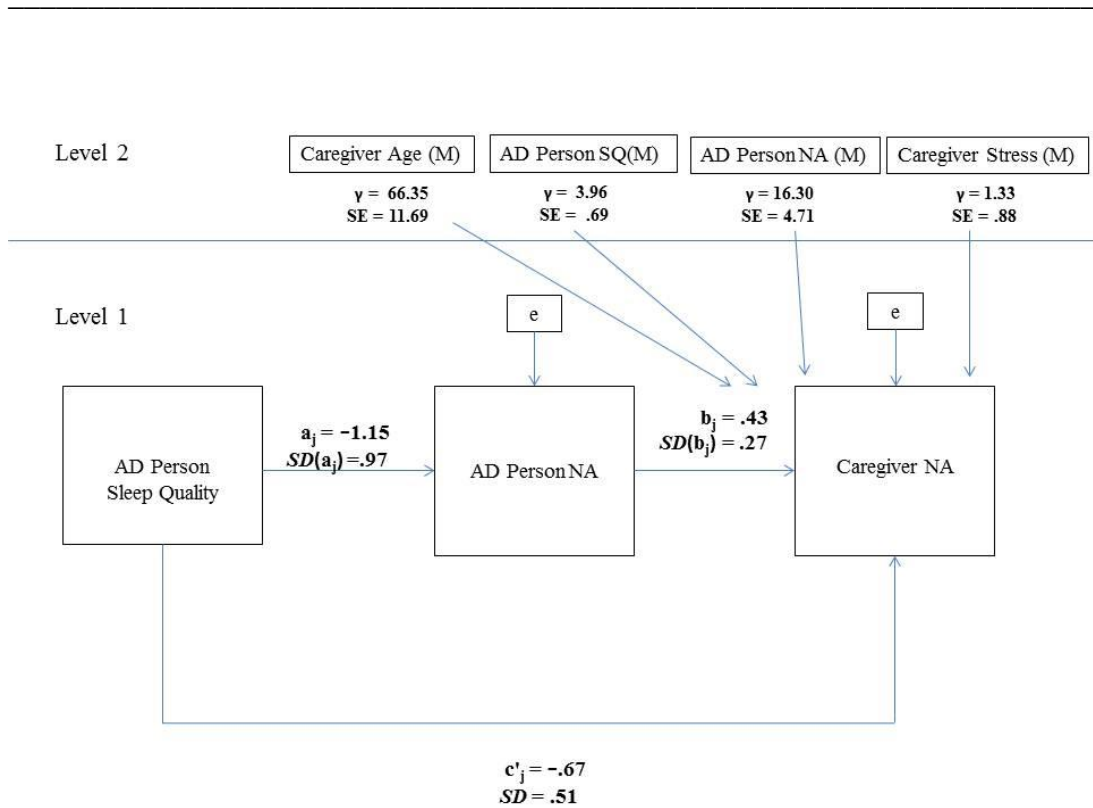
Note: The total effect that was mediated was $-.76$ ($SE = .36$, $p < .05$), which represents the sum of the indirect ($a \times b$), and the direct effect when the mediator is present (c'). The indirect effect was $-.42$ ($SE = .16$, $p < .01$), and mediated 55 percent of the total effect.

Figure 3: Indirect Effect of Caregiver Sleep Quality on the Association between AD Person Sleep Quality and Caregiver Daily NA.



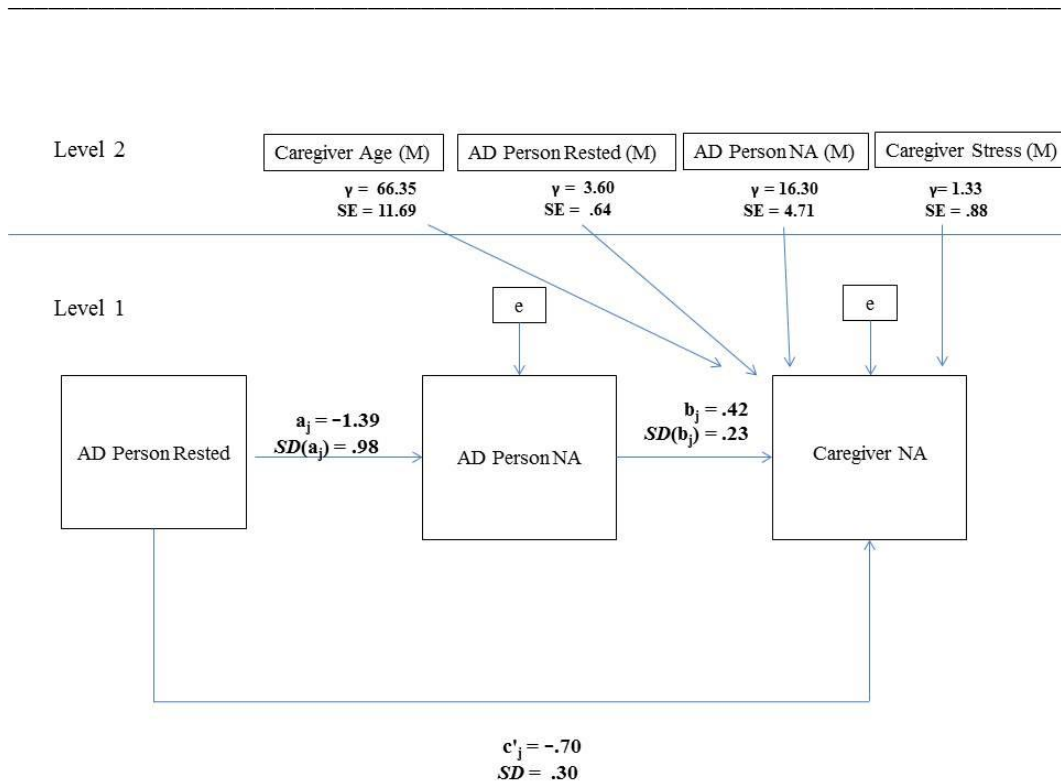
Note: The total effect that was mediated was $-.68$ ($SE = .37$, $p = .06$), which represents the sum of the indirect ($a \times b$), and the direct effect when the mediator is present (c'). The indirect effect was $-.32$ ($SE = .14$, $p < .05$), and mediated 47 percent of the total effect.

Figure 4: Indirect Effect of Caregiver Feeling Rested on the Association between AD Person Sleep Quality and Caregiver Daily NA.



Note: The total effect that was mediated was -1.19 (SE = .38, $p < .01$), which represents the sum of the indirect ($a \times b$), and the direct effect when the mediator is present (c'). The indirect effect was -.53 (SE = .21, $p < .01$), and mediated 44 percent of the total effect.

Figure 5: Indirect Effect of NA in the Person with AD on the Association between AD Person Sleep Quality and Caregiver Daily NA.



Note: The total effect that was mediated was -1.30 (SE = .35, $p < .01$), which represents the sum of the indirect ($a \times b$), and the direct effect when the mediator is present (c'). The indirect effect was -.61 (SE = 2.10, $p < .01$), and mediated 46 percent of the total effect.

Figure 6: Indirect Effect of NA in the Person with AD on the Association between AD Person Appearing Rested and Caregiver Daily NA.

APPENDIX C

DEFINITION OF ABBREVIATIONS

AD – Alzheimer’s Disease

ADL – Activities of Daily Living

CDR – Clinical Dementia Rating Scale

CESD – Center for Epidemiological Studies Depression Scale

NA – Negative Affect

PA – Positive Affect

PSC – Physical Symptoms Checklist

PSS – Perceived Stress Scale

PSQI – Pittsburgh Sleep Quality Index

SPT – Sleep Period Time

TST – Total Sleep Time

WASO – Wake After Sleep Onset

ZBI – Zarit Burden Interview

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