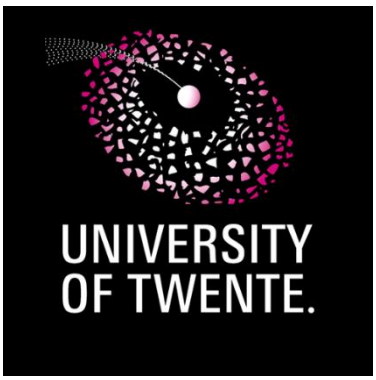

Summary of Masterthesis:

The Relationship between Burnout and Sleep: Four Longitudinal Case Studies

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Summary Masterthesis

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Introduction

Burnout is a growing problem in the Netherlands and the number of people with burnout continues to rise. In 2007 in the Netherlands, 11% of employees showed burnout symptoms. In 2011, the percentage was 13% and in 2014 the percentage increased to 14% (Centraal Bureau van Statistiek, 2014). In general, burnout is defined as a slow process of progressive loss of energy and loss of enthusiasm resulting from chronic stress (Leiter & Maslach, 2006; cited in Bakker, Demerouti & Sanz-Vergel, 2014).

Results of multiple studies show that people with burnout symptoms show impaired sleep (Harrison & Horne, 1999; Nilsson et al., 2005; Van Dongen, Maislin, Mullington, & Dinges, 2003; cited in Söderström et al., 2012; Ekstedt et al., 2006). This emphasizes the importance to do research about impaired sleep in individuals with burnout. In the present case study, sleep data of four individuals suffering from (pre)burnout collected via activity trackers for over seven months is analyzed. This is one of the first longitudinal studies with an extensive period of sleep- data tracking in individuals with burnout.

Activity trackers, sleep and burnout

Actigraphy is a method to monitor peoples' rest/activity cycles. Actigraphy involves the use of an activity tracker which is a portable device usually worn on the wrist that records movement over a period by means of accelerometry (Berry, 2003). The activity trackers are easy to wear, carry almost no burden for participants and are suitable for long term studies (Kosmadopoulos et al., 2014). Therefore, in this study activity trackers are used to measure sleep on the long-term.

Earlier research with activity trackers about sleep in relation to burnout has been conducted (Tzischinsky et al. 2001; Shea et al, 2014; and Tan et al., 2017). Tzischinsky et al.

(2001) researched sleep duration in relation to burnout in shift workers using actigraphy for over five nights. Results showed that sleep duration was not related to burnout symptoms. Results from another actigraphy study that lasted for four weeks, showed that a higher amount of sleep was predictive of a lower amount of (reported) burnout symptoms (Shea et al., 2014). Tan et al. (2017) used actigraphy in their study for over four weeks to measure sleep duration and time to fall asleep (amongst other things) in faculty members and residents and related it to burnout. Results were that faculty members showed higher burnout rates, less sleep and a shorter time to fall asleep compared to residents. Astill et al. (2013) looked at chronic stress in relation to sleep with actigraphy for over a week in adolescents. Results show that chronic stress in adolescents was positively related to nocturnal awakenings, lower sleep efficiency and subjective lower sleep quality.

Sleep dynamics in healthy people

A limitation of the above mentioned actigraphy studies is that they were quite short, with the study by Tan at al. (2017) of four weeks being the longest. Because burnout is a slow and progressive process, understanding more about the dynamics of sleep over time specifically for people with burnout can provide insights about the relation between the development of burnout and sleep. Therefore, this study has a longitudinal design.

To get an understanding of sleep dynamics in people with burnout on the long-term, it's important to understand how healthy peoples sleep develop over an extensive period to compare them to. In a study by Hoch et al. (1997) of 3 years, sleep duration, sleep quality sleep latency and sleep efficiency remain stable over time for a group of adults between 61 to 74 years old. Results of a study by Gaines et al. (2015) of 3 years show that total sleep time, wake time after sleep and sleep onset latency remain stable over three years.

The present study

In this study multiple sleep parameters will be tracked by actigraphy for seven months in four (pre)burnout individuals to see if any changes will happen. The research question we address has an exploratory nature and is as follows: how does sleep quality, nocturnal awakenings, sleep duration, time awake and light sleep change over time in participants during a (pre)burnout state? The approach is chosen because of the small sample size. Setting up null hypothesis testing and drawing conclusions based on data of only four participants does not seem sensible.

It is interesting to find out if clear patterns in sleep can be found with actigraphy for people with burnout. If we do find obvious patterns, it is promising for future studies to use actigraphy for investigating sleep in burnout patients for longitudinal studies. An advantage is that activity trackers are cheap and not intrusive for participants. Understanding how sleep changes in burnout patients over time is a valuable source of information, which can bring new insights about impaired sleep and can possibly generate hypothesis' for future research.

Methods

Participants

Data of the four participants with (pre)burnout and data of 3 healthy participants was used for the analysis. The participants were employees of a further undisclosed company (for anonymity reasons).

Measurements

Sleep

In this study, several parameters of sleep were measured with actigraphy for over seven months which were smart wristbands. The activity trackers that were used were the Jawbone UP move wristbands.

Light sleep, sleep quality, sleep duration, sleep state, time awake

The technology used to measure sleep was actigraphy: sleep was measured by tracking movements of participants while they were sleeping with the help of an accelerometer (Berry, 2003).

For Light sleep, the Jawbone UP wristband uses multi-sensor technology to analyze unique physical characteristics associated with this specific phase. After analyzing these characteristics, the phase of light sleep could be identified and classified accordingly. Light sleep was measured and expressed in number of hours per night.

Sleep quality was calculated afterwards over a night of sleep based on the different parameters of sleep during that specific night (light sleep, sleep duration, awake time, number of awakenings). Sleep quality was measured on a scale from 0 to 100, with 0 being very low quality and 100 the best quality of sleep possible. A side note must be made: the used wrist bands had a potential ceiling effect for sleep quality. This means that the wrist band possibly tends to record sleep quality more positive than it is, which results in frequent measures of 100 percent sleep quality. A possible reason why this ceiling effect exist in the first place, could be due to commercial purposes: if a participant sees 100 percent sleep quality as feedback, it gives a feeling of satisfaction and stimulates the person to continue using the activity tracker.

Being awake or asleep was expressed from the start time of being awake/asleep until the end time. To determine beginning and ending of being asleep or awake, participants had

to press a button when they went to sleep and when they woke up. The reason for choosing manual input is because this makes the recording likely more valid. False measures of sleep or awake state are avoided: sometimes a person sits very still and the activity tracker might interpret this as if the person is asleep while this is not the case. The duration of sleep per night was expressed in hours and minutes and measured when participants were asleep. Time awake was measured in hours and minutes when participant was awake.

Burnout

Burnout is not an official disorder that can be categorized in the DSM-IV (American Psychiatric Association, 2013). In the Netherlands, burnout can be diagnosed by a doctor or a psychologist. In this case, a doctor who worked for the company detected burnout and/or pre-burnout in the 4 individuals.

Procedure

Participants were asked to read and sign an informed consent. For the participants with (pre)burnout, double permission was asked and an extra informed consent was filled out. In the first place, the experiment in which participants participated, was not focused on burnout. Therefore, extra consent was necessary to get approval from the ethics committee of the faculty of BMS at the university of Twente. The approval was granted from the ethics committee. Sleep analytics and feedback were available on their mobile application as well as some notifications of irregular behavior (i.e.: a shorter or longer period of total sleep often popped up as a notification to alert of a change from the individual's norm). Sleep was presented in terms of each day and trends were represented with multiples days, weeks, or months. The Jawbone application suggested a nightly overall sleep period (including light

and deep sleep) of totally 8 hours. Some individuals followed this goal, and some adjusted it to a different time. They were asked to behave naturally and engage in their normal daily activities. Wearing the wristband was voluntary and the individuals could stop wearing the wristband at any time.

Data Analysis

For execution of the data analysis, the software package *Statistical Package of the Social Sciences* (SPSS) was used (Version 25, Nie, Bent & Hull 1970). The analysis was focused on the intra-individual nature of the research question.

Because this is an exploratory study, no specific hypothesis will be stated. For the data analysis, we calculated descriptive statistics of all the variables. Pearson correlations were calculated, to analyze the correlation between time in days and sleep quality, time in days and sleep duration, time in days and light sleep, time in days and awakenings and time in days and awake time in burnout participants. We did focus on particular relations in the entire dataset when there were some tentative directions in previous research. Söderström et al. (2012) state that 'too little sleep' is the main risk factor for development of burnout. Additionally, Shea et al. (2014) and Tan et al. (2017) found a negative relation between sleep duration and burnout Therefore, we expect sleep duration to go down over time in a (pre)burnout state. Astill et al. (2013) found that people with chronic stress report lower sleep quality and more nocturnal awakenings. Thus, we expect that sleep quality deteriorates over time in days for the four burnout cases in (pre)burnout state. Furthermore, we expect awakenings to happen more frequently over time in (pre)burnout state. Burnout is a slow and progressive process, so if we find any results, we expect sleep parameters to

deteriorate slowly. We have no expectations about the parameters of awake time and light sleep.

For frequency of awakenings, a method developed by Lane and Gast (2014) was used which was specifically developed for analyzing trends in single case studies. With this method we will calculate the direction of trends and stability of datapoints of the number of awakenings. This will be done by calculating the stability envelope which states that 80 percent of the data needs to fall within the stability envelope. For more details on this method, see Lane and Gast (2014).

Additionally, we analyzed the data of three other, non-burnout participants to compare the results of the burnout participants to. In case we find interesting results for the burnout cases, it is valuable to check if the results we found are present in non-burnout participants. If our results are unique to the burnout participants, this would provide ground for a large follow up study to test whether this difference holds at population level.

Results

Participants

Not all participants recorded their sleep every night for seven months, which led to missing data. For every participant, data was manually sorted in SPSS and missing values were noted. Values of 0 for sleep duration, sleep quality, light sleep were interpreted as missing values and indicated accordingly.

Participant 1

The variables time in days and sleep quality were significantly negatively correlated, r (74) = - 0.263, p = 0.02. When time in days got higher, sleep quality went down. The

variables time in days and the variable light sleep were significantly negatively correlated, $r(74) = -0.292$, $p = 0.01$. When time in days increased, light sleep went down. The variables time in days and sleep duration were significantly negatively correlated, $r(74) = -0.288$, $p = 0.01$. When time in days increased, sleep duration went down. No significant correlation between time awake and time in days was found.

Frequency of awakenings

The method of Lane and Gast (2014) was applied to analyze possible trends and stability of data for frequency of awakenings over time of the 4 burnout participants. The total number of awakenings for every two weeks was calculated for all participants. To make reliable calculations to find trends, at least 80 percent of data during each two-week-period needed to be available. In week 9 up until 14 more than 20 percent of data was missing so these weeks were excluded. Evaluation of level change show that there is an accelerating trend. The percentage of datapoints within the stability envelope is 75%. This is below the stability criterion of 80% which means that de data is unstable. Therefore, we conclude that no distinguishable stable trend was found for participant 1. For more details on this method, see Lane and Gast (2014).

Participant 2

The variables time in days and the variable sleep quality were significantly negatively correlated, $r(100) = -0.207$, $p = 0.04$. When time in days got higher, sleep quality deteriorated. No significant correlations between time in days and light sleep, time in days and sleep duration and time in days and time awake were found for participant 2.

Frequency of awakenings

The method of Lane and Gast was applied (2014) to calculate trends and stability. For week 13 until 16 more than 20 % of data was missing so these weeks were excluded from analyses. Figure 4 shows the frequency of awakenings for participant 2. Evaluation of level change show that there is a decelerating trend. The percentage of datapoints within the stability envelope is 66,66%. This is below the stability criterion of 80% which means that de data is not stable. Therefore, no distinguishable stable trend was found.

Participant 3

The variables time in days and sleep duration were significantly negatively correlated, r (234) = -0.192, $p < 0.01$. When time in days progressed, participant 3 slept less. The variables time in days and light sleep were significantly negatively correlated, r (234) = -0.140, $p = 0.03$. When time passed by, amount of light sleep went down. No significant correlation was found for time in days and sleep quality and time in days and time awake.

Frequency of awakenings

Only for this participant, data of different burnout states was available. Therefore, it was possible to conduct 3 different analysis. An analysis over the data in general, a within-condition and a between-condition analyses have been performed for participant 3 according to the method of Lane and Gast (2014). In this case, the conditions are different burnout states. The condition A is when participant was diagnosed with burnout and went on sick leave, condition B is when participant recovered from burnout and went back to work.

General analysis. Evaluation of level change indicated there was a decelerating trend. The percentage of datapoints within the stability envelope is 53,33%. This is below the stability criterion of 80% which means that de data is not stable. Therefore, no distinguishable stable trend was found for the data in its totality.

Within-condition analysis. Evaluation of level change within conditions indicated that awakenings were decelerating during burnout and non-burnout state. Results of the analysis show that data was stable during condition A, burnout state (100% data within stability envelope), and condition B, non-burnout state (87.5% data within stability envelope). A decelerating stable trend was observed in both conditions.

Between-condition analysis. With consideration of within condition analysis of trends, no real change in trends between conditions was found: both trends were decelerating. Furthermore, the level change measures did not show unanimous deterioration or improvement. The percentage of overlapping data was 75% and percentage of non-overlapping data was 25%. Therefore, no real level change in number of awakenings between conditions was found.

Participant 4

The variables time in days and light sleep were significantly negatively correlated, r (42) = -0.357, p = 0.02. Light sleep went down as time progressed. No correlation was found between time in days and sleep quality, time in days and sleep duration and time in days and time awake.

Frequency of awakenings

For 3 of the 5 two-week-periods, more than 20 % of data was missing. With only two periods available for analysis, trend and stability of data cannot be calculated.

Non-burnout participants

Three participants without burnout, participant 5, 6 and 12, were randomly selected to compare the burnout participants to. For participant 12, a significant correlation was found for time in days and time awake, r (104) = -0.242, p = 0.01. When time in days progressed, the time awake decreased. No other significant correlations were found for the three participants for time in days and sleep quality, time in days and sleep duration, time in days and light sleep and time in days and awake time.

Frequency of awakenings

Participant 5

For 4 of the 5 two-week-periods, more than 20 % of data was missing. With only one period available for analysis, trend and stability cannot be calculated.

Participant 6

The method of Lane and Gast (2014) was applied to calculate stability and trend. The results show that there is an accelerating trend. The percentage of datapoints within the stability envelope is 100%. This is above the stability criterion of 80% which means that de data is stable. Therefore, a distinguishable stable trend was found.

Participant 12

For week 3-4 until week 11-12, and for week 17-18 more than 20 % of the data was missing. With a gap of 5 two-week-periods, trend and stability cannot be calculated.

Discussion

In this study we looked at the relationship between sleep and burnout in four burnout cases for over seven months. We found that two of the four people with (pre)burnout showed a progressive decrease in sleep quality over time. Furthermore, we found that sleep duration went down for two of the four (pre)burnout cases over time. Light sleep went down for three (pre)burnout cases. The decrease in sleep quality, sleep duration and light sleep over time was not present for healthy participants. Additionally, a decelerating trend in awakenings during the burnout state (on sick leave) and during the non-burnout state (back to work) was found for participant 3.

The lower amount of sleep quality and sleep duration over time for the burnout cases was one of the tentative expectations of this study. It must be noted that the effect sizes of these findings were small, which means that there is only a small decline in sleep quality and sleep duration over time.

It is possible that light sleep is related to sleep duration. For two burnout cases, sleep duration and light sleep both went down. It seems logical that if sleep duration goes down, the amount of light sleep also goes down. When sleep duration goes down, the amount of sleep of all sleep phases gets shorter, so also amount of light sleep would go down (Maquet, 2004). Additionally, we are very cautious with interpreting the light sleep data of the participants, because research by Mantua et al. (2016) has shown that the validity of measuring sleep phases (like light sleep) with activity trackers is not good.

For participant 3 we found stable decelerating trends for number of awakenings during the burnout phase and the non-burnout phase. The most logical explanation is that the decline in awakenings is connected to the decline in sleep duration we found for participant 3. If this person sleeps less at night when time in days progresses, there is a smaller timeframe for the person to experience nocturnal awakenings. This smaller timeframe could lead to less awakenings at night.

No changes in sleep parameters are found for healthy participants, except for one participant, who showed a decrease in time awake and an upward trend for number of awakenings as time progressed. Overall, this suggests that the data is not very variable and supports the use of activity trackers for measuring sleep. This is in line with the sleep research about healthy participants of (Hoch et al., 1997; Gaines et al., 2015). Sleep parameters remain stable for months and even for years. The stability of sleep for the healthy participants support the idea that trends that we found in burn-out participants are unique to burnout.

A limitation of this study is the low number of participants with burnout. No strong conclusions can be drawn, only hypothesis can be generated for potential future research. Another limitation is the high amount of missing data points for almost all participants. The missing information can give a distorted image of the dynamics of the sleep parameters. Missing data also gives us less information and makes it harder to detect the true dynamics of different sleep parameters. For future research, it is advisable to use activity trackers that do not require the participant to press a button before going to sleep and after waking up. Activity trackers that automatically detect wake or sleep state make sure that all data will be recorded. However, validity can be questionable for automatic activity trackers (e.g. sleep state can be falsely detected if a person sits very still). On the other hand, technology is

rapidly developing which hopefully leads to improvement of validity of automatic activity trackers

This study can be considered as a pilot study where sleep was tracked in people with burnout for a long period. Fort two of the four burnout cases sleep quality and sleep duration went down slowly over time, whereas this was not the case for healthy people. Furthermore, decelerating trends were found in number of awakenings for one participant during sick leave and return to work. Because of the slow progressive nature of burnout, we did not expect a large deterioration of these sleep parameters. Thus, the small effect sizes and lack of results for a part of the burnout cases are not surprising. Therefore, we are uncertain if there truly is a progressive deterioration of sleep quality, sleep duration and awakenings in relation to burnout. To provide more certainty, it would be valuable to see if these findings hold at population level in a larger follow up study. This study showed that certain sleep parameters can be tracked for long-term studies with activity trackers. Use of activity trackers is beneficial because it's not very intrusive and relatively cheap compared to other methods. More knowledge of sleep in relation to burnout could be used by psychologists for psycho-educational purposes during therapy. This would give patients deeper insights about their own burnout symptoms in relation to their sleep. Additionally, activity trackers could possibly serve as a warning system. For example, if sleep quality drops down to a certain percentage, the person gets a warning that he or she is at risk of developing burnout. Even though this was a case study with a very small sample, we found some interesting results that provide ground for a large follow up study to see whether these findings hold at population level.

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