Sleep Quality and Emotional Memory in Hypertensive and Type 2 Diabetic Patients

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Abstract

Literature shows that sleep is important for the consolidation of memory and emotion regulation processing. Patients with diabetes and hypertension have known sleep problems, emotion processing difficulties and cognitive impairments. However, little research has been conducted to investigate the relationship between sleep, cognition and emotion in these patients. Understanding this interaction could have an important impact on treatment strategies for diabetic and hypertensive patients. This study investigated the relationship between sleep and emotional memory in 10 patients with diabetes and/or hypertension, and 10 matched healthy controls. We hypothesised that, compared to matched healthy controls, diabetic and hypertensive patients will (a) experience poor sleep quality, and (b) perform more poorly on tests of emotional memory. Participants completed the Pittsburgh Sleep Quality Index and Difficulties in Emotion Regulation Scale through an online form, and the International Affective Picture Scale test via video call. Results showed that the patient group experienced significantly poorer sleep quality and more emotional memory impairments compared to the control group. Across both groups, sleep quality had a negative correlation with recall for specific emotional categories. This study demonstrated that diabetic and hypertensive patients do have poor sleep and emotional memory recall, and that there is a relationship between sleep and emotional memory. These findings will assist future studies to research sleep objectively, and suggests that treatment strategies should focuses on improving sleep for this population.

Keywords: sleep, emotion, memory, International Affective Picture Scale, Pittsburgh Sleep Quality Index, Difficulties in Emotion Regulation Scale

Sleep Quality and Emotional Memory in Hypertensive and Type 2 Diabetic Patients

This study investigated the relationship between sleep and emotional memory in patients with hypertension and diabetes. We open by reviewing literature on sleep, emotion and cognition in diabetic and hypertensive patients. That literature review concludes by identifying a pertinent knowledge gap that underlies the study's rationale and hypotheses. Next, the methods of the study are described as well as the results. The discussion will explain these results and link them back to current literature. The discussion will also include limitations and recommendations for future research.

Diabetes Mellitus: Associations with Cognitive Dysfunction, Emotion Regulation and Sleep Disruption

Diabetes mellitus refers to a group of diseases characterized by ineffective use of circulating insulin (a hormone that regulates blood glucose levels) or by insufficient insulin production (Egan & Dinneen, 2018). These diseases affect an estimated 415 million people globally (5.3% of the population; Cho et al., 2018). Type 2 diabetes is most common, accounting for 95% of diabetes cases (Loke, 2021).

Type 2 diabetes is characterised by insulin resistance and hindered β-cell functioning (Egan & Dinneen, 2018). Inhibited β-cells are linked to reduced production of antibodies, thus making the individual vulnerable to disease (Egan & Dinneen, 2018). A frequent consequence of uncontrolled or non-medicated diabetes is hyperglycaemia (raised blood sugar), which can cause severe neurological damage.

Diabetes-associated cognitive decline is reported commonly (Kong et al., 2021). For instance, Cukierman-Yaffe et al. (2009) found that their sample of individuals with diabetes were 1.5 times more likely than their non-diabetic counterparts to display cognitive impairment (especially memory deficits). Similarly, Bobrow (2018) found a high prevalence (54%) of neurocognitive impairment (including memory deficits) in their sample of 499 individuals with diabetes.

Patients with diabetes also experience difficulties with emotion processing. Fisher et al. (2007) reported that diabetic patients were more likely than non-diabetic controls to internalise negative emotions. Similarly, Kane et al. (2018) found, in a sample of type 2 diabetes patients, positive associations between the number of physical symptoms and the number of negative emotions experienced.

Patients with diabetes often experience disrupted sleep (Khalil et al., 2020; Silke, 2018). Diabetes interrupts central control of respiration and thus causes sleep disturbances, often in the form of obstructive sleep apnea (OSA) or abnormal sleep duration (Resnick et al., 2003). Even when total sleep is maintained, reduced duration of slow-wave sleep (SWS) can lead to further decrease in insulin sensitivity, exacerbating the diabetic condition (Srinivasan et al., 2015). Separate lines of research suggest that sleep quality in type 2 diabetes is directly correlated with glucose tolerance and insulin sensitivity (Buxton et al., 2010; Ogilvie & Patel, 2018). Furthermore, diabetes patients are susceptible to diabetic eye disease, which induces a thinning of the outer retina (Dumpala et al., 2019). This disrupts circadian rhythms and melatonin secretion due to differences in light exposure (Dumpala et al., 2019). For these reasons, it is clear that sleep deficits are an important factor contributing to difficulties in functioning for diabetic patients.

Although much research has been conducted regarding sleep, memory, and emotion in diabetic patients, no research has examined how these variables might interact in patients.

Hypertension: Associations with Cognitive Dysfunction, Emotion Regulation and Sleep Disruption

Hypertension, which is diagnosed when systolic blood pressure is greater than 140 mmHg while diastolic blood pressure is greater than 90 mmHg, affects 1.28 billion adults globally (Shimizu, 2021). Age, obesity, smoking, a sedentary lifestyle, and unhealthy nutritional patterns are risk factors (Sarki et al., 2015). Consistently high blood pressure can cause major target-organ damage, and hence hypertension increases vulnerability to diseases involving the heart, kidneys, and brain (Gabb, 2020; Jennings, 2016).

As is the case with diabetes, a diagnosis of hypertension is often associated with cognitive impairment and with emotion processing difficulties (see, e.g., Van Etten et al., 2020; Zhuang et al., 2020). In a recent functional neuroimaging study, Feng et al. (2020) reported that hypertension-associated impairment in prospective memory functioning was related to reduced hippocampal connectivity. A systematic review by Wiener et al. (2020) reported that patients with hypertension exhibited dysfunction in prefrontal and parietal cortical regions, both of which are involved in inhibitory control. The same review reported that patients with hypertension tend to display more emotional reactivity than non-hypertensive individuals, especially toward negative emotional content.

As is also the case with diabetes, a diagnosis of hypertension often coexists with sleep disruption. One-third of patients with hypertension struggle with OSA (Floras, 2015). Whereas in healthy adults heart rates decrease during sleep cycles, in hypertensive patients heart rate remains high throughout sleep (Jennings, 2016). This is mainly due to OSA, which hinders the reduction of blood pressure, causing the individual to experience hypertension at night (Floras, 2015). OSA also triggers vascular nerve and muscle activity, causing high blood pressure to continue throughout the day.

Again as is the case in patients with diabetes, little research examines how sleep, cognition and emotional processing might interact in patients with hypertension. Given the importance of sleep in memory consolidation (Cukierman-Yaffe et al., 2009) and emotion processing (Fisher et al., 2007; Kane et al., 2018), research into this interaction may be important in understanding patients' lived experience.

Sleep and Emotional Memory

Broadly speaking, human sleep is divided into two main stages – non-rapid eye movement (NREM) and rapid eye movement (REM), which alternate in 90-minute cycles roughly four to six times during the course of the night (Irwin, 2015). Four distinct stages of NREM are differentiated from each other by the predominant brainwaves measured by EEG as sleeping time proceeds. Stage 1 lasts around 10 minutes; it is marked by the eyes closing and the body relaxing. Stage 2 is a light sleep that lasts up to 25 minutes. During this stage, body temperature drops in preparation for Stages 3 and 4, which are the deepest stages of sleep, commonly referred to as SWS (Carskadon & Dement, 2010; Irwin, 2015). REM sleep, which follows directly after SWS, is characterized by rapid eye movements, dreaming, faster and irregular breathing, and muscle immobilization (Peever & Fuller, 2016).

Although sleep is characterized by external inactivity, internally various processes occur that are important for healthy daytime functioning (Ogilvie & Patel, 2018). Among these is *memory consolidation*: the process whereby recently acquired information is changed, stabilized, and stored in long-term memory (Squire et al., 2015).

Under ordinary circumstances, sleep preferentially consolidates events featuring prominent emotional aspects rather than those without (i.e., the former is remembered more accurately; see, e.g., Groch et al., 2015; Morgenthaler et al., 2014; Walker & van der Helm, 2009). SWS and REM appear to play complementary roles in the consolidation of emotionally salient material (see, e.g., Hu et al., 2006; Walker & van der Helm, 2009). In partial illustration of this point, Nishida et al. (2009) demonstrated that participants in a nap condition (but not those in a waking condition) had preferential enhancement of memory for

negative pictures (e.g., crying children) shown before the nap. Such enhancement was not present for neutral pictures (e.g., a mop and bucket). Moreover, within the nap group there was a significant correlation between the amount of REM sleep achieved and the degree of emotional memory facilitation. Wagner et al. (2006) also found that emotional passages were best remembered following a period of REM, while Cairney et al. (2015) showed that engagement in a period of SWS predicted superior recognition memory for negative (but not neutral) images encoded 24 hours earlier.

Rationale, Aims and Hypotheses

Independent lines of research indicate that patients with diabetes and hypertension (a) have disrupted sleep and experience reduced sleep quality, (b) display impaired performance on standardized neuropsychological tests (especially those assessing memory function), and (c) show deficits in their emotional processing. There are indirect suggestions that these three clinical characteristics of the metabolic disorders may be related. We know, for instance, that sleep plays an important role in the consolidation of emotional memories. However, there are no studies investigating whether poor sleep quality in those patients is predictably and mechanistically associated with impaired emotional memory. This knowledge gap is worth exploring because interventions targeting disrupted and poor quality sleep in those patients have the potential to improve important aspects of their cognitive and affective functioning and, hence, of their overall well-being.

Therefore, the primary aim of this research project was to explore the relationship between diabetic/hypertensive patient status and sleep quality, and to investigate the effects that these patients' disrupted sleep has for their emotional memory processing. Based on extensive findings across disparate literatures, we hypothesised that, compared to matched healthy controls, diabetic and hypertensive patients would (a) experience poor sleep quality, and (b) perform more poorly on tests of emotional memory. We further hypothesised that sleep quality would function as a mediating factor between diabetes/hypertension and emotional memory performance.

Method

Design and Setting

The study was of cross-sectional design. It measured the relationship between sleep and emotional memory in two groups – a patient group (consisting of diabetic and hypertensive patients) and a healthy control group. Screening and self-report data collection took place via online survey. Emotional memory data collection took take place via video call.

Participants

Sample

G*Power software (Erdfelder et al., 1996) indicated that, to generate statistical power of (1 - β) = .80 when using a linear regression analysis and parameters of α = .05 and Cohen's f^2 = .15 (a medium effect size, based on previous studies; Sivertsen & Tubaro, 2021), a sample size of at least 68 participants (34 in each group) would be needed. However, this study only had 20 participants (10 in each group). Although 67 individuals filled out the required questionnaires, only 20 participants were eligible and willing to continue on to the video calls for the study. The sample consisted of 10 patients with type 2 diabetes and/or hypertension, and 10 healthy controls. Participants were matched for age (within 5 years), sex and, where possible, level of education (within 3 years). This matching was important because (a) there are age-related effects on sleep and cognitive functioning (Skeldon et al., 2016), (b) there are sex-related differences in sleep, where women report better sleep quality than men and men function better cognitively on fewer hours of sleep than women (Krishnan & Collop, 2006), and (c) education has significant effects on cognitive performance (Chen et al., 2019).

Recruitment

We used three avenues of recruitment, which together used convenience and snowball sampling.

First, we used the Department of Student Affairs (DSA) listserv to advertise the study to all UCT students. Our advertisement (see Appendix A; see Appendix B) asked if they were eligible or willing to participate, and if they could refer friends or family members who had been diagnosed with diabetes or hypertension. Each student who successfully completed the study, or who referred a participant had their name entered into a prize-giving draw (four x R300 Takealot vouchers).

Second, we transmitted a MedPages broadcast to Western Cape medical professionals requesting the voluntary participation of their hypertensive and diabetic patients (see Appendix C).

Third, we advertised the study on social media networks (see Appendix D; see Appendix E). Facebook groups dedicated to diabetic and hypertensive patients were used for advertisement, but no participants were recruited through these groups.

Fourth, we asked successfully recruited participants if any family members or friends were eligible for the study and willing to participate.

We advertised for controls in the same way that we advertised for diabetic and hypertensive participants – using adverts on the DSA mailing list and social media platforms, excluding the Facebook groups.

Inclusion Criteria

All participants were aged between 18 and 65 years and had a body mass index (BMI) < 40 kg/m^2. These criteria were selected because both age and obesity can affect sleep, memory, and physical health (Djalalinia et al., 2015; Kim et al., 2021; Pekar et al., 2020; Volkwein-Caplan & McConatha, 2018).

Diabetic patients included in the study had a haemoglobin HbA1c < 8 g/%. Values > 8 g/% indicated that their diabetes is uncontrolled (Siebert et al., 2010).

Hypertensive patients included in the study met the World Health Organisation's definition of hypertension, which stipulates that the medical condition is marked by blood pressure levels ≥ 130/80 mmHg (Shimizu, 2021).

Exclusion Criteria

To minimise confounding variables, individuals were excluded from study participation if they reported that they were pregnant, had target organ damage, used medication or other substances that might disrupt sleep patterns (e.g., alcohol, cocaine; Brutcher & Nadar, 2013), have a neurological disorder (e.g., epilepsy), or had experienced a serious head injury (i.e., one that caused unconsciousness or required hospitalisation). Those who reported experiencing chronic physical illnesses (except, in the patient group, diabetes or hypertension) or psychiatric diagnoses that require medication were also excluded. Finally, because high levels of depression, anxiety, and stress disrupt sleep patterns and have negative effects on cognitive performance (Christensen & Baune, 2019; Eraydin et al., 2019), individuals displaying significant symptoms of these forms of psychological distress were excluded from participation and were given information about referral services (see Appendix F).

Materials and Measures

Sociodemographic Questionnaire

This study-specific self-report questionnaire (see Appendix G) acquired information about sociodemographic details (e.g., age, sex/gender, income, and education level) as well as general medical history (e.g., psychiatric or medical conditions that may lead to exclusion). Additionally, patients were asked about their time since diagnosis, medication regimen, and other relevant diabetes- or hypertension-related information.

Pittsburgh Sleep Quality Index (PSQI)

This 19-question self-report measure (Buysse et al., 1988; see Appendix H) assessed quality of sleep over the month prior to reporting. Items enquire about sleep duration, sleep latency, and prevalence/severity of sleep difficulties. The 19 questions are categorised into seven subgroups, with each subgroup given a weighted score of 0–3. Hence, the PSQI total score is a global sleep quality index that can range from 0–21, with higher scores indicating poorer sleep quality.

The PSQI has been used successfully in previous studies of diabetes and hypertension. For instance, high PSQI scores are found in patients with prevalent hypertension (Carolina et al., 2008; Fiorentini et al., 2007; Zhang et al., 2019). Luyster & Dunbar-Jacob (2011) report that high PSQI scores were correlated with low scores on the diabetes quality of life index. The developers of the PSQI report good internal consistency (Cronbach's $\alpha = .83$; Buysse et al., 1988). Independent evaluations indicate good test-retest reliability ($r = .85$; Shahid et al., 2012). Validity is demonstrated by the fact that the instrument can clearly distinguish healthy controls from insomnia patients, and that its scores correlate well with objective polysomnographic data (Buysse et al., 1988; Carpenter & Andrykowski, 1998; Fiorentini et al., 2007).

Difficulties in Emotion Regulation Scale (DERS-18)

This 18-item self-report questionnaire (Victor & Klonsky, 2016; see Appendix I) is a brief form of the original, 36-item DERS developed by Gratz and Roemer (2004). It measures difficulties adults might have in self-regulation of their emotional states. The instrument's six subscales (Nonacceptance, Goals, Impulse, Awareness, Strategies, and Clarity) reflect four dimensions of emotion regulation: awareness and understanding of emotions; acceptance of emotions; ability to engage in goal-directed behaviour while refraining from impulsive behaviour, especially when experiencing negative emotions; and access to emotion regulation strategies that are perceived to be effective. Each item is rated on a 5-point Likert-type scale (score range 1–5). Higher scores (on each subscale, as well as the aggregate score across subscales) indicate greater difficulty with emotion regulation (Victor & Klonsky; 2016).

In Ginton et al. (2022), the DERS was used as a measure of emotion regulation in a sample of 87 South Africans made up of 34 PTSD and 53 non-PTSD participants. The scale accurately measured emotion regulation difficulties cross-culturally.

The developers report that, overall, the DERS-18 has high internal consistency (Cronbach's $\alpha = .91$; item-total correlations ranging from $r = .77–.90$) and that, similarly, each

of its subscales have at least adequate internal consistency (Cronbach's $\alpha \geq .80$ for each; Victor & Klonsky, 2016). This brief scale is as reliable and valid as the original, 36-item DERS scale developed by Gratz and Roemer (2004; Victor & Klonksy, 2016).

International Affective Picture System (IAPS)

The IAPS (Lang et al., 1997) is a set of images, widely used in experimental psychology research, designed to evoke an emotional response in viewers. Some IAPS images have a negative valence (e.g., scenes of physical violence with bruised bodies); others have a positive valence (e.g., pictures of newborn babies); and others have a neutral valence (e.g., pictures of plants and chess pieces; see Appendix J). The current study will use a set of IAPS images to measure emotional memory. Drace et al. (2013) report that the IAPS has very good internal consistency (Cronbach's $\alpha = .72$ for valence ratings, .96 for arousal ratings, and .96 for dominance ratings).

Procedure

Online Form

The study advertisement included links to Google Forms (patient group: https://forms.gle/xB1WKajh2fF3hWRg7; control group: https://forms.gle/7GQu6X4A7E45S4vk6). The first section of the form provided basic information about the study and a consent form. The consent form informed participants of their confidentiality, volition and beneficence while taking part in the study (see Appendix K; see Appendix L). Potential participants needed to indicate, by clicking a "yes" button, that they consent to participate in the study before proceeding to subsequent pages. Next, participants moved to the next section of the form, where they provided their contact details and sociodemographic information. If they were referred by a student, this section also required the name and student number of that student for the purpose of the prize-draw. Subsequent sections included these questionnaires: Beck Depression Inventory -II (BDI-II; see Appendix M), Beck Anxiety Inventory (BAI; see Appendix N), Perceived Stress Scale (PSS-10; see Appendix O), DERS-18, and PSQI.

After they have completed the online form, we will contact them by telephone or email to schedule the next two stages of the procedure: two video calls, during which the IAPS tasks will be administered.

Video Call 1: IAPS Encoding

We scheduled the call to take place within 2 hours of the participant's usual sleep time, and at a time when it is unlikely that they will encounter significant events before bedtime.

During this video call, the participant was shown a slideshow with a total of 60 IAPS pictures: 20 positive, 20 negative, and 20 neutral. The order of the pictures was randomised so that negative, neutral and positive pictures are evenly dispersed, but each participant will view the pictures in the same order. Each picture was presented for 6 seconds, and then the participant was asked to rate its valence and arousal using the Self-Assessment Manikin (SAM) scale (Lang et al., 1997). The calls were recorded so that responses could be transcribed on a spreadsheet at a later point.

Video Call 2: IAPS Recognition

On the morning after Video Call 1, a researcher video called the participant again. This call took place within two hours of their normal waking time. On this video call, the participant was shown another set of 60 IAPS pictures (10 from each of the three valence categories presented during the previous call and 30 'new' pictures). The order of presentation was randomized in similar fashion as before. After each picture is displayed, the participant answered "yes" or "no" to indicate whether they recalled viewing the picture before, and rated the valence and arousal of the image in the same way as before. Again, the call was recorded for transcription at a later point. Researchers debriefed with the participants at the end of this video call and each participant received a debriefing email (see Appendix P).

Ethical Approval

The study is part of a larger research programme that has obtained ethical approval from the Faculty of Health Sciences Human Research Ethics Committee (see Appendix Q). This particular study has received ethical approval from the Department of Psychology (see Appendix R)

Data Management and Statistical Analysis

We scored the BDI-II, BAI, and PSS-10 as per their standardised scoring guidelines. These scores were attained through the sum of the number associated with each response. These scores were only used to assess the eligibility of participants and so further analysis was not continued with these measures. However, the DERS and the PSQI scores were used in data analysis. Standardised scoring for the DERS required certain responses to be reverse scored, and certain responses were summed to create scores for each subscale. The total

DERS score was equal to the sum of each subscale. Scoring of the PSQI required a similar procedure to the DERS.

To create the emotional memory outcome variable, participants were given a score of 1 or 0 for each correctly remembered picture. In the second video call, 30 pictures were presented that had been shown in the previous call (repeated pictures), and 30 new pictures were presented that had not been shown to the participant before. If participants stated that they had seen a repeated picture before, they were given a score of 1. If they stated that they had not seen the repeated picture before, they were given a score of 0. For the 30 new pictures, participants were given a score of 1 if they stated that they had not seen that new picture before, and they were given a score of 0 if they stated that they had seen that new picture before. These scores were then broken down into six sections – repeated, positive pictures, repeated negative pictures, repeated neutral pictures, new positive pictures, new negative pictures and new neutral pictures, so that patterns in emotional memory could be observed. For example, these categories allowed for observations of whether participants had more difficulty remembering neutral pictures than emotionally valanced (ie., negative and positive) pictures.

Record was made of valence and arousal ratings for each picture. Responses were then grouped so that a mean valence and arousal rating could be calculated for positive pictures, negative pictures and neutral pictures for each participant's first call. For the responses from the second call, valence and arousal were also grouped into the six categories used for recall – positive, negative and neutral for both repeated and new pictures. Means were calculated for each participant for each category, so that valence and arousal responses could be compared.

We then began our statistical analyses using SPSS, with the threshold for statistical significance (α) set at .05 unless otherwise noted. First, we generated a set of descriptive statistics for the participant's sociodemographic data, questionnaire scores and IAPS outcome variable. Second, independent sample t-tests (or chi-square tests for categorical variables), assessed between-group differences in sociodemographic variables, PSQI, and DERS scores, and the IAPS outcome variables. Third correlational analyses were conducted to investigate the relationship between IAPS outcome variables and PSQI and DERS scores within each group. Within the patient group only, correlations assessed the relationship between clinical variables (length of illness and duration of treatment) and IAPS outcome variables and PSQI and DERS scores. Finally, a mediation analyses was attempted, but could not be completed due to group status having a lack of predictive power.

Results

Sample Characteristics

Table 1 describes the socio-demographic characteristics of the sample. Within each group, 60% were female and 40% male. On average, both patients and controls were 47 years of age (p = 0.480). There was no significant difference between the groups in terms of BMI (p = .260), sex (p = 1.00), education (p = .177), income (p = .502) and marital status (p = ?), indicating that the groups were adequately matched. In line with eligibility criteria, all participants scored <29 on the BDI-II, <36 on the BAI, and <26 on the PSS-10.

Table 1

Between-Group Differences in Sociodemographic Variables

Variable	Control	Patients	t/χ^2	*p*	d/V
Age	46.60 (17.35)	47.10 (17.56)	-0.06	.950	0.03
BMI	26.86 (4.78)	28.45 (6.04)	-0.65	.522	0.29
Sex			0.00	1.00	.00
Male	4 (40%)	4 (40%)			
Female	6 (60%)	6 (60%)			
Education			1.98	.160	0.31
Secondary	2 (20%)	5 (50%)			
Tertiary	8 (80%)	5 (50%)			
Income			4.33	.502	0.47
R0-R999	1 (10%)	2 (20%)			
R10 000- R20 000	0 (0%)	2 (20%)			
R20 000- R40 000	3 (30%)	3 (30%)			
R40 000- R60 000	2 (20%)	2 (20%)			
R60 000- R100 000	1 (10%)	0 (0%)			
More than R100 000	3 (30%)	1 (10%)			
Marital Status			3.53	.171	0.42
Single	3 (30%)	2 (20%)			
Divorced	0 (0%)	3 (30%)			
Married	7 (70%)	5 (50%)			

Note: For the variables age, BMI, and education, means are presented with standard deviations in parentheses. For the variables sex and income, frequencies are presented with proportions in parentheses. d = Cohen's d, the effect size for an independent sample t-test. V = Cramer's V, the effect size for a chi-square test.

The patient group included participants with diabetes alone (n=1), hypertension alone (n=5) and both diabetes and hypertension (n=4). All participants were within the appropriate blood pressure and HbA1c levels for inclusion in the study.

Participants with diabetes had an average illness duration of 10.6 (*sd* = 4.35) years and had been undergoing treatment for diabetes for an average of 9.3 (*sd* = 5.99) years. Generally, treatment was being taken in the form of daily medication such as metformin (20% of the patient group takes this medication), gliclazide (10%) and vildagliptin (10%). One participant was being treated through doses of insulin. Two participants noted that they are also monitoring their food intake and engaging in physical activities to manage their diabetes.

Participants with hypertension indicated an average illness duration of 5.6 (*SD* = 6.10) years and an average treatment duration of 4.5 (*SD* = 6.05) years. However, this average duration excludes one participant with an illness duration of 36 years and treatment duration of 26 years. Including this participant, the average illness duration would be 8.9 (*SD* = 11.63) years and the average treatment duration would be 6.9 (*SD* = 9.12) years. Hypertensive participants reported only tablets as treatment for their illness. These tablets included aspirin (20%), calcium channel blockers (20%), angiotensin receptor blockers (40%) and diuretics (20%).

Between-Group Comparisons: PSQI and DERS Scores

In terms of PSQI responses, the patient group reported significantly poorer sleep quality (p = .003) and efficiency (p = .010), more sleep disturbances (p = .041) and poorer sleep overall (p = .010) on the PSQI (see Table 2). The control group indicated significantly poorer emotion regulation in relation to goals than the control group (p = .008), but the total DERS score shows that patient group demonstrated poorer emotion regulation skills overall in comparison to healthy controls (M = 35.90 vs. 30.60, respectively; p = .091). While the between group difference in total DERS scores was insignificant, it was trending towards significance.

Table 2

Between-Group Differences for PSQI and DERS

	Control		Patient		*t*	*p*	*d*
	Mean	SD	Mean	SD			
PSQI							
Quality	0.70	0.48	1.40	0.52	3.13	.003*	.50
Latency	0.70	0.82	1.10	0.99	0.98	.170	.91
Duration	0.70	0.82	1.40	1.17	1.54	.071	1.01
Efficiency	0.10	0.32	1.10	1.20	2.55	.010*	.88
Disturbance	1.00	0.00	1.30	0.48	1.96	.041*	.34
Use of medication	0.00	0.00	0.00	0.00	-	-	-
Daytime Dysfunction	1.00	0.67	0.70	0.82	0.90	.191	.75
Total Score	3.60	2.12	7.00	3.53	2.61	.010*	2.91
DERS							
Awareness	5.60	1.58	7.40	3.27	1.57	.071	2.57
Clarity	4.80	1.48	5.10	2.64	0.31	.379	2.14
Goals	7.50	3.24	4.40	1.35	2.79	.008*	2.48
Impulse	3.70	1.25	3.30	0.67	0.89	.193	1.01
Nonacceptance	4.90	1.37	5.30	2.45	0.45	.329	1.99
Strategies	4.10	1.37	3.40	0.70	1.44	.087	1.09
Total	30.60	8.04	35.90	8.99	1.39	.091	8.53

Between-Group Comparison: IAPS

In terms of valence, there was a significant between-group difference for valence ratings of negative pictures in the initial test, with the patient group generally responding to these pictures with a more pleasant rating (M = 2.92 vs 1.87 respectively, $p = .005$; see Table 3). Likewise, there was a significant between-group difference for valence ratings of negative pictures in the recall tests, with the patient group again responding to these pictures with more pleasant ratings (M = 3.33 vs 2.22, respectively, $p = .006$). There were no between-group differences for arousal ratings (all *p*s > 0.500).

In terms of recall, the patient group had significantly worse recall of repeated positive pictures (p = .033) and recall of new negative pictures (p=.041) compared to healthy controls.

Table 3

Between-Group Differences for Valence, Arousal and Recall of IAPS pictures

	Control		Patient		*t*	*p*	*d*
	Mean	SD	Mean	SD			
Initial Test							
Valence							
Positive	7.45	0.85	7.05	1.13	0.91	.188	1.00
Negative	1.87	0.44	2.92	.99	3.05	.005*	.77
Neutral	6.40	0.84	6.16	1.02	0.58	.283	.93
Arousal							
Positive	3.80	1.69	3.99	2.06	0.22	.413	1.89
Negative	6.80	1.39	6.24	1.87	0.75	.230	1.65
Neutral	3.33	1.22	3.70	1.56	0.60	.279	1.40
Recall Test							
Valence							
Repeated Positive	7.39	0.78	7.47	.90	0.21	.417	.84
Repeated Negative	2.22	0.44	3.33	1.10	2.96	.006*	.84
Repeated Neutral	6.43	0.88	7.01	1.25	1.20	.123	1.01
New Positive	7.03	0.65	7.09	.56	0.22	.414	.61
New Negative	2.02	0.76	2.75	1.27	1.56	.068	1.05
New Neutral	6.45	2.10	6.77	.76	0.45	.328	1.58
Arousal							
Repeated Positive	3.59	1.77	3.60	2.09	0.01	.495	1.94
Repeated Negative	6.37	1.36	5.71	1.92	0.89	.193	1.66
Repeated Neutral	3.10	1.35	3.32	1.34	0.37	.360	1.35
New Positive	3.81	1.29	3.62	1.76	0.28	.393	1.54
New Negative	6.78	1.01	5.94	2.12	1.13	.136	1.66
New Neutral	3.19	0.95	3.20	1.67	0.02	.94	1.36
Recall							
Repeated Positive	9.90	0.32	9.2	1.03	2.05	.033*	.76
Repeated Negative	9.40	0.84	9.60	.70	0.58	.286	.78
Repeated Neutral	9.80	0.42	9.90	.32	0.60	.278	.37
New Positive	9.60	0.70	9.60	.52	0.00	.500	.62
New Negative	10.00	0.00	9.70	.48	1.96	.041*	.34
New Neutral	10.00	0.00	9.70	.48	1.41	.097	.48
Total	58.70	1.25	57.70	1.95	1.37	.096	1.64

Control Group: Correlations Between Recall and PSQI/DERS Scores

In the control group, correlations between sleep and recall showed that control participants with poorer sleep efficiency performed significantly worse on recall of repeated, positive pictures (r = 1.00, p = .000; see Table 4). Similarly, participants with greater daytime

dysfunction performed significantly worse on recall of repeated, neutral pictures (r = .79, p = .006).

Control participants with worse emotion regulation with regards to awareness (r = .64, p = .049), clarity (r =.70, p = .025) and goals (r = .69, p = .027) performed significantly better on recall of repeated, negative pictures.

Table 4

Correlations Between IAPS Recall and PSQI/DERS Scores in the Control Group

	Recall Repeated Positive	Recall Repeated Negative	Recall Repeated Neutral	Recall New Positive	Recall New Negative	Recall New Neutral	Recall Total
PSQI							
Quality	-.22	-.22	-.33	-.07	.[b]	.[b]	-.35
Latency	.30	.19	.13	.35	.[b]	.[b]	.44
Duration	-.56	-.29	-.51	.15	.[b]	.[b]	-.42
Efficiency	-1.00[**]	.25	.17	.20	.[b]	.[b]	.08
Disturbance	.[b]	.[b]	.[b]	.[b]	.[b]	.[b]	.[b]
Use of Medication	.[b]	.[b]	.[b]	.[b]	.[b]	.[b]	.[b]
Daytime Dysfunction	.00	-.40	-.79[**]	.24	.[b]	.[b]	-.40
Total PSQI	.60	-.40	-.60	.11	.[b]	.[b]	-.26
DERS							
Awareness	-.09	.64[*]	-.13	-.26	.[d]	.[d]	.21
Clarity	-.05	.70[*]	.11	.24	.[d]	.[d]	.63
Goals	-.27	.69[*]	.16	-.05	.[d]	.[d]	.43
Impulse	.20	.13	-.34	-.41	.[d]	.[d]	-.21
Nonacceptance	-.28	.42	-.23	.07	.[d]	.[d]	.18
Strategies	-.23	.44	.04	.51	.[d]	.[d]	.54
Total	1.00	-.25	-.17	.01	.[d]	.[d]	.42

Note: Correlation coefficients are not available for new, negative pictures and new, neutral pictures, because all control participants attained a perfect recall score for these categories. Similarly, no data is available for Use of Medication, as no control participants used medication to assist their sleep.

Patient Group: Correlations Between Recall and PSQI/DERS Scores

In the patient group, correlation tests between PSQI scores and recall indicated a negative correlation between sleep disturbance and recall performance for repeated, positive pictures (r = -.80, p = .005) as well as for overall recall (r = -.72, p = .019; see Table 5). This shows that participants from the patient group with increased sleep disturbance will perform more poorly in recall for repeated, positive pictures and overall recall. PSQI scores for perceived sleep quality (r = .67, p = .035), sleep duration (r = .66, p = .038) and overall sleep (r = .67, p = .034) were directly correlated with recall for new, positive pictures. This

indicates that poor sleep quality, duration and overall sleep is an indicator of better recall of new, positive pictures.

With regards to DERS ratings, goals (r = -.75, p = .012) and nonacceptance (r = -.64, p = .048) subscale scores were correlated with the recall of repeated, negative pictures such that poor goals and nonacceptance scores indicate poor recall of repeated, negative pictures. Similarly, poor scores for the strategies subscale were correlated with poor recall of new, neutral pictures (r = -.66, p = .038).

Table 5

Correlations Between IAPS Recall and PSQI/DERS Scores in the Patient Group

	Recall Repeated Positive	Recall Repeated Negative	Recall Repeated Neutral	Recall New Positive	Recall New Negative	Recall New Neutral	Recall Total
PSQI							
Quality	.25	.49	-.41	.67*	.54	-.26	.46
Latency	-.13	-.10	.39	.52	.07	-.28	.02
Duration	.11	.62	-.18	.66*	.63	-.25	.50
Efficiency	-.02	.19	.32	.25	.06	-.37	.06
Disturbance	-.80**	-.59	.22	.09	-.05	-.38	-.72*
Use of Medication	.c	.c	.c	.c	.c	.c	.c
Daytime Dysfunction	.21	-.43	-.13	.47	.03	.02	.08
Total PSQI	-.03	.14	.10	.67*	.33	-.37	.18
DERS							
Awareness	-.16	-.36	.26	.24	-.20	.21	-.08
Clarity	-.25	-.58	.15	.36	-.06	.14	-.189
Goals	-.38	-.75*	.36	-.06	.20	.02	-.37
Impulse	-.57	-.19	.16	-.26	.31	.22	-.26
Nonacceptance	.02	-.64*	.04	.19	-.48	-.21	-.35
Strategies	-.28	-.09	.20	.49	.07	-.66*	-.23
Total	-.26	-.56	.27	.52	-.03	-.12	-.21

Patient Group: Correlation Between Length of Illness and Recall, PSQI and DERS Scores

With regards to the duration of diabetes (r = -.93, p = .024) and length of treatment (r = -.88, p = .046), an indirect correlation was found between both variables and recall of repeated, positive pictures (see Table 6). Duration of diabetes (r = -.93, p = .024) and length of treatment (r = -.88, p = .046) were also indirectly correlated with the recall of new, negative pictures. These results indicates that longer duration of diabetes and length of treatment are correlated with poorer recall of repeated, positive pictures and new, negative pictures.

Longer duration of hypertension (r = -.87, p = .002) and treatment for hypertension (r = -.79, p = .012) was correlated with poorer recall of repeated, neutral pictures.

In terms of the relationship between illness and sleep, duration of diabetes (r = .90, p = .035) and treatment (r = .9, p = .025) were significantly correlated with greater sleep latency. This shows that longer duration of diabetes and treatment of diabetes equates that an individual will take a longer time to fall asleep.

No significant correlations were found between duration of illness and treatment and DERS scores (all ps >.05)

Table 6

Correlations Between Duration of Illness/Length of Treatment and Recall, PSQI and DERS Scores

	Duration Diabetes	Length of Treatment Diabetes	Duration Hypertension	Length of Treatment Hypertension
Recall				
Repeated Positive	-.93*	-.88*	.34	.30
Repeated Negative	-.30	-.31	.17	.24
Repeated Neutral	.42	.59	-.87*	-.79*
New Positive	.11	.04	.08	.11
New Negative	-.93*	-.88*	-.08	-.11
New Neutral	-.51	-.50	.09	-.01
Total	-.70	-.66	.11	.08
PSQI				
Quality	-.40	-.44	.25	.27
Latency	.90*	.93*	-.51	-.40
Duration	-.33	-.32	-.11	-.07
Efficiency	-.08	.08	-.47	-.51
Disturbance	.63	.59	-.36	-.34
Use of Medication	.[d]	.[d]	.[d]	.[d]
Daytime Dysfunction	.10	.01	.05	-.03
Total PSQI	.17	.18	-.33	-.31
DERS				
Awareness	.77	.72	-.45	0.42
Clarity	.58	.51	-.41	0.40
Goals	-.04	.05	-.43	-.46
Impulse	-.07	.06	-.23	-.17
Nonacceptance	.69	.65	.37	.43
Strategies	.63	.59	-.35	-.32
Total	.60	.57	-.57	-.053

Note: Use of Medication has no correlation coefficients because no participants reported the use of medication for assistance in sleep. This table represents correlation coefficients (r-values). * indicates that that the r-value is significant ($p<.05$).

Mediation Analysis

This study's third hypothesis anticipated sleep to function as a mediator between group status and IAPS recall scores. However, the mediation analysis could not be conducted because group status was not a significant predictor for any recall outcome variables. This was likely impacted by the small sample size and lack of power to predict recall scores.

Discussion

We assessed whether emotional memory and sleep were impaired in patients with diabetes and hypertension compared to healthy controls. Further, we investigated whether poor sleep quality was related to impaired memory performance in these patients. Based on relevant literature, we hypothesised that, compared to matched healthy controls, diabetic and hypertensive patients would (a) experience poor sleep quality, and (b) perform more poorly on tests of emotional memory. We further hypothesized that sleep quality would function as a mediating factor between diabetes/hypertension and emotional memory performance. Partially confirming our hypotheses, patients performed significantly more poorly on recall of repeated positive pictures and new negative pictures. They also reported significantly poorer sleep quality and efficiency, more sleep disturbances, and poorer sleep overall. However, contrary to our main hypothesis, sleep did not mediate the relationship between group and emotional memory performance.

Sleep

In concurrence with research by Khalil et al. (2020) and Silke (2018), PSQI responses indicated that the patient group did experience worse sleep than the control group. The specific deficits reported were lower quality of sleep, increased number of sleep disturbances, and decreased sleep efficiency. Sleep quality in the PSQI refers to the participant's general, perceived quality of sleep. In the questionnaire, sleep disturbances have been specified as snoring or coughing, awakening during the night, needing to get out of bed to use the bathroom, difficulty with breathing, discomfort due to temperature, nightmares and pain. Respiratory disturbances, such as snoring or difficulty with breathing, are supported by previous findings that many diabetic and hypertensive patients suffer with OSA due to the impact of these diseases on the brain's control centre for respiration (Floras, 2015; Jennings, 2016; Resnick et al., 2003). Causes of disrupted sleep in diabetic patients also include dysregulation of melatonin and circadian rhythms due to deficits in the function and structure of their outer retina that are attributed to diabetic eye disease (Dumpala et al., 2019). Restless legs syndrome is also a major factor contributing to sleep disruption for diabetic and

hypertensive patients (Ahmed et al., 2018; Ferini-Strambi et al., 2014; Lopes et al., 2005). This links to participants' reported pain during the night. These disturbances reported by our patients group could contribute to the lower sleep efficiency and quality experienced by the patient group.

Recall of Emotional Pictures

Our second hypothesis was that diabetic and hypertensive patients would perform more poorly on emotional memory recall. This hypothesis was based on findings in literature indicating that individuals with diabetes and hypertension have poorer emotion regulation (Fisher et al., 2007; Kane et al., 2018; Van Etten et al., 2020; Wiener et al., 2020; Zhuang et al., 2020) and cognitive functioning (Bobrow, 2018; Cukierman-Yaffe et al., 2009; Kong et al., 2021) due to the their disease. While results showed that the control group reported significantly more difficulty in emotion regulation relating to goals, the patient group's mean DERS total score was higher, indicating that the patient group generally experienced more emotion regulation difficulties. This finding was further corroborated by valence ratings on the IAPS test. Specifically, the patient group rated negative pictures as significantly more pleasant than the control group, possibly indicating a numbness towards negative stimuli.

In terms of emotional memory, two categories of recall indicated significantly better performance in the control group compared to the patient group. These categories are the repeated, positive pictures and the new, negative images. This demonstrates that the patient group had more difficulty than the control group in remembering both positive and negative pictures, but that there was no significant difference in recall of neutral pictures. In a healthy sample, Hamann (2001) found that emotional material, such as positive and negative material, was less likely to be forgotten than neutral material. This is in line with the findings of our study, suggesting that emotion dysregulation in the patient group may impact their memory of emotional material.

Correlational analysis of the control group revealed a significant correlation between emotion regulation difficulties in relation to awareness, clarity and goals and the recall of negative pictures. The direction of these correlations indicate that in controls, poorer emotion regulation was related to *better* performance in recall. From these results, it appears that control participants are able to maintain strong cognitive functioning while experiencing emotion regulation difficulties. However, this is not the case in patients with diabetes and hypertension. In fact, patients who scored poorly in the goals and nonacceptance sections of the DERS showed significantly poorer performance in recall of negative pictures. Further, in the patient group, correlations show that poor emotion regulation for strategies was related to

worse recall of neutral pictures. Therefore, it appears that when individuals with diabetes and hypertension experience emotion regulation difficulties, those difficulties are related to poorer cognition, whereas no such relationship is found in healthy controls. A possible explanation is that in the patient group, emotion regulation difficulties are compounded by poor sleep quality and perhaps the presence of the disease itself. Thus, patients' cognitive functioning might be negatively impacted by the interaction of these factors.

Sleep and Recall

Given the known relationship between sleep and cognitive functioning, we investigated, within each group, whether scores on the PSQI were correlated with performance on IAPS recall. In the patient group, increased sleep disturbance was correlated with poor performance for recall of positive pictures and total recall scores. Similarly, in the control group results showed a correlation between worse sleep efficiency and poorer recall of positive pictures. Furthermore, in the control group, increased daytime dysfunction correlated with poorer recall of neutral pictures. These findings all indicate that worse sleep has a negative impact on emotional memory performance. This is supported by previous research findings that both memory consolidation (Luo et al., 2013, Peter-Derex, 2019; Timol, 2014) and emotion regulation (Gruber & Cassoff, 2014; Palmer & Alfano, 2016) are dependent on sleep. Peter-Derex (2019) points to the interaction of hippocampus neuroactivity and slow waves of NREM sleep as key for memory consolidation during sleep. Palmer and Alfano (2017) explain that sleep deprivation leads to deficits in connection between the ventral anterior cingulate cortex and medial prefrontal cortex. Both of these structures are involved with regulating and monitoring emotions, demonstrating why a lack of sleep decreases emotion regulation (Palmer & Alfano, 2017). Our study's results are in accordance with these lines of research indicating that poor quality of sleep negatively impacts both emotion regulation and memory consolidation.

One anomaly in the patient group is that poor sleep quality was correlated with better performance for recall of new, positive pictures, which does not support the previous findings. Since this is not in line with findings across literature, this could be a spurious correlation due to the small sample size.

Duration of Illness and Treatment in Patient Group

Considering the negative impacts that diabetes and hypertension might have on sleep, emotion and cognition, it could be expected that the longer an individual has had these illnesses, the more severe the impacts on sleep, emotion and cognition would become. This was supported by correlations between duration of illness and length of treatment in the

patient group. Patients who had diabetes for a longer duration, and thus had been on treatment for a longer period of time, were found to have worse recall of positive and negative pictures. Duration of illness and treatment was also correlated with taking longer to fall asleep. Similarly, patients who had hypertension for a longer period of time and had been on treatment for a longer period had worse recall of neutral pictures. This suggests that duration of the disease causes an increase in negative symptoms related to sleep, emotion and cognition.

It has been suggested that cognitive difficulties in diabetic patients may be due to the brain's exposure to chronically high glucose levels (Cukierman-Yaffe, 2009). With regard to memory and hypertension, Van Etten et al. (2020) found that hypertensive patients who reported memory complaints also presented with differences in the volume of the right hippocampus, providing a possible reason for memory deficits experienced by the patients group. From these findings, it can be expected that cognitive impairments would increase in relation to disease duration, and may be a possible explanation as to why disease duration correlated with worse memory recall in patient group.

Regarding emotion regulation, Kane et al. (2018) explains that individuals with diabetes who are experiencing a physical burden of disease may experience more negative affect, such as pessimism, and are more likely to use maladaptive emotion regulation strategies to cope with the physical and emotional burden. These coping strategies could become a pattern of behaviour as the diseases continues. However, coping strategies were not measured in this study, and so we cannot confirm that this is the cause of emotion regulation difficulties in patients.

As previously mentioned, patients with both diseases experience sleep deficits due to either breathing difficulties (Floras, 2015; Jennings, 2016; Resnick et al., 2003), restless legs syndrome (Ahmed et al., 2018; Ferini-Strambi et al., 2014; Lopes et al., 2005) or melatonin dysregulation (Dumpala et al., 2019). The negative impacts of sleep compound over the length of time that the disease persists.

Limitations

There were several limitations for this study, including small sample size, use of self-report data, and ceiling effects on the memory recall test.

Small Sample Size

Firstly, the results of a power analysis suggested we needed 68 participants (34 in each group). Therefore, our sample of 20 participants (10 in each group) means our study was

underpowered. We did not have had enough power to detect the between-group differences. Our mediation analysis was compromised by this small sample size.

Use of Self-Report Measures

Second, our use of self-report data of sleep may not provide an accurate reflection of participants' sleep. Furthermore, self-report sleep data does not give an indication of participants' sleep architecture. Much research has indicated that specific stages of sleep are important for memory consolidation and emotion regulation (Ackerman & Rasch, 2014; Strauss et al., 2022; Yuksel, 2017). In order to fully understand the relationship between sleep and emotional memory, objective sleep data obtained from polysomnography needs to be obtained.

Ceiling Effects on Memory Recall Test

Lastly, there was a notable ceiling effect in the recall component of the IAPS, where many participants attained perfect or near perfect scores for IAPS recall. This impacted data analysis, as a recall score of 56 out of 60 pictures was considered a "poor" recall score in relation to other participants' scores. This limitation may have been mitigated by increasing the number of IAPS pictures presented in each to call to 90 pictures instead of 60.

Summary and Conclusion

This research has found that individuals with Type 2 diabetes and hypertension experience poorer sleep and perform worse on emotional memory tasks compared to matched healthy individuals. However, these results seem specific to positively and negatively valanced images but not neutral images. Importantly, poor sleep was related to worse memory performance, although this finding was not specific to the patient group. In the patient group however, patients who had a longer disease duration had poorer sleep quality and worse memory recall for positive and negative pictures. These results suggest that further investigations into the precise mechanisms underpinning memory and sleep deficits in patients need to be understood.

Implications for future research. Future studies using a similar design should consider the limitations of this study and attempt to recruit more participants, use more IAPS pictures to increase the difficulty of recall and mitigate the ceiling effect, and incorporate objective measure of sleep architecture to better understand the relationship between sleep and emotional memory in patients with diabetes and hypertension. Future research regarding treatment of diabetes and hypertension should specifically focus on reducing sleep deficits, as

patients do experience disturbed sleep, which may be related to increased emotional memory deficits.

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Appendix A

Department of Student Affairs Email Advertisement for Patient Participants

The Department of Psychology at the University of Cape Town is currently running a study on Sleep, Emotion and Thinking, and is looking for patients with hypertension and diabetes to take part.

Dear students. Do you or someone you know have diabetes or hypertension? If you refer someone with Type 2 diabetes or hypertension to take part in this study you will be entered in a draw to win one of four R300 Takealot vouchers. The more people you refer, the more entries you get into the draw.

What does one have to do if they decide to take part?

Participants will be required to fill out questionnaires relating to sleep, stress, and emotion. There is also an assessment regarding thinking which will be performed over two video calls. The questionnaire and two video calls should take 2 hours altogether.

How does one know if they qualify to take part?

People who are between the ages of 18 and 65, have access to a computer with internet, and have Type 2 diabetes or hypertension, qualify to take part.

What are the benefits and risks of taking part?

This information will be used for a larger study investigating the impact of sleep on cognition. The aim of the larger study is to improve our understanding of how sleep affects well-being and thinking in patients with diabetes and hypertension in a South African context. This knowledge may be useful for future treatment of patients. Some images that will be shown during the video calls may be disturbing. We will ensure that participants have a list of resources available for support if the images are found to be distressing. Participation in this study will not cost anything.

Interested in taking part?

Go to the following link to access the questionnaires: https://forms.gle/xB1WKajh2fF3hWRg7

You can also contact the principal researcher, Michelle Henry, via email at m.henry@uct.ac.za if you have any questions you want to ask about the study.

Appendix B

Department of Student Affairs Email Advertisement for Control Participants

The Department of Psychology at the University of Cape Town is currently running a study on Sleep, Emotion and Thinking, and is looking for participants.

Dear students. Please take part in our study regarding sleep, emotion and cognition. If you or someone that you refer takes part in this study you will be entered in a draw to win one of four R300 Takealot vouchers. The more people you refer, the more entries you get into the draw.

What does one have to do if they decide to take part?

Participants will be required to fill out questionnaires relating to sleep, stress, and emotion. There is also an assessment regarding thinking which will be performed over two video calls. The questionnaire and two video calls should take 2 hours altogether.

How does one know if they qualify to take part?

People who are between the ages of 18 and 65 and have access to a computer with internet qualify to take part.

What are the benefits and risks of taking part?

This information will be used for a larger study investigating the impact of sleep on cognition. The aim of the larger study is to improve our understanding of how sleep affects well-being and cognitive functioning in patients with diabetes and hypertension in a South African context. Some images that will be shown during the video calls may be disturbing. We will ensure that participants have resources available for support if the images are found to be distressing. Participation in this study will not cost anything.

Interested in taking part?

Go to the following link to access the questionnaires: https://forms.gle/xB1WKajh2fF3hWRg7

You can also contact the principal researcher, Michelle Henry, via email at m.henry@uct.ac.za if you have any questions about the study.

Appendix C

MedPages Letter

Dear Doctor,

Re: **Online survey and telephonic interview to determine hypertensive and diabetic patients' quality of life, sleep, emotion and cognition.**

It is well known that sleep is essential for optimal physical, emotional and cognitive well-being. We also know that patients with diabetes and hypertension frequently experience poor quality of life, sleep problems, depression and anxiety, and cognitive impairment. Despite the knowledge that poor sleep may be an underlying mechanism linked to reduced quality of life, mood and cognitive problems, very little research has been done to holistically understand this relationship in patients with diabetes and hypertension. Because of the important relationships between sleep, health, emotion and cognition, disrupted sleep could be a useful target for treatment interventions, which may reduce the severity of negative emotional and cognitive symptoms, and improve patients' quality of life.

We are requesting that you invite your patient with diabetes or hypertension to participate in an online survey and video call interview. In this survey and interview, we will be asking your patients to answer some questions about their sleep, quality of life, emotions and cognition. Since we know that sleep is an important predictor of physical, emotional and cognitive health, we wish to determine to what extent patients with diabetes and hypertension report problems in these domains.

We are looking for **patients between the ages of 18 - 65 years**, who **do not have any target organ damage**. Further, we would like to recruit **patients with Type 2 diabetes who have a HbA1C < 8 g/%,** and **patients with hypertension who have a BP <130/80 mmHg**. These BP and HbA1c cut points represent values when patients are treated / well-managed / stable. Patients need to have been treatment-stable for the past 3 months.

If your patients agree to participate in this study or if they have any questions about the study, we would be grateful if you will share their contact details with me, Dr M. Henry (m.henry@uct.ac.za or mhmish@gmail.com). This way their privacy and confidentiality will be assured. Alternatively, you may give patients my contact details (cell phone number: 0722727107; email: mhmish@gmail.com) and they can contact me directly. On initial contact I, or a research assistant, will take telephonic informed consent.

Overall, our objectives are two-fold, namely to (1) assess to what extent patients self-report problems with their quality of life, sleep, emotion regulation and cognition, and (2) determine the role that sleep plays in predicting patients' physical and emotional well-being and their cognitive functioning.

My sincere thanks,
Dr Michelle Henry,

University of Cape Town
Email address: m.henry@uct.ac.za / mhmish@gmail.com
Cellphone number: 0722727107

Appendix D

Social Media Advertisement (Patient Group)

Do you or someone you know have diabetes or hypertension? If you refer someone with Type 2 diabetes or hypertension to take part in this study, you will be entered in a draw to win one of four R300 Takealot vouchers. The more people you refer, the more entries you get into the draw.

The Department of Psychology at the UCT is running a study on Sleep, Emotion and Thinking and is looking for patients with **hypertension and Type 2 diabetes** to take part.

What does one have to do if they decide to take part?

Participants will be required to fill out questionnaires relating to sleep, stress, and emotion. There is also an assessment regarding thinking which will be performed over two video calls. The questionnaire and two video calls should take 2 hours altogether.

Go to the following link to access the questionnaires:
https://forms.gle/xB1WKajh2fF3hWRg7

Please contact the researchers if you would like any more information:
Rebecca Yoko (ykxreb001@myuct.ac.za
Lindo Ntshangase (ntslin034@myuct.ac.za)

Appendix E

Social Media Advertisement (Control Group)

Please take part in our study regarding sleep, emotion and thinking. If you take part, or refer someone to take part in this study, you will be entered in a draw to win one of four R300 Takealot vouchers. The more people you refer, the more entries you get into the draw.

The Department of Psychology at UCT is running a study on Sleep, Emotion and Thinking and is looking for participants.

What does one have to do if they decide to take part?

Participants will be required to fill out questionnaires relating to sleep, stress, and emotion. There is also an assessment regarding thinking which will be performed over two video calls. The questionnaire and two video calls should take 2 hours altogether.

Go to the following link to access the questionnaires:
https://forms.gle/xB1WKajh2fF3hWRg7

Please contact the researchers if you would like any more information:
Rebecca Yoko (ykxreb001@myuct.ac.za
Lindo Ntshangase (ntslin034@myuct.ac.za)

Appendix F:
Counselling Referrals

If you feel distressed or uncomfortable after participating in this study, please do contact one of the free counselling services listed below:

Lifeline

Lifeline provides confidential counselling at no charge apart from the cost of the call. Calls with their trained counsellors are confidential, and they will listen, provide support and refer to other professionals if needed. They are available from 10am to 10pm, every day of the year.

Landline: 021 461 1111

WhatsApp Call: 063 709 2620

https://lifelinewc.org.za/

SADAG (South African Depression and Anxiety Group)

SADAG provides counselling and support groups for a range of mental health challenges. They will assess your needs with you and help you decide on how to move forward.

011 234 4837

https://www.sadag.org/

FAMSA (Family and Marriage Society of South Africa)

The counsellors at FAMSA will ensure that you have support for any issue that you are facing. They will walk alongside you as you work towards the changes that you would like to see in your life.

021 447 7951

https://www.famsawc.org.za/counselling-services

If you have any concerns or questions regarding this research, please contact:

Rebecca Yoko at YKXREB001@myuct.ac.za [*email*],

Or Lindokuhle Ntshangase at NTSLIN034@myuct.ac.za

or the supervisors for the study

Michelle Henry at m.henry@uct.ac.za

Kevin Thomas at kevin.thomas@uct.ac.za

Appendix G

Contact Details and Sociodemographic Google Form

Section A: Personal Information and Demographic Survey

Full name:

_____

Contact number:

_____

Email address:

_____

If referred by a UCT student, please provide their name:

_____

If referred by a UCT student, please provide their student number:

_____

Do you have access to a laptop with internet connection?

- Yes
- No

Date of birth

_____

Age

_____

Sex

- Female
- Male
- Other

Home language

_____

Height (metres)

_____

Weight (kilograms)

_____

Marital Status

- Married
- Single
- Divorce

What is the total monthly income of the household I which you live? If you are a student, please take care to put your immediate caregiver's monthly income, not your own.

- R0 – R999
- R1000 – R2499
- R2500 – R5499
- R5500 – R9999
- R10 000 – R20 000
- R20 000 – R40 000
- R40 000 – R60 000
- R60 000 – R100 000
- More than R100 000

Highest level of education level attained:

- No formal education
- Primary education (grades 1-7)
- Secondary education (grades 8-12)
- Tertiary education (college/university)

Do you smoke? If so, how many a day?

_____

Do you drink alcohol? If so, how many units per week? (example: one unit = one glass of wine)

_____

Are you pregnant?

- Yes
- No

Have you ever had a head injury? If yes, please specify.

_____

Have you ever had a stroke? If yes, please specify.

_____

Do you have dementia?

- Yes
- No

Do you have epilepsy?

- Yes
- No

Do you have target organ damage?

_____

Do you have any other physical conditions? If yes, please specify.

_____

Do you suffer from depression?

- Yes
- No

Do you suffer from anxiety?

- Yes
- No

List all medications you are currently taking:

_____

Do you have any psychological/psychiatric disorders? If yes, please specify.

_____

Section B: For diabetic patients only

When were you first diagnosed with diabetes?

_____

What forms of treatment are you currently on for your diabetes?

_____

Please provide more information about treatment:

_____

How long have you been on this treatment?

_____

What was your last measured HbAlc?

_____

When was this measurement taken?

_____

Do you suffer from any other chronic illnesses (physical or psychological)? If yes, please specify.

_____

Are you on any type of medication/medical treatment for the other chronic illness/es If yes, please specify which medication/medical treatment.

_____

Section C: For hypertensive patients only

When were you first diagnosed with hypertension?

_____

What forms of treatment are you currently on for your hypertension?

_____

Please provide more information about treatment:

_____

How long have you been on this treatment?

_____

What was your last measured blood pressure?

_____

When was this measurement taken?

_____

Do you suffer from any other chronic illnesses (physical or psychological)? If yes, please specify.

_____

Are you on any type of medication/medical treatment for the other chronic illness/es If yes, please specify which medication/medical treatment.

_____

Appendix H

Pittsburgh Sleep Quality Index (PSQI)

Name:_____ Date:_____

Instructions: The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and night in the past month. Please answer all questions.

1. During the past month, what time have you usually gone to bed at night?_____
2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night?_____
3. During the past month, what time have you usually gotten up in the morning?_____
4. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spent in bed.)_____

5.During the past month, how often have you had trouble sleeping because you…	**Not during the last month**	**Less than once a week**	**Once or twice a week**	**Three or more times a week**
a. Cannot get to sleep within 30 minutes				
b. Wake up in the middle of the night or early morning				
c. Have to get up to use the bathroom				
d. Cannot breathe comfortably				
e. Cough or snore loudly				
f. Feel too cold				
g. Feel too hot				
h. Have bad dreams				
i. Have pain				
j. Other reason(s), please describe:				

6. During the past month, how often have you taken medicine to help you sleep (prescribed or “over the counter”)?				
7. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?				
	No problem at all	**Only a very slight problem**	**Somewhat of a problem**	**A very big problem**
8. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?				
	Very good	**Fairly good**	**Fairly bad**	**Very bad**
9. During the past month, how would you rate your sleep quality overall?				
	No bed partner or room mate	**Partner/roommate in other room**	**Partner in same room but not same bed**	**Partner in same bed**
10. Do you have a bed partner or roommate?				
	Not during the past month	**Less than once a week**	**Once or twice a week**	**Three or more times a week**

If you have a roommate or bed partner, ask him/her how often in the past month you have had:				
a. Loud snoring				
b. Long pauses between breaths while asleep				
c. Legs twitching or jerking while you sleep				
d. Episodes of disorientation or confusion during sleep				
e. Other restlessness while you sleep, please describe:				

Appendix I

Difficulties in Emotion Regulation Scale (DERS-18)

Response categories:

1 – Almost Never

2 – Sometimes

3 - About Half the Time

4 – Most of the Time

5 – Almost Always

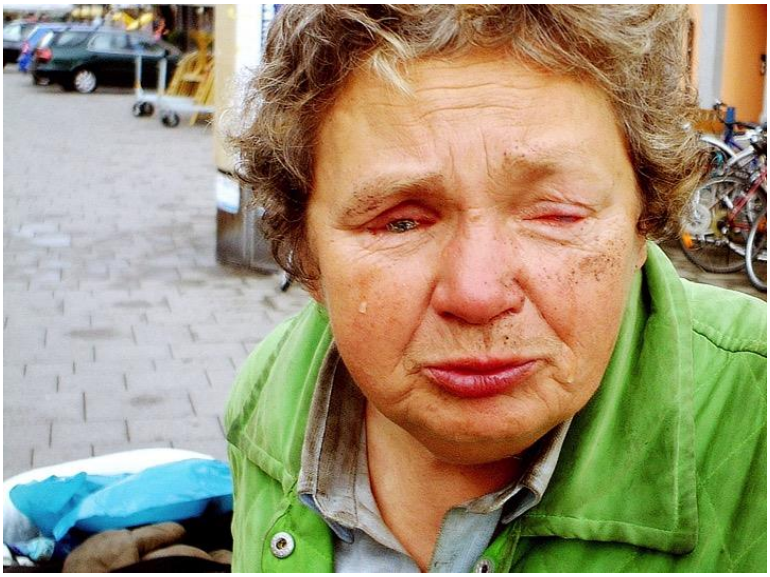
1. I pay attention to how I feel. _____
2. I have no idea how I am feeling. _____
3. I have difficulty making sense out of my feelings. _____
4. I am attentive to my feelings. _____
5. I am confused about how I feel. _____
6. When I'm upset, I acknowledge my emotions. _____
7. When I'm upset, I become embarrassed for feeling that way. _____
8. When I'm upset, I have difficulty getting work done. _____
9. When I'm upset, I become out of control. _____
10. When I'm upset, I believe that I will remain that way for a long time. _____
11. When I'm upset, I believe that I'll end up feeling very depressed. _____
12. When I'm upset, I have difficulty focusing on other things. _____
13. When I'm upset, I feel ashamed with myself for feeling that way. _____
14. When I'm upset, I feel guilty for feeling that way. _____
15. When I'm upset, I have difficulty concentrating. _____
16. When I'm upset, I have difficulty controlling my behaviours. _____
17. When I'm upset, I believe that wallowing in it is all I can do. _____
18. When I'm upset, I lose control over my behaviours. _____

Appendix J

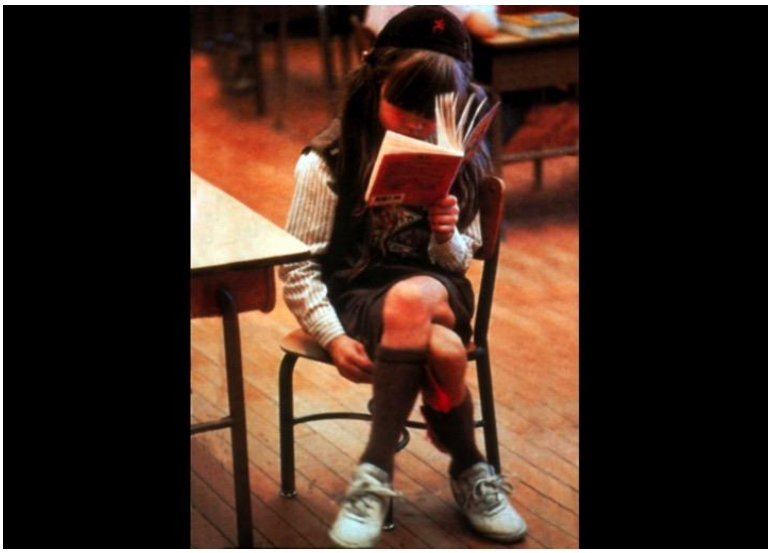
Examples of International Affective Picture System (IAPS) Pictures

Positive Pictures

Negative Pictures



Neutral Pictures



Appendix K

Consent Form (Patient Group)

Consent to Participate in Research Study

Sleep and Emotional Memory in Hypertensive and Diabetic Patients

As researchers specialising in psychology (Dr Michelle Henry/Professor Kevin Thomas) and endocrinology (i.e., relating to hormones) (Associate Professor Ian Ross) at the University of Cape Town and Groote Schuur Hospital, we wish to determine the relationship between sleep, quality of life, emotion and thinking. Two psychology Honours students (Lindo Ntshangase and Rebecca Yoko) will be assisting with data collection for their project.

Why are you being invited to take part?

We are calling on you as you have diabetes/hypertension.

Why is this research being done? What is it trying to find out?

This research is trying to understand how sleep impacts quality of life, emotion regulation and thinking processes in order to inform better treatment options for patients living with hypertension and diabetes. Patients with hypertension/diabetes will be compared to control participants. We wish to ask you several questions relating to your sleep, quality of life, emotions and thinking, and some personal and medical questions.

To take part in this study you must:

- be between the ages of 18 to 65 years
- not be pregnant
- not have any other chronic illnesses
- be free from neurological disorders and psychiatric illness
- have a BMI less than 40kg/m2
- not be on any medication that could affect your sleep

What does participation in this research entail?

If you choose to participate in this study, you will first be asked to answer some online questionnaires that will take approximately 30-40 minutes to complete. You will then be asked to take part in two video calls within the next 5 days, during which you will complete a cognitive assessment and rate 60 pictures that will be shown to you. These two calls should take about 90 minutes in total.

Are there are any risks and discomforts in taking part in this research?

Some images that will be shown during the video calls may be disturbing. We will ensure that participants have a list of resources available for support if the images are found to be distressing. Participation in this study will not cost you anything.

Are there any benefits to you if you take part in this research?

There is no financial compensation for taking part in this research. However, you may learn a bit more about your own quality of life, sleep, emotion and thinking. You will also be assisting in our knowledge of how sleep quality affects quality of life, thinking and emotions, and this information is potentially useful in our understanding of how to improve patients' well-being. You are encouraged to ask questions if you are unsure about anything.

What happens if you do not want to take part in this research?

Participation in this study is completely voluntary. It is your right to refuse to take part in this research. If you do not want to take part in this research, it will in no way affect you or the treatment that you are supposed to receive from your doctor. If, after starting the questionnaire, you no longer wish to participate, you may withdraw your permission at any stage and without it affecting your treatment in any way.

What happens at the end of the research?

All your information and your answers to this study will be kept completely private. Your information will be recorded under a number and will not be linked to your name. Only researchers working on this project will know your personal details and information will not be communicated to anyone apart from them. If we publish the results of this study, we will not communicate any of your personal and private information.

Questions?

If you have any questions about the study, now or in the future, you can call Michelle Henry on 0216501804 or on m.henry@uct.ac.za. If you have questions or concerns about your rights as a research participant, you can contact the Chair of the Human Research Ethics Committee of the Faculty of Health Sciences at the University of Cape Town on 021 650 1236 or hrec-enquiries@uct.ac.za.

Appendix L

Consent Form (Control Group)

Consent to Participate in Research Study

Sleep and Emotional Memory

As researchers specialising in psychology (Dr Michelle Henry/Professor Kevin Thomas) and endocrinology (i.e., relating to hormones) (Associate Professor Ian Ross) at the University of Cape Town and Groote Schuur Hospital, we wish to determine the relationship between sleep, quality of life, emotion and thinking. Two psychology Honours students (Lindo Ntshangase and Rebecca Yoko) will be assisting with data collection for their project.

Why are you being invited to take part?

We are looking for healthy participants for our control group.

Why is this research being done? What is it trying to find out?

This research is trying to understand how sleep impacts quality of life, emotion regulation and thinking processes in order to inform better treatment options for patients living with hypertension and diabetes. Patients with hypertension/diabetes will be compared to control participants. We wish to ask you several questions relating to your sleep, stress, emotions and thinking, and some personal and medical questions.

To take part in this study you must:

- be between the ages of 18 to 65 years
- not be pregnant
- not have any chronic illnesses
- be free from neurological disorders and psychiatric illness
- have a BMI less than 40kg/m2
- not be on any medication that could affect your sleep

What does participation in this research entail?

If you choose to participate in this study, you will first be asked to answer some online questionnaires that will take approximately 30-40 minutes to complete. You will then be asked to take part in two video calls, during which you will complete a cognitive assessment and rate 60 pictures that will be shown to you. These two calls should take about 60 minutes in total.

Are there are any risks and discomforts in taking part in this research?

Some images that will be shown during the video calls may be disturbing. We will ensure that participants have resources available for support if the images are found to be distressing. Participation in this study will not cost you anything.

Are there any benefits to you if you take part in this research?

There is no financial compensation for taking part in this research. However, you may learn a bit more about your own quality of life, sleep, emotion and thinking. You will also be assisting in our knowledge of how sleep quality affects quality of life, thinking and emotions, and this information is potentially useful in our understanding of how to improve patients' well-being. You are encouraged to ask questions if you are unsure about anything.

What happens if you do not want to take part in this research?

Participation in this study is completely voluntary. It is your right to refuse to take part in this research. If you do not want to take part in this research, it will in no way affect you or the treatment that you are supposed to receive from your doctor. If, after starting the questionnaire, you no longer wish to participate, you may withdraw your permission at any stage and without it affecting your treatment in any way.

What happens at the end of the research?

All your information and your answers to this study will be kept completely private. Your information will be recorded under a number and will not be linked to your name. Only researchers working on this project will know your personal details and information will not be communicated to anyone apart from them. If we publish the results of this study, we will not communicate any of your personal and private information .

Questions?

If you have any questions about the study, now or in the future, you can call Michelle Henry on 0216501804 or on m.henry@uct.ac.za. If you have questions or concerns about your rights as a research participant, you can contact the Chair of the Human Research Ethics Committee of the Faculty of Health Sciences at the University of Cape Town on 021 650 1236 or hrec-enquiries@uct.ac.za.

Appendix M

Beck Depression Inventory (BDI-II)

This depression inventory can be self-scored. The scoring scale is at the end of the questionnaire.

1.

0 I do not feel sad.

1 I feel sad

2 I am sad all the time and I can't snap out of it.

3 I am so sad and unhappy that I can't stand it.

2.

0 I am not particularly discouraged about the future.

1 I feel discouraged about the future.

2 I feel I have nothing to look forward to.

3 I feel the future is hopeless and that things cannot improve.

3.

0 I do not feel like a failure.

1 I feel I have failed more than the average person.

2 As I look back on my life, all I can see is a lot of failures.

3 I feel I am a complete failure as a person.

4.

0 I get as much satisfaction out of things as I used to.

1 I don't enjoy things the way I used to.

2 I don't get real satisfaction out of anything anymore.

3 I am dissatisfied or bored with everything.

5.

0 I don't feel particularly guilty.

1 I feel guilty a good part of the time.

2 I feel quite guilty most of the time.

3 I feel guilty all of the time.

6.

0 I don't feel I am being punished.

1 I feel I may be punished.

2 I expect to be punished.

3 I feel I am being punished.

7.

0 I don't feel disappointed in myself.

1 I am disappointed in myself.

2 I am disgusted with myself.

3 I hate myself.

8.

0 I don't feel I am any worse than anybody else.

1 I am critical of myself for my weaknesses or mistakes.

2 I blame myself all the time for my faults.

3 I blame myself for everything bad that happens.

9.

0 I don't have any thoughts of killing myself.

1 I have thoughts of killing myself, but I would not carry them out.

2 I would like to kill myself.

3 I would kill myself if I had the chance.

10.

0 I don't cry any more than usual.

1 I cry more now than I used to.

2 I cry all the time now.

3 I used to be able to cry, but now I can't cry even though I want to.

11.

0 I am no more irritated by things than I ever was.

1 I am slightly more irritated now than usual.

2 I am quite annoyed or irritated a good deal of the time.

3 I feel irritated all the time.

12.

0 I have not lost interest in other people.

1 I am less interested in other people than I used to be.

2 I have lost most of my interest in other people.

3 I have lost all of my interest in other people.

13.

0 I make decisions about as well as I ever could.

1 I put off making decisions more than I used to.

2 I have greater difficulty in making decisions more than I used to.

3 I can't make decisions at all anymore.

14.

0 I don't feel that I look any worse than I used to.

1 I am worried that I am looking old or unattractive.

2 I feel there are permanent changes in my appearance that make me look unattractive

3 I believe that I look ugly.

15.

0 I can work about as well as before.

1 It takes an extra effort to get started at doing something.

2 I have to push myself very hard to do anything.

3 I can't do any work at all.

16.

0 I can sleep as well as usual.

1 I don't sleep as well as I used to.

2 I wake up 1-2 hours earlier than usual and find it hard to get back to sleep.

3 I wake up several hours earlier than I used to and cannot get back to sleep.

17.

0 I don't get more tired than usual.

1 I get tired more easily than I used to.

2 I get tired from doing almost anything.

3 I am too tired to do anything.

18.

0 My appetite is no worse than usual.

1 My appetite is not as good as it used to be.

2 My appetite is much worse now.

3 I have no appetite at all anymore.

19.

0 I haven't lost much weight, if any, lately.

1 I have lost more than five pounds.

2 I have lost more than ten pounds.

3 I have lost more than fifteen pounds.

20.

0 I am no more worried about my health than usual.

1 I am worried about physical problems like aches, pains, upset stomach, or constipation.

2 I am very worried about physical problems and it's hard to think of much else.

3 I am so worried about my physical problems that I cannot think of anything else.

21.

0 I have not noticed any recent change in my interest in sex.

1 I am less interested in sex than I used to be.

2 I have almost no interest in sex.

3 I have lost interest in sex completely.

Total Score:_____

Beck et al. (1996)

Appendix N

Beck Anxiety Inventory (BAI)

	Not at all	Mildly but it didn't bother me much	Moderately – it wasn't pleasant at times	Severely – it bothered me a lot
Numbness or tingling	0	1	2	3
Feeling hot	0	1	2	3
Wobbliness in legs	0	1	2	3
Unable to relax	0	1	2	3
Fear of worst happening	0	1	2	3
Dizzy or lightheaded	0	1	2	3
Heart pounding/racing	0	1	2	3
Unsteady	0	1	2	3
Terrified or afraid	0	1	2	3
Nervous	0	1	2	3
Feeling of choking	0	1	2	3
Hands trembling	0	1	2	3
Shaky/unsteady	0	1	2	3
Fear of losing control	0	1	2	3
Difficulty in breathing	0	1	2	3
Fear of dying	0	1	2	3
Scared	0	1	2	3
Indigestion	0	1	2	3
Faint/lightheaded	0	1	2	3
Face flushed	0	1	2	3
Hot/cold sweats	0	1	2	3

Beck et al. (1988).

Appendix O

Perceived Stress Scale (PSS-10)

For each question, choose from the following alternatives:

0 – never

1 – almost never

2 – sometimes

3 – fairly often

4 – very often

1. In the last month, how often have you been upset because of something that happened unexpectedly? _____
2. In the last month, how often have you felt that you were unable to control the important things in your life? _____
3. In the last month, how often have you felt nervous and stressed? _____
4. In the last month, how often have you felt confident about your ability to handle your personal problems? _____
5. In the last month, how often have you felt that things were going your way? _____
6. In the last month, how often have you found that you could not cope with all the things that you had to do? _____
7. In the last month, how often have you been able to control irritations in your life? _____
8. In the last month, how often have you felt that you were on top of things? _____
9. In the last month, how often have you been angered because of things that happened that were outside of your control? _____
10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them? _____

Appendix P

Debriefing Form

Thank you for participating in this study on Sleep and Emotional Memory in Hypertensive and Diabetic Patients. There are many studies that demonstrate the harmful effect poor sleep has on memory and emotion processing, and it is also established that hypertensive and diabetic patients experience sleep, emotion regulation and memory difficulties. However, no published study has examined the *relationship* between sleep, memory and emotion in patients with hypertension and diabetes. The aim of this study was to explore sleep quality and emotional memory in patients with hypertension and diabetes and in healthy controls.

How was this tested?

You were asked to fill out several questionnaires asking about your sleep, emotion, and well-being. You also completed memory tasks where learning of materials was separated from memory testing by 12 hours of sleep.

We expect to find that:

Compared to matched healthy controls, diabetic and hypertensive patients will (a) experience poor sleep quality, and (b) perform more poorly on tests of emotional memory. Furthermore, in those patients, sleep quality and emotional memory performance will be associated with one another.

Why is this important to study?

It is hoped that this body of psychological research will serve to further understand patients with hypertension and diabetes. By confirming our hypotheses, the study will lay the foundation for future studies with a view to developing interventions targeted at directly improving sleep patterns and thereby indirectly improving memory and emotion functioning. By expanding the body of literature, hypertensive and diabetic patients can experience an improved quality of life.

What if I want to know more?

You will receive a summary of the findings when the research is completed.

If you feel distressed or uncomfortable after participating in this study, please do contact one of the free counselling services listed below:

Lifeline

Lifeline provides confidential counselling at no charge apart from the cost of the call. Calls with their trained counsellors are confidential, and they will listen, provide support and refer to other professionals if needed. They are available from 10am to 10pm, every day of the year.

Landline: 021 461 1111

WhatsApp Call: 063 709 2620

https://lifelinewc.org.za/

SADAG (South African Depression and Anxiety Group)

SADAG provides counselling and support groups for a range of mental health challenges. They will assess your needs with you and help you decide on how to move forward.

011 234 4837

https://www.sadag.org/

FAMSA (Family and Marriage Society of South Africa)

The counsellors at FAMSA will ensure that you have support for any issue that you are facing. They will walk alongside you as you work towards the changes that you would like to see in your life.

021 447 7951

https://www.famsawc.org.za/counselling-services

If you have any concerns or questions regarding this research, please contact:

Rebecca Yoko at YKXREB001@myuct.ac.za [*email*],

Or Lindokuhle Ntshangase at NTSLIN034@myuct.ac.za

or the supervisors for the study

Michelle Henry at m.henry@uct.ac.za

Kevin Thomas at kevin.thomas@uct.ac.za

Appendix Q

Faculty of Health Sciences Ethics Approval

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee

Room G50- Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6492
Email: hrec-enquiries@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

12 October 2021

HREC REF: 515/2021

Dr M Henry
Centre for Higher Education Development
Room 5.04 Hoerikwaggo Building-UCT
Email: m.henry@uct.ac.za
Student: SVRABI001@myuct.ac.za & TBRJUL002@myuct.ac.za

Dear Dr Henry

PROJECT TITLE: THE ROLE OF SLEEP DISRUPTION IN PREDICTING QUALITY OF LIFE, EMOTION REGULATION AND COGNITION IN NON-COMMUNICABLE DISEASES-HONS CANDIDATES-MS ABBY SIVERTSEN & MS JULIA TUBARO

Thank you for your response letter, addressing the issues raised by the Faculty of Health Sciences Human Research Ethics Committee (HREC).

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

This approval is subject to strict adherence to the HREC recommendations regarding research involving human participants during COVID -19, dated 17 March 2020; 06 July 2020 & 01 July 2021.

Approval is granted for one year until the 30 October 2022.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

The HREC acknowledge that the students: Ms Abby Sivertsen & Ms Julia Tubaro will also be involved in this study.

Please quote the HREC REF 515/2021 in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate institutional approval, where necessary, before the research may occur.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, FACULTY OF HEALTH SCIENCES HUMAN RESEARCH ETHICS COMMITTEE
Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938
NHREC-registration number: REC-210208-007

This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use: Good Clinical Practice (ICH GCP), South African Good Clinical Practice Guidelines (DoH 2006), based on the Association of the British Pharmaceutical Industry Guidelines (ABPI), and Declaration of Helsinki (2013) guidelines. The Human Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

HREC/REF 515/2021sa

Appendix R

Department of Psychology Ethics Approval

UNIVERSITY OF CAPE TOWN

Department of Psychology

University of Cape Town Rondebosch 7701 South Africa
Telephone (021) 650 3417
Fax No. (021) 650 4104

16 August 2022

Lindokuhle Ntshangase and Rebecca Yoko
Department of Psychology
University of Cape Town
Rondebosch 7701

Dear Lindokuhle and Rebecca

I am pleased to inform you that ethical clearance has been given by an Ethics Review Committee of the Faculty of Humanities for your study, *Sleep and Emotional Memory in Hypertensive and Diabetic Patients.* The reference number is PSY2022-032.

I wish you all the best for your study.

Yours sincerely

Lauren Wild (PhD)
Associate Professor
Chair: Ethics Review Committee

UNIVERSITY OF CAPE TOWN
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PLAGIARISM DECLARATION

1. I know that plagiarism is wrong. Plagiarism is using another's work and to pretend that it is one's own.

2. I have used the American Psychological Association (APA) as the conventions for citation and referencing. Each significant contribution to, and quotation in, this project proposal from the work, or works of other people has been attributed and has been cited and referenced.

3. This project proposal is my own work.

4. I have not allowed, and will not allow, anyone to copy my work with the intention of passing it off as his or her own work.
5. I acknowledge that copying someone else's assignment or essay, or part of it, is wrong, and I declare that this is my own work

SIGNATURE: ____ R.Yoko_____

DATE: _____27 October, 2022_____