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Predictors of subjective sleep quality in midlife women

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Predictors of subjective sleep quality in midlife women

Abstract

An overwhelming number of women report sleep difficulties in midlife. The purpose of the present research was to identify possible factors contributing to this. Menopausal status, vasomotor symptoms, psychological health, health behaviours and demographic characteristics were examined as predictors of sleep quality. A total of 292 women aged 40-60 years (*M*=51.01) completed an online questionnaire assessing: sleep quality (Pittsburgh Sleep Quality Index), menopausal status, vasomotor symptoms (Greene Climacteric Scale), depression (Patient Health Questionnaire-9), anxiety (General Anxiety Disorder Assessment-7), alcohol consumption, smoking status, physical activity level and demographic information. Results revealed that 80.3% of women were poor sleepers. A multiple regression analysis identified that vasomotor symptoms, anxiety and depression were unique predictors of poor sleep quality. Depression was found to make the largest contribution. Overall, findings propose specific factors which may play a significant role in the sleep difficulties reported by midlife women. In consideration of these findings, promising implications for future research and interventions are discussed.

KEY WORDS:	SUBJECTIVE SLEEP QUALITY	MIDLIFE WOMEN	MENOPAUSE	VASOMOTOR SYMPTOMS	PSYCHOLOGICAL HEALTH

Introduction

Women report finding new energy and enthusiasm for life during middle age (Dennerstein, Lehert, & Guthrie, 2002). Yet paradoxically, such women are twice as likely to report sleep problems compared to younger equivalents (Minarik, 2009). Prevalence studies show around 40-60% of women aged 40-65 years report frequent sleep complaints (Ağan et al., 2015; Lampio, Saaresranta, Engblom, Polo, & Polo-Kantalo, 2016; Kravitz et al., 2003; Kravitz et al., 2008; Xu, Zhao, Chen, & Jing, 2016). Of these women, 30% report their sleep problems to be severe and have substantial effects on their daily lives (Polo-Kantolo, 2011; Baker, De Zambotti, Colrain & Bei, 2018). Typically, midlife women report having significant troubles initiating sleep, awakening throughout the night, waking up early and feeling unrefreshed (National Sleep Foundation [NSF], 2002). National studies have found such sleep difficulties occur more than 3-times per week (NSF, 2007; Kravitz et al., 2008). Disturbingly, troubles are found to persist for 3 years on average (Tom, Kuh, Guralnik & Mishra, 2010) and this is not without detrimental consequence. Insufficient or inefficient sleep has been associated with copious adverse outcomes. Common impairments include cognitive decline (Roth & Ancoli-Israel, 1999), occupational dysfunction (NSF,2007), poor interpersonal relationships (Chasens, Twerski, Yang & Umlaug, 2010), susceptibility to disease (Foley, Ancoli-Israel, Britz & Walsh, 2004), poorer quality of life (Bolge, Balakrishnan, Kannan, Seal & Drake, 2010), and most worryingly, early mortality (Cappuccio, D'Elia, Strazzulo & Miller, 2010). Midlife women have specifically reported being involved in car crashes and near fatal accidents due to driving whilst feeling tired (NSF, 2007). Given the global aging population, women spend a greater proportion of their lives in midlife than in previous generations (Lahdenperä, Lummaa, Helle, Tremblay & Russell, 2004). Thus, they are at greater risk of the aforementioned consequences caused by sleep disruption. In order for health professionals to be able to reduce such risks, the aetiology of sleep disruption for midlife women must be understood.

Midlife coincides with the menopause, and sleep is negatively affected during the menopause transition. Menopause or 'perimenopause' is defined as the cessation of menstruation (National Institute for Health and Care Excellence [NICE], 2015), preceded by 'premenopause', whereby menstruation remains regular; and followed by the 'postmenopause', whereby menstruation has ceased for 12 months (The Stages of Reproductive Aging Workshop [STRAW]- Harlow et al., 2012). Subjective sleep studies have established that women's sleep complaints increase across the menopausal transition. Perimenopausal and postmenopausal women are consistently found to have greater prevalence of sleep difficulties than premenopausal women (Shaver, Giblin & Paulsen, 1991; Kuh, Wadsworth & Hardy, 1997; Owens & Matthews, 1998; Chung & Tang, 2006; Tom et al., 2010; Freeman, Sammel, Gross & Pien, 2015). In a study of 12,600 women, Kravitz et al. (2003) found approximately 50% of perimenopausal and postmenopausal women had sleeping difficulties, relative to 30% of premenopausal women. More recently, Xu and Lang (2014) conducted a meta-analysis reviewing 24 studies (*n*=63,500), concluding that women in perimenopause and postmenopause have a 2-fold risk of experiencing sleep problems compared to premenopause. Incidence of specific sleep complaints are also associated with the menopause. For example, in a 5-year longitudinal study, Lampio et al. (2017) found that relative to premenopausal women, menopausal (perimenopausal and postmenopausal) women were more likely to experience sleep difficulties such as;

'difficulty falling asleep' (11% vs 43%) and 'nocturnal awakenings' (26% vs 55%). Although overwhelming evidence suggests that women self-report poorer sleep within the menopause (Baker, Simpson & Dawson, 1997; Barnabei et al, 2002; NSF, 2007; Cheng et al., 2008; Berecki-Gisolf, Begum & Dobson, 2009; Woods & Mitchell, 2010), not all studies report such an association (Pien, Sammel, Freeman, Lin & DeBlasis, 2008; Blümel et al., 2012). This highlights that menopause may not invariably have a negative effect on sleep quality. Typically, authors conclude that specific symptoms associated with the menopause have greater influence upon sleep difficulties than the menopause transition itself (Xu et al., 2016).

One core symptom of menopause, vasomotor symptoms (VMS); comprises of night sweats and hot flushes. Women with symptoms experience an intense and transient sensation of heat during sleep and awaken to find themselves covered in perspiration (NIH, 2005; Ameratunga, Goldin & Hickey, 2012). Unsurprisingly, research demonstrates that symptomatic women report poorer sleep quality than their asymptomatic equivalents (Chasens et al., 2010; Ohayon, 2006; Pien et al., 2008). Kravitz et al. (2003) found that sleep problems were 2-times greater in those experiencing VMS relative to those who were not. Subsequent research into 3000 midlife women (Kravitz et al., 2008), reported odd ratios (OR) were significantly higher for women with severe VMS (>6 days in a 2-week period) than no symptoms on 3 sleep difficulties; trouble falling asleep (5.3 vs 1.9), awakening during the night (4.9 vs 1.7) and waking up early (3.9 vs 1.7). Similarly, Woods and Mitchell (2010) reported across their 17-year longitudinal study, that the frequency of hot flushes, alongside other symptomology (e.g. backache); were associated with problems going to sleep, severity of night time awakening and early morning awakenings. Studies using objectives measures also draw similar conclusions (Woodward & Freedman, 1994; Baker, Willoughby, Sassoon, Colrain & De Zambotti, 2015). Joffe et al. (2013) hormonally induced VMS in 29 healthy, premenopausal women (aged 18-45 years) with no history of sleep disturbance. Utilising Polysomnography (PSG) and self-report measures, they identified that VMS correlated directly with degree of sleep fragmentation. In critique, Thurston et al. (2008) proposed that research should consider the associated bother and interference of VMS, above the frequency or physiological presence of symptoms. Xu et al. (2012) reported only bothersome hot flushes, but not hot flushes alone, were associated with sleep disturbance (OR: 2.7 vs 1.3). However, this is the only study to address this and there is need for further exploration into the perceived "bothersomeness" of VMS and sleep difficulty.

Research exploring women's perceptions of their symptoms is important because in addition to the physical effects of midlife, psychological symptoms are associated with sleep quality. Previous research has established that depressive complaints are often accompanied by severe sleep problems (Ford & Kamerow, 1989; McCall, Reboussin & Cohen, 2000). For example, Sivertson et al. (2012) found depressed individuals were twice as likely to report sleep difficulties as opposed to non-depressed (22% vs 10%). Research into midlife women report similar findings. Bosworth et al. (2001) studied 581 women aged 45-55 years, concluding that sleep problems were significantly greater in depressed, compared to non-depressed women (61% vs 39%). Chung and Tang (2006) identified that relative to non-depressed women, depressed women had a 4-fold increased risk of reporting disturbed sleep. When analysing specific sleep quality variables, Joffe et al. (2009) found depressed midlife women took significantly longer to fall asleep and had a shorter total sleep time than their non-

depressed equivalents. Lampio et al. (2014) added that depressive symptoms also increased nocturnal awakenings, and daytime tiredness within their midlife female sample. Similar effects on sleep have been found when individuals report having only mild psychological symptoms (Buysse et al., 2008). Thus, plentiful research highlights that depression and low mood has an impact on sleep within this cohort (Xu et al., 2016; Tom et al., 2010).

Like depression, anxiety correlates with poor sleep quality (Rawsawh, Stein, Belik, Jacobi & Sareen, 2009; Soehner & Harvey, 2012). Surprisingly, it has received much less attention in the studies of midlife women, despite being more strongly related to sleep problems than depression (OR: 3.35 vs 1.96 - Jansson & Linton, 2006). Thus far, research has understood that women with higher levels of anxiety report poorer sleep quality (Freedman & Roehrs, 2007). Xu et al. (2016) identified that symptomatic women were 3 times more likely to report sleep difficulties than asymptomatic women. A qualitative analysis by the NSF (2007), found that 'worrying too much' and/or 'being stressed or anxious' were the most common reasons for sleep difficulties. Around 80% of women reported such complaints. Cheng et al. (2008) identified that females with high anxiety typically exhibited troubles initiating and maintaining sleep. They also reported frequently using sleep medication to aid their troubles. Overall, there is very limited research addressing the association between anxiety and sleep in midlife women. However, a greater understanding is imperative. Midlife constitutes a 'vulnerable window' for women - where they are 14-times more likely to develop psychological problems (Schmidt, Haq & Rubinow, 2004). Therefore, the impact on sleep, and its further consequences, could be detrimental if left unexplored.

Moreover, health behaviour change is common in midlife, and unhealthy habits have been associated with sleep problems (Gold et al., 2000). Schoenborn and Adams (2008) highlighted that those engaging in health risk behaviours such as smoking, alcohol consumption and physical inactivity, reported less sleep duration compared to those whom did not (<6 hours vs 7-8 hours sleep per night). However, less is understood about the effect of such habits on sleep quality - particularly in midlife women. Thus far, female cigarette smokers, relative to non-smokers; are found to have greater sleep difficulties (31% vs 7% - Ağan et al., 2015). In a sample of 3,655 women (aged 34-67 years), Soltani et al. (2012) found sleep quality decreased in proportion to the number of cigarettes smoked daily. Those smoking over 20 cigarettes per day were twice as likely to report poor sleep quality than non-smokers (14% vs 7%). Similarly, midlife women whom report physical inactivity are twice as likely to exhibit sleep problems than women who are active (Gold et al., 2000). The NSF (2013) compared a large sample *(n*=1000) of male and female (aged 23-60 years) vigorous, moderate, light and non-exercisers. Reports of good sleep quality reduced from 83%, 77%, 76% to 56% respectively. Conversely, in other studies, greater physical exertion has been found to promote sleep troubles. Trinkoff, Storr, & Lipscomb (2001) found physically demanding occupations, such as nursing; were associated with self-reported inadequate sleep. Mixed results are also documented for the relationship between alcohol consumption and sleep quality. Controversially, some studies show that alcohol has a beneficial, sedative effect on sleep. For example, Soltani et al. (2012) found women drinking 1-2 glasses of alcohol per day more frequently reported no sleep problems than those who abstained (69% vs 63%). However, research also suggests that high consumption may have a negative, stimulating effect on sleep. Women whom drank more than 2 glasses of alcohol per day were found to have

marginally poorer sleep quality than those who drank 1 (8% vs 6%) (Soltani et al., 2012). Woods and Mitchell (2010) found that increased alcohol consumption was associated with both night time awakenings and shorter sleep onset in midlife women, providing evidence of both stimulating and sedative effects of alcohol on sleep. Overall, research addressing an association between health behaviours and sleep quality in midlife women is very limited. Yet further exploration is due, as risk behaviours are significantly greater within this stage of life (Office for National Statistics [ONS], 2018) thus, placing midlife women in greater likelihood of sleep deficiencies.

Overall, the aforementioned literature clarifies the complex and multifactorial aetiologies of sleep disturbance in midlife women. In reflection of this, the present research examined the relative importance of menopausal status, VMS, psychological health (depression and anxiety) and health behaviours (cigarette smoking, physical activity and alcohol consumption) on predicting sleep quality in midlife women. The following study extended previous research by examining the effect of bothersome VMS, anxiety symptoms and health behaviours, all of which have been neglected within previous research regarding midlife women; and warrant further understanding. The purpose of this study was to explore the relationship between menopausal status, VMS, psychological health, health behaviours and sleep quality. Additionally, to identify if the variables aforementioned could collectively and independently predict sleep quality, and if so, which variable predicts sleep quality the greatest. To the authors knowledge, this research is the first to explore such variables together, thus no specific predictions were made. Findings will provide greater understanding as to what may be influencing the poor sleep quality consistently reported by midlife women. To reiterate, poor sleep quality can have detrimental effects on health and functioning. Therefore, it is important for researchers and clinicians to gain greater understanding as to what factors may contribute to midlife women's sleep quality in order to be able to formulate treatment strategies, or even preventative measures.

Method

Participants

The inclusion criteria of this study were (1) female, (2) aged 40-60 years. This age bracket was decided as women are highly symptomatic around these ages (Harlow et al., 2017), and previous research examines this age group (Blümel et al., 2012). Exclusion criteria included women who had (1) undergone hysterectomy surgery or (2) utilised contraception *and* not had a regular menstrual cycle within the past 3 months. This was enforced so women could report their menopausal status, as hysterectomy surgery and contraception can artificially decrease regularity or stop menstruation completely.

This study's final sample comprised of 292 women aged 40-60 years old (M=51.01, SD=5.07). Although 428 participants gave consent, 83 responses were excluded due to questionnaire incompletion and 53 responses were excluded due to participants meeting exclusion criteria.

Procedure

Following approval from Oxford Brookes University Psychology Ethics Committee, questionnaires were distributed from the 20th of December 2018 until the 5th of February 2019. Participants were recruited online, through advertisement on the researchers personal Facebook, and an inclusive women's Facebook group ("UK Ladies Menopause Support Group"), of which the researcher gained permission to access. A snowball sampling technique was also adopted, as participants were encouraged to distribute the questionnaire link via their own Facebook. Those whom participated were presented with the participant information sheet (PIS); a brief description outlining the purpose and procedures of the research, and participants' right to withdraw. Those consenting to participate were assured that their anonymity would be preserved, as no IP addresses were collected, and data was both encrypted and password protected. In adherence to the British Psychological Society (BPS) guidelines, the PIS was piloted on an individual who satisfied inclusion criteria (Female, aged 53) to ensure suitability and readability of the language for the sample population.

Measures

An online questionnaire was designed and presented to participants on Qualtrics. Its completion time was approximately 15 minutes. The main questionnaire consisted of 6 sections assessing; sleep quality, menopausal status, VMS, psychological health, health behaviours and demographic information. Before this could be completed, participants completed a section regarding their eligibility to participate.

Section 1: Exclusion questionnaire.

Eligibility was established using 3 dichotomous questions. Participants were excluded from the study if they answered 'yes' to having undergone hysterectomy surgery, and/or utilising 1 of the 4 contraception methods (e.g. "contraception implant"), *and* 'no' to having vaginal bleeding within the last 3 months. However, those answering 'yes' to utilising contraception *and* 'yes' to having vaginal bleeding within the past 3 months were included. Likewise, those responding 'no' to hysterectomy surgery were included and taken to the next section. This section was created to enforce exclusion criteria that may have been overlooked in the PIS.

Section 2: Sleep quality: Pittsburgh Sleep Quality Index (PSQI).

The PSQI (Buysse, Reynolds, Monk, Berman & Kupfer, 1989) comprises of 19-items that measure participants sleep quality over a 1-month period. The first 4 questions are open-ended and require participants to report their time-related sleep habits (e.g. "How long [in minutes] has it usually taken for you to fall asleep each night?"). The remaining 6 questions require participants to answer on a 4-point scale. Firstly, how often they have experienced sleeplessness symptoms during the past month (e.g. "cannot get to sleep within 30 minutes" - 0= 'Not during the past month' to 3= 'Three of more times a week'). Secondly, how they rate their sleep ("How would you rate your sleep quality overall?" - 0= 'Very good' to 3= 'Very Bad'), and thirdly, how much of a problem daytime dysfunction has been (e.g. "enthusiasm to get things done" - 0= 'No problem at all' to 3= 'A very big problem'). Question 10 concerning bed partners was omitted from the present questionnaire, due to its exclusion from published scoring.

Items yield 7 component scores; subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications and daytime dysfunction. Each scored 0-3. Components are then summed to create a Global PSQI score, ranging from 0-21. A higher score signifies worse sleep quality. A PSQI score of 5 or greater defines the participant as a "Poor" sleeper. This cut off point is shown to have diagnostic sensitivity and specificity of around 90% (Buysse et al., 1989). The instrument was found to have high internal consistency (9 items, α= 0.78).

Section 3: Menopausal status.

Three definitions were presented describing different frequencies and regularities of vaginal bleeding. Participants were required to select one definition that best described their vaginal bleeding pattern. Women reporting "I have experienced normal bleeding in the past 3-months, and it has been regular over the past year" were categorised as "premenopausal"; those reporting "I have experienced bleeding within the past 12-months, but it has decreased in regularity over the past year" were defined as "perimenopausal"; and women answering "I have experienced no bleeding within the past 12-months" were considered to be "postmenopausal". Definitions utilised in this section were based upon the recommended staging system of STRAW (Harlow et al.,2012).

Section 4: VMS severity: Greene Climacteric Scale (GCS).

The GCS (Greene, 1998) comprises of 21-items that divide into 4 domains measuring the severity of menopausal symptoms. For the present questionnaire, only the domain of interest (VMS) consisting of 2-items was utilised. Participants were required to indicate on a 4-point scale the extent to which the symptoms ("Hot flushes" and "Sweating at night") had bothered them within the past month (0= 'Not at all' to 3= 'Extremely'). Scores were summed to create a Vasomotor severity score, ranging from 0-6. Higher scores reflect greater symptom severity. Normative data reported by Greene (1991) used a similar sample (200 Scottish women, aged 40-55 years), and found a mean score of 1.79 within the general population sample, compared to 4.41 in the menopause clinic sample. This scale was found to have good internal consistency (2- items, α= .76).

Section 5: Psychological health.

Depression: Patient Health Questionnaire- 9 (PHQ-9).

The PHQ-9 (Kroenke, Spitzer & Williams, 2001) consists of 10-items measuring depression severity over a 2-week period. The first 9-items present statements that relate to potential depressive symptoms (e.g. "Little interest or pleasure in doing things"). Participants are required to state on a 4-point scale how many days they have experienced each symptom (0= 'Not at all' to 3= 'Nearly every day'). Question 10 regarding difficulties in everyday life was discounted from the present questionnaire, due to its exclusion from the scoring. The first 9-item scores were summed to create the PHQ-9 score, ranging from 0-27. Higher scores reflected greater depression severity. PHQ-9 scores of 5, 10, 15 and 20 represented cut-off points for "mild", "moderate", "moderately severe", and "severe" depression groups respectively. This instrument demonstrated good internal consistency (9-items, α = .89)

Anxiety: General Anxiety Disorder Assessment- 7 (GAD-7).

The GAD-7 (Spitzer, Kroenke, Williams & Löwe, 2006) consists of 7-items which measure anxiety severity over a 2-week period. Participants were presented with statements relating to anxiety symptoms (e.g. “Feeling nervous, anxious or on edge”) and asked to report on a 4-point scale how many days such symptoms had been bothersome (0 = ‘Not at all’ to 3 = Nearly every day’). All scores were summed to create a GAD-7 score, ranging from 0-21. Higher scores reflected greater anxiety severity. Cut-off points of 5, 10, and 15 represented “mild”, “moderate” and “severe” levels of anxiety. The scale was found to have excellent internal consistency (7-items, $\alpha = 0.92$).

Section 6: Health behaviours.

Alcohol consumption.

A single-item assessed participants’ alcohol intake on a typical week. Participants were asked to place themselves in 1 of 4 groupings that best reflected their weekly unit intake. A unit guide from the AUDIT-C was presented to participants to aid their estimations. Responses of ‘0 units’, ‘0.5-7 units’, ‘7.5-14 units’ or ‘Over 14 units’ corresponded to coding’s of “abstainer”, “light drinker”, “moderate drinker” or “heavy drinker” respectively. This scale was based upon the UK government’s guidelines that recommends adults consume no more than 14-units of alcohol per week, to keep alcohol-related health risks low (Department of Health, 2016).

Cigarette smoking status.

Smoking status was assessed on whether participants had smoked a cigarette within the past month. Those reporting ‘no’ to smoking were coded as “non-smokers”. Those reporting ‘yes’ to smoking were required to select 1 of 4 coding’s that reflected the frequency of their smoking: “light daily smoker (1-5 cigarettes per day)”, “moderate daily smoker (6-10 cigarettes per day)”, “heavy daily smoker (11 or more cigarettes per day)” or “social smoker (usually only smoke with friends or on a night out)”. Criterion for each category was defined using Husten’s (2009) review of smoking status definitions across research.

Physical activity level.

Three statements were presented describing different physical activity levels (“Low”, “Moderate” or “High” physical activity). Each statement included examples of different activities at each intensity level, such as; exercise/sports, household/garden chores, occupation activities, and the amount of time approximately spent exercising per week. Statements were devised by the researcher based on the definitions of physical activity levels provided in literature (Bandmann, 2008; Scholes & Mindell, 2013; NHS, 2018). Participants were required to select the statement describing their physical activity level within a typical week.

Sections 7: Demographics

This section collected participants personal information such as their age, marital status, bed partner status, whether they had children and if so, whether their children lived at home.

The questionnaire concluded with contact information and website links to guide participants who wanted further help and support.

Results

Before analysis commenced, the raw data was checked for missing values (i.e. items left blank). If approximately 80% of a scale was missing values, participants' data were excluded for that scale. For example, a participant answered 2/9 PHQ-9 items (78% of data missing), resulting in exclusion from PHQ-9 analyses. Alternatively, when participants had the majority of their data, missing values were added by the researcher. This was only required for the PSQI on Likert scale items. Participants with missing values were assigned a 0 in assumption that the item in question did not occur. This was to avoid the loss of valuable data.

In addition, variables were checked for normality. Inspection of histograms and normality plots showed data for global PSQI and VMS severity scores were normally distributed. However, PHQ-9 and GAD-7 scores deviated, displaying a positive skew.

Exploration of sleep quality.

Overall, the mean PSQI global score was 9.49 with a range of 0-20 (Table 1). This indicated that on average participants experience 'poor sleep quality' (Buysee et al., 1989). Eighty- six percent of participants were poor sleepers (PSQI>5), compared to 13.7% as good sleepers (PSQI ≤ 5) (Table 2).

A frequency summary of the PSQI component scores can be seen in Table 3. Overall, 43.2% of participants reported their sleep to be fairly bad, while 10.6% reported their sleep to be good. Thirty-eight percent of women took less than 15 minutes to fall asleep, and 12% took more than an hour. Fifty percent of participants had a total of 5-6 hours of sleep every day, whilst 15.4% stated their sleep duration was over 7 hours per night. The mean hours of sleep were 6.11 (Table 1). Additionally, 30.8% had sleep efficiencies greater than 85%, but a similar percentage (26.7%) had sleep efficiencies less than 65%. The mean sleep efficiency was 76.14% (Table 1). In relation to sleep disturbance, the 4 most frequently cited events were "waking up in the middle of the night or early morning", "getting up to use the bathroom", "feeling too hot" and "cannot get to sleep within 30 minutes". The majority did not use sleep medication (78.4%) and did not have daytime dysfunction (68.2%).

Table 1
Means and standard deviations of Global PSQI, sleep duration (in hours) and sleep efficiency (%) of participants (n=292)

	M ± *SD*
Global PSQI	9.49 ± 4.27
Sleep Duration	6.11 ± 1.19
Sleep Efficiency	76.14 ± 14.99

Table 2
Frequencies and percentages of good and poor sleepers (n=292)

	N (%)
Good Sleeper (PSQI ≤ 5)	40 (13.7)
Poor Sleeper (PSQI > 5)	252 (86.3)

Table 3.
Frequencies and percentages for scores on each PSQI component and types of sleep disturbance reported (n= 292)

	Score							
	0		1		2		3	
Component	N	%	N	%	N	%	N	%
Subjective Sleep Quality	31	10.6	103	35.5	126	43.2	32	11
Sleep Latency	111	38	81	27.7	65	22.3	35	12
Sleep Duration	45	15.4	76	26	146	50	25	8.5
Sleep Efficiency	90	30.8	75	25.7	49	16.8	78	26.7
Sleep Disturbance								
Cannot get to sleep within 30 minutes.	75	25.7	58	19.9	64	21.9	95	32.5
Waking up in the middle of the night or early morning.	19	6.5	38	9.6	53	18.2	192	65.8
Getting up to use the bathroom.	31	10.6	48	16.4	53	18.2	160	54.8
Not breathing comfortably.	221	75.7	31	10.6	20	6.8	20	6.8
Coughing or snoring loudly	141	48.3	36	12.3	63	21.3	52	17.8
Feeling too cold.	180	61.6	65	22.3	24	8.2	23	7.9
Feeling too hot.	48	16.4	39	13.4	79	27.1	126	43.2
Having bad dreams.	157	53.8	68	23.3	48	16.4	19	6.5
Having pain.	138	47.3	51	17.5	45	15.4	58	19.9
Use of Sleep Medication	229	78.4	17	5.8	18	6.2	28	9.6

Daytime Dysfunction	199	68.2	45	15.4	38	13	10	3.4

Note.
For:
Subjective Sleep Quality, “0” = very good, “1” = fairly good, “2” = fairly bad, “3” = very bad.
Sleep Latency, 0” = <15 minutes, “1” = 16-30 minutes, “2” = 31-60 minutes, “3” = >60 minutes
Sleep Duration, 0” = >7 hours, “1” = 6-7 hours, “2” =5-6 hours, “3” = < 5 hours.
Sleep Efficiency, 0” = >85%, “1” = 75-84%, “2” = 65-74%, “3” = <65%.
Sleep Disturbance & Use of Sleep Medication and Daytime Dysfunction: 0” = not during past month, “1” = less than once a week, “2” = once or twice a week, “3” = three or more times each week.

Factors related to sleep quality.

Firstly, analysis involved exploring predictor variables (demographics, menopausal status, VMS, psychological health and health behaviours), and looking for significant differences in these variables for those with poor and good sleep. Next, examining the strength of any associations between variables and overall sleep quality. Finally, a multiple regression was conducted to examine the predictive contribution, both collectively and independently, of all predictor variables on reported sleep quality.

Demographic variables

All of participants’ demographic characteristics are presented in Table 4. The mean age of the sample was 51.01 years (*SD*= 5.07), with a range of 40-60. Commonly, women reported having a bed partner (70.5%) and child(ren) living at home (57.9%). Only child status was found to significantly vary according to sleep quality status (X^2 (2, 292) = 8.75, p=.013, Cramer’s *V*=.17). The majority of both poor (55.6%) and good sleepers (72.5%) had children living at home.

Menopausal status

The majority of participants within the sample identified as ‘Postmenopausal’ (47.9%) (Table 4). The number of women with poor and good sleep quality varied significantly by menopausal status (X^2 (2, 292) = 7.99, p=.018, Cramer’s *V*=.17). Higher percentages of poor sleepers were postmenopausal (50.4%) and perimenopausal (32.5%), compared to premenopausal (17.1%). The majority of good sleepers were premenopausal (35%).

Vasomotor symptoms

The mean total VMS severity score was 2.45 with a range of 0-6 (Table 4). Normative data previously identified a mean score of 1.79 within the general population, and 4.41 in the menopausal clinic sample (Greene, 1991). This suggests the present sample displayed higher levels of bothersome symptoms than expected within the general population, but below clinical significance. Symptoms differed significantly between poor and good sleepers (*t*(290)=-9.17, p=<.001). Greater bothersome VMS were experienced by poor sleepers (*M*=2.69) than good sleepers (*M*=0.93). Scores were still not within a range considered to reach clinical significance. Additionally, participants were categorised into ‘Bothersome’ symptoms on the basis of reporting either ‘a little’, ‘quite a lot’ or ‘extremely’ bothersome VMS. ‘Not Bothersome’ reported ‘not at all’ to experiencing symptoms. Compared to good sleepers, poor sleepers

reported significantly greater bothersome (88.9% vs 55%) and less not bothersome symptoms (11.1% vs 45%) (X^2 (1, 292) = 29.87, p<.001, *phi*=.32).

Psychological Health

The mean total score of the PHQ-9 was 8.66 with a range of 0-27 (Table 4). This indicated that on average participants experience 'mild depression severity' (Kroenke et al., 2001). A significant difference was found between depression scores for those with poor and good sleep quality (*U*=1265, *p*= <.001). On average, poor sleepers fell in the 'moderate depression' band (*M*=9.65), whereas good sleepers fell in the 'no depression' category (*M*=2.43). The percentages for each depression group (None, Mild, Moderate, Moderately Severe and Severe) are displayed in Table 4. The differences found between these groups were also significant (X^2 (4, 291) = 59.93, p<.001, Cramer's *V*=.45).

Additionally, the mean total score of the GAD-7 was 6.59 with a range of 0-28 (Table 4). This indicated that women experienced 'mild anxiety severity' on average (Spitzer et al., 2006). A significant difference was found between anxiety scores and good and poor sleep quality (*U*= 2031, *p*=<.001). On average, poor sleepers fell into the 'mild anxiety' category (*M*=7.27), whereas good sleepers fell into the 'no anxiety' band (*M*=2.40). Details for each anxiety group (None, Mild, Moderate, and Severe) can be seen in Table 4. Differences between groups were also found to be significant (X^2 (3, 292) = 22.72, p<.001, Cramers *V*=.28).

Health Behaviours

Details of the frequencies of each health behaviour are displayed in Table 4. The highest proportion of participants were 'light drinkers' (40.8%), 'non-smokers' (85%), and had 'moderate' physical activity levels (52.4%). As very few participants identified within a smoker group ('heavy daily smokers' [*n*= 15], 'moderate daily smokers' [*n*= 9], 'light daily smokers' [*n*= 8], or 'social smoker [*n*= 1]), a total 'smoker' group (*n*=33) was computed and used for further analyses. None of the examined health behaviours were significantly related to sleep quality.

Table 4.
Bivariate analysis of the relationship between Sleep Quality and demographic variables, menopausal status, vasomotor symptoms, psychological health and health behaviours.

	Overall (n= 292) N (%) or *M* ± *SD*	Good (n= 40) (PSQI ≤ 5) N (%) or *M* ± *SD*	Poor (n=252) (PSQI > 5) N (%) or *M* ± *SD*	*χ2* or *t* or *U*	*p*
Demographic variables					
Age	51.01(5.07)	51.65 ± 5.76	52.07± 4.96	-.48	.629
Bed Sharing Status				.26	.878
No	52(17.8)	6(15)	46 (18.3)		
Sometimes	34(11.6)	5 (12.5)	29(11.5)		
Yes	206(70.5)	29(72.5)	177(70.2)		
Child Status				8.75	.013
No children	45(15.4)	8(20)	31(14.7)		
Child not living at home	78(26.7)	3(7.5)	75(29.8)		
Children living at home	169(57.9)	29(72.5)	140(55.6)		
Menopause status				7.99	.018
Premenopause	57 (19.5)	14(35)	43(17.1)		
Perimenopause	95 (32.5)	13 (32.5)	82 (32.5)		
Postmenopause	140 (47.9)	13 (32.5)	127 (50.4)		
Vasomotor symptoms					
Total VMS severity score	2.45±1.79	0.93 ± 0.99	2.69 ± 1.764	-9.17	<.001
Bothersome	246 (84.2)	22 (55)	224(88.9)	29.87	<.001
Not Bothersome	46(15.8)	18 (45)	28 (11.1)		
Psychological Health					
Depression					
Total PHQ-9 Score	8.66±6.25	2.43 ± 3.26	9.65 ± 6.04	1265	<.001
None	85(29.2)	32 (80)	53(21.1)	59.93	<.001
Mild	93(32)	7(17.5)	86(34.3)		
Moderate	59(20.3)	0(0)	59(23.5)		
Moderately Severe	34(11.6)	1(2.5)	33(13.1)		
Severe	20(6.8)	0(0)	20 (8)		
Anxiety					
Total GAD-7 score	6.59 ± 3.58	2.40 ± 3.30	7.27 ± 5.35	2031	<.001
None	122(41.9)	30(75)	92(36.5)	22.72	<.001
Mild	91(31.2)	8(20)	83(32.9)		
Moderate	47(16.1)	2 (5)	45(17.9)		
Severe	32(11)	0(0)	32(12.7)		
Health behaviours					
Alcohol Consumption				6.73	.081
Abstainer	90(30.8)	10(25)	80(31.7)		

Light	119(40.8)	18(45)	101(40.1)		
Moderate	47(16.1)	3(7.5)	44(17.5)		
Heavy	36(13.3)	9(22.5)	27(10.7)		
Smoking Status				1.78	.183
Non-Smoker	259(88.7)	33(82.5)	226 (89.7)		
Smoker	33(11.3)	7(17.5)	26(10.3)		
Light Daily	8(2.7)				
Moderate Daily	9(3.1)				
Heavy Daily	15(5.1)				
Social	1(0.3)				
Physical Activity				1.79	.410
Low	100(34.2)	13(32.5)	87(34.5)		
Moderate	152(52.4)	19(47.5)	134(53.2)		
High	39(13.4)	8(20)	31(12.3)		

Strength of association between predictor variables and sleep quality.

As parametric assumptions were violated, a non-parametric Spearman's Rho was used to explore the relationship between the predictor variables (demographics, menopausal status, VMS, psychological health and health behaviours) and overall sleep quality (Table 5).

Results showed a weak positive correlation between menopausal status and global PSQI *(*r_s (292) = .16, p = .008), a moderative positive relationship between VMS severity scores and global PSQI (r_s (292) = .49, p = <.001), and a strong positive relationship between both GAD-7 (r_s (292) = .61, p = <.001) and PHQ-9 (r_s (291) = .66, p = <.001), and Global PSQI. However, none of the examined health behaviours (alcohol consumption, cigarette smoking status, physical activity level) or demographic variables (age, bed partner status, child status) significantly correlated with Global PSQI scores.

Table 5.
Spearman's Rho correlation for all variables.

Scale	1	2	3	4	5	6	7	8	9	10	11
1.Global PSQI											
2. Menopausal status	.16**										
3. VMS severity	.49**	.16**									
4. PHQ-9	.66*	-.01	.39**								
5. GAD-7	.61**	.00	.38**	.69**							
6. Alcohol consumption	-.09	.08	-.05	-.18**	-.06						
7. Cigarette Smoking status	-.04	.01	.04	-.07	-.05	.01					
8. Physical Activity Level	-.08	-.07	.01	-.20**	-.14*	.18**	.06				
9. Age	.07	.71**	.02	-.10	-.11	.07	.05	-.00			
10. Bed partner status	-.14	-.05	-.10	-.19**	-.11	.04	.01	.10	-.01		
11. Child status	.05	-.21**	.13*	.08	.13*	-.09	.06	-.01	-.24**	.07	

Note.
**= significant at p<.001 level
*= significant at p<.05 level

Predictive contribution of menopausal status, vasomotor symptoms, psychological health, health behaviours and demographics to sleep quality.

A multiple linear regression using an enter approach was conducted to examine the contribution of the aforementioned predictor variables to sleep quality. Parametric assumptions of homoscedasticity, collinearity, and independence (Durbin Watson value = 2.01) were met. However, normality was violated, due to skewed PHQ-9 and GAD-7 scores. Data for both variables were transformed by square rooting. Only distribution of the GAD-7 scores improved, thus the original data for PHQ-9 was utilised for analysis. Results regarding this variable should be interpreted with caution.

The results for the multiple regression can be seen in Table 6. Overall, the regression model was found to be significant, explaining 54.9% of variance in Global PSQI scores (*F (10,280) = 34.13, p<.001,* R^2 *=.54).* This demonstrates that collectively menopausal status, VMS, depression, anxiety, alcohol consumption, cigarette smoking status, physical activity level, age, bed partner status, and child status predict sleep quality. However, only 3 predictors; VMS severity *(*β = .258, p=<.001), PHQ-9 *(*β = .369, p=<.001) and GAD-7 *(*β = .233, p=<.001), were statistically significant independent predictors. This illustrates that only VMS, depression and anxiety are significantly associated with sleep quality. Beta values indicated that as bothersome VMS, depressive symptoms and anxiety symptoms increase, sleep quality scores increase (indicating poorer sleep quality). Additionally, of these three variables, the PHQ-9 made the largest unique contribution (β = .369). This suggests that depression relates to sleep quality the greatest when the variance explained by other variables is controlled for.

Table 6. Summary of linear multiple regression model for variables predicting sleep quality (Global PSQI)

Predictors	B	SE	β	t	p
Menopausal Status	.385	.326	.069	1.182	.238
VMS severity	.618	.109	.258	5.667	<.001
PHQ-9	.271	.047	.369	5.829	<.001
GAD-7	.825	.235	.233	3.503	<.001
Alcohol Consumption	-.030	.184	-.007	-.161	.872
Cigarette Smoking Status	.043	.547	.003	.078	.938
Physical Activity Level	.037	.275	.006	.135	.893
Age	.055	.049	.066	1.137	.257
Bed Partner Status	.112	.227	.020	.495	.621
Child Status	-.189	.243	-.033	-.779	.437

Discussion

In the present research, an overwhelming 86.3% of midlife women reported poor sleep quality. This prevalence is greater than previously documented, whereby 40-60% of midlife women are found to have sleep impairments (Kravitz et al., 2008; Ağan et al., 2015). Findings could suggest that sleep problems within midlife are rising over time, or perhaps reflect that British women (presumed to be the majority population within this sample) have greater sleep difficulties compared to other populations used within previous research (e.g. Turkish women - Ağan et al., 2015). Nonetheless, findings emphasise a greater need to understand what is contributing to poor sleep. In light of this, the present study aimed to identify risk factors of poor sleep quality. Menopausal status, VMS, psychological health (depression and anxiety) and health behaviours (cigarette smoking, physical activity and alcohol consumption) were examined as correlates and predictors of sleep quality.

Menopause itself was found to not be inevitably associated with poor sleep quality. The present study demonstrated that menopausal status did not predict sleep quality. Such findings have been confirmed by some previous research, but not all. Pien et al.'s (2008) 8-year longitudinal study, for example; found women's sleep quality did not differ through the menopause transition. Additionally, Blümel et al. (2012) study of women from 11 American states, concluded that the influence of menopause on sleep disturbance was modest. Conversely, research often demonstrates that menopause significantly relates to poor sleep (Xu & Lang, 2014; Lampio et al., 2017). Kravitz et al. (2003) found peri and post-menopausal women had greater sleep difficulties (50%) than premenopausal (30%). Likewise, the present study illustrated that women in peri (32.5%) and post-menopause (50.4%) had poorer sleep quality than premenopause (17.1%). Importantly, however, this relationship became nonsignificant when other variables were controlled. Other studies also demonstrate that menopause relates to sleep in unadjusted conditions, but not controlled. Both Chung and Tang (2006) and Xu et al. (2016) found at bivariate analysis that post and peri-menopausal had significantly greater sleep difficulties than premenopausal (22-25% vs 7% and 47-49% vs 30% respectively). However, in both studies, regression analyses (controlling for other variables) identified menopause had no strength in predicting sleep quality. Thus, the present results are consistent with previous research. Arguing that menopause *per se* correlates with poorer sleep; however, does not predict sleep quality when other factors are considered.

Bothersome VMS were found to be strongly associated with poor sleep quality. Women's symptom scores were found to be significantly higher for poor sleepers than good (VMS severity score: 2.69 vs 0.93). Previous research draws similar conclusions. Kravitz et al.'s (2003) study of 12,600 women, found those with present VMS had greater sleep difficulties. Likewise, in subsequent research, Kravitz et al. (2008) reported that those with severe symptoms (>6 days in a 2-week period) were more likely to report poorer sleep. However, caution needs to be taken when comparing the present findings to previous research. The aforementioned literature only considers the presence/frequency of VMS, whereas this study measured how bothersome women perceived symptoms to be. Thurston et al. (2008) proposed that understanding the bothersomeness of symptoms is important, as symptoms could occur without interference on sleep. In the present study, poor sleep was significantly predicted by

bothersome VMS. A greater frequency of women with poor sleep reported bothersome symptoms (88.9%) compared to not-bothersome (11%). This supports research by Xu et al. (2012), who reported bothersome symptoms, but not symptoms without bother, predicted sleep disturbance. Interestingly, the prevalence of bothersome symptoms in their study was much less than the present (30% vs 84.2%). An explanation for this discrepancy could be that the current sample was skewed towards postmenopausal women (47.9%). Hardy and Kuh (2002) observed that VMS increased in postmenopausal women, relative to women in other menopausal stages. Thus, the effects on sleep may be overestimated within the present study. Nonetheless, findings add to the limited literature that attempts to disentangle the relationship between perceived bothersomeness of VMS and sleep.

In addition, the present study found both psychological health variables, depression and anxiety, to be independent risk factors of poor sleep quality. In regard to depression, women reporting poor sleep had greater depression severity scores compared to those reporting good sleep (PHQ-9 score; 9.65 vs 2.43). This finding is consistent with previous research that reports robust associations with depression and poor sleep. Tom et al. (2010) found greater prevalence of depression in women with troubled sleep compared to less troubled sleep (40% vs 27%). Similarly, Xu et al. (2016) found depression to be 2-times greater in poor sleepers than good (44% vs 23%). Research also suggests that depression makes the strongest predictive contribution to poor sleep quality, relative to other variables investigated. For example, Hsu and Lin (2005) investigated occupational status, chronic disease, menopausal status, number of medical illnesses, menopausal symptoms, age and depression as predictors of sleep quality. Depression was found to be the major predictor of sleep quality, accounting for 33% of the variance. Likewise, the present study found that out of all significant predictor variables, depression made the largest unique contribution to sleep quality. Findings indicated that as depression severity increased, women's subjective sleep quality ratings decreased. Interestingly, a greater proportion of women with poor sleep reported mild depression (34.3%), compared to severe (8%). This could support Buysse et al.'s (2008) finding, that adverse effects on sleep are found when individuals report only mild psychological symptoms. However, a better explanation could be that the present sample overall had more women with mild (32%) than severe depression (6.8%). Unfortunately, other studies are not directly comparable to the present research as they only measure depression dichotomously ('depression' or 'no depression'). Future research examining sleep quality should therefore consider depression severity and not presume only the presence of symptoms predict poor sleep quality.

Moreover, anxiety was found to be a significant predictor of sleep quality. Women reporting poor sleep had significantly higher anxiety severity scores than good sleepers (GAD-7 score: 7.27 vs 2.40). Likewise, research from Freedman and Roehrs (2007) found higher anxiety scores predicted low subjective sleep quality in midlife women. More specifically, Xu et al (2016) identified that the prevalence of anxiety was 3-times greater in poor sleepers, compared to good sleepers (43% vs 13%). These findings, alongside the present study, suggest that anxiety has an important relationship with the sleep of midlife women, which may not be surprising when considering the overlap between anxiety and insomnia (American Psychiatric Association, 2013). Yet, the role between anxiety and sleep in this age group is not well understood. One proposed reason for the association between sleep and anxiety

in this age group is that midlife is a time of multiple changes, including children leaving the family home ('empty nest' phenomenon) and interpersonal relationships failing (e.g. divorce) (Wang, Shu, Dong, Luo & Hao, 2013; Kuh, Hardy, Rodgers & Wadsworth, 2002). This study examined the effects on sleep quality of both children not living at home, and relationship status. No significant relationships were found. In fact, poor sleep was found to occur more often when children were living at home. Therefore, conclusions can be made that although psychological symptoms predict poor sleep quality, the mechanisms underlying this is not clearly understood. Nonetheless, this study makes significant contributions to the limited research findings, emphasising the need for further investigation within the future.

In contrast, all health behaviours (alcohol, smoking and physical activity) were found to not be associated with poor sleep quality. This contradicts the limited existing research that suggests risk behaviours increase sleep difficulties (Woods & Mitchell, 2010; Gold et al., 2000; NSF, 2013; Ağan et al., 2015). Disparity in findings could be due to the different methods used to obtain health behaviours in the present and previous research. For example, significant associations between health behaviours and sleep quality are commonly found when using interviews to gather data (Gold et al., 2000; Ağan et al., 2015). Whereas, when questionnaires are used (like the present study), non-significant relationships between health behaviour and sleep are reported (Tom et al.,2010). This could suggest that non-significant findings may be attributed to the way in which data was collected in this study. One reason for this may be that questionnaires (as opposed to interviews) promote misreporting, as participants cannot confirm any ambiguity. But equally, significant findings from interviews may be the result of bias - as interviewers can lead questions to obtain answers that support the desired outcome. Thus, one method is not more desirable than the other. However, a more likely reason for the non-significant relationship between health behaviours and sleep quality within the present study, is that only small numbers of women actually engaged in unhealthy behaviours. For example, only 33 women smoked; whereas 259 didn't. This controversially suggests that midlife women may not engage in greater risk behaviours - as the ONS (2018) suggested. Perhaps midlife women are more health conscious than previously thought, which could be why negative effects on sleep were not found.

Furthermore, findings of the current study need to be considered in light of a number of limitations. Firstly, a cross-sectional design was used; meaning that a causal relationship between VMS, depression, anxiety and sleep quality could not be determined. Previously, research has acknowledged that the relationship between these variables is complex. For example, psychological symptoms can both precede the onset and occur as a consequence of poor sleep quality. Sivertson et al. (2009) found that depression (without insomnia) or insomnia (without depression) at baseline, predicted insomnia or depression at the follow up respectively. Additionally, the independence of variables is unclear. The domino hypothesis (Campbell & Whitehead, 1997) proposes that sleep disturbances mediate a relationship between VMS and psychological variables. Simply, VMS disturb sleep, and sleep causes psychological symptoms. In the present study vasomotor symptoms were found to positively correlate with both psychological health variables. However, due to the design of this study the complex bidirectionality of relationships could not be captured. To understand these relationships in future research, a longitudinal design would be required.

Moreover, subjective sleep was the only outcome studied. Discrepancies between subjective and objective sleep in midlife women has been well documented. Young, Rabago, Zgierska, Austin, and Laurel (2003) illustrated this in their examination of menopausal status and sleep quality. In subjective sleep quality measures, menopausal women had poorer sleep than premenopausal. However, objective measures (using PSG), found that menopausal women had significantly better sleep quality (i.e. longer sleep duration) than premenopausal. This highlights that questionnaire findings, like the present, may not be an accurate reflection of women's objective sleep quality. To reinforce significant findings, future research should include objective measures to validate the subjective information provided by participants. Nonetheless, subjective studies still remain important; after all, one's own perception of health is what prompts them to seek medical help and guides the direction of medical interventions (Mishra & Kuh, 2006).

Despite some limitations, the present study has much strength, such as its large sample size, use of standardised measures for key variables, novel findings and directions for future research. Additionally, findings provide promising implications for guiding development of future interventions. By understanding that VMS and psychological health significantly contribute to poor sleep within midlife women, targeting these symptoms may improve sleep and reduce the related consequences (e.g. early mortality - Cappuccio et al., 2010). An existing sleep intervention, hormone replacement therapy (HRT), effectively reduces both physical and psychological symptoms of menopause (NHS, 2016). Pinkerton, Abraham, Bushmakin, Cappelleri and Komm (2016) found HRT reduced the frequency of VMS from >7 to 5 per day. Likewise, Boyle and Murrihy (2001) found HRT significantly reduced psychological symptoms compared with controls. Both studies also reported significant reductions in sleep problems. Therefore, utilising HRT to target the symptoms may be more effective than treating sleep directly. Currently, sleep problems in midlife women are widely treated with sedatives that do not target all predictors of sleep found within this study (Hall, Kline & Nowakowski, 2015). This may be an important reason why the prevalence of poor sleep in midlife women remains extremely high.

In summary, this study identified that VMS, anxiety and depression were unique predictors of poor sleep quality in midlife women. The latter was found to be the strongest contributor. Menopausal status did correlate with poor sleep quality, however, was not an independent predictor when other factors were controlled. This proposes that menopause symptoms (vasomotor and psychological) may mediate the effect of menopause on sleep. Health behaviours were found to not be related to poor sleep quality. Collectively, findings demonstrate what may predominantly be contributing to the poor sleep described by midlife women. In understanding this, recommendations can be given to clinicians to treat the active symptoms and effectively reduce sleep difficulties and their detrimental consequences. However, before this can be done with confidence, further research is required and should expand on the measures and design used within this study. Nonetheless, the present study contributes to a limited body of research and proposes factors that may play a significant role in the high rates of sleep difficulties reported by midlife women.

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