Sleep in obsessive-compulsive disorder: A systematic review and meta-analysis

Amparo Díaz-Román [a], Lilisbeth Perestelo-Pérez [b], Gualberto Buela-Casal [a,*]

[a] Mind, Brain and Behavior Research Center, CIMCYC, University of Granada, Granada, Spain

[b] Evaluation Unit of the Canary Islands Health Services Research on Chronic Patients Network (REDISSEC), Tenerife, Spain

* Corresponding author. Mind, Brain and Behavior Research Center, CIMCYC, University of Granada, 18011 Granada, Spain.

Tel.: 34 958243750

E-mail address: gbuela@ugr.es (G. Buela-Casal).

Abstract

Objectives: The aim of this study was to determine whether there are differences in sleep between people with and without obsessive-compulsive disorder (OCD), and, if so, whether such differences are associated with comorbid depressive symptoms or other conditioning factors.

Methods: We conducted a search for articles published until March 2013 in PubMed, Web of Knowledge, PsycINFO, Scopus, Trip Database, Dissertation Abstracts and OpenSIGLE. We retrieved 9,658 records, which were assessed against the inclusion and quality criteria.

Results: Six studies were included in the review and four were included in the meta-analysis. They were all cross-sectional studies with medium methodological quality. All studies except one were polysomnographic. The total sample of the meta-analysis consisted of 111 patients with OCD and 141 controls.

Conclusion: The synthesis of results showed differences in sleep between people with and without OCD. The presence of comorbid depression was a key issue in the amount and type of differences found. Nevertheless, in order to support these results, longitudinal studies should be conducted with larger sample sizes and different age ranges.

Keywords:

Sleep

Obsessive-compulsive disorder

OCD

Systematic review

Meta-analysis

Abbreviations

Chi^2 = heterogeneity test

DSM = Diagnostic and statistical manual of mental disorders

I^2 = heterogeneity index (%)

ICD = International classification of diseases

OCD = obsessive-compulsive disorder

REM = rapid eye movement

SIGN = Scottish intercollegiate guidelines network

SD = standard deviation

SMD = standardized mean difference

SR = systematic review

Y-BOCS = Yale-Brown obsessive-compulsive scale

Z = test for overall standardized mean difference

1. Introduction

Obsessive-compulsive disorder (OCD) is an anxiety disorder characterized by the presence of repetitive obsessions and compulsions that are senseless and out of control, generate anxiety and distress in those who experience them and interfere with their daily activities. Obsessions are intrusive ideas, thoughts or images of various types, and compulsions are acts or behaviors that individuals perform to suppress the anxiety generated by obsessions. Although OCD is characterized by a heterogeneity of symptoms, the most common obsessions are associated with the following issues: fear of causing harm to others or to oneself, being contaminated, making mistakes or exhibiting inappropriate behaviors; the need for order and symmetry; and sexual or religious ideas or beliefs. The most common compulsions are checking, cleaning, repeating words, counting and hoarding [1-4].

OCD is one of the most serious and disabling diseases [3] and has an estimated prevalence of about 2% in the general population [5]. Although the exact cause of its onset is unknown [1], it can appear as much in childhood as in adulthood, without important differences in symptoms between older and younger individuals. However, there are differences in sex and comorbidity between child and adult populations [4]. Comorbid diseases are very frequent among people with OCD. The most usual comorbidities are depression, eating disorders, Tourette's syndrome, substance abuse and certain anxiety disorders [3]. A relationship between OCD and certain sleep disturbances has been also found, although the results of studies carried out on this question are contradictory.

Whereas the results of some studies suggest differences between people with and without OCD regarding sleep continuity, like in sleep duration and time awake before or after sleep [6-8], the results of other studies show differences in relation to sleep architecture. For instance, Kluge, Schussler, Dresler, Yassouridis and Steiger [9] found that participants with OCD spent a lower amount of time in stage 4 sleep than controls. There are also authors who

pointed out a relationship between OCD symptoms and insomnia or delayed sleep phase disorder [10,11]. However, other authors, oppositely, did not find differences between people with OCD and people without OCD in any sleep variable assessed [12]. Moreover, in some studies, changes in sleep in some participants may have been due to a greater severity of their disease or to the presence of concomitant depression. This type of depression, similarly to other psychiatric and neurodegenerative diseases, has already been associated with sleep and circadian rhythm disorders [13].

It is important to consider sleep patterns in clinical diseases because they are a key factor in people's health and quality of life. In fact, there is a relationship between sleep patterns and various physical, mental and social impairments [14-20]. There are also reasons to believe that sleep disturbances can aggravate the course and treatment of various diseases [21].

Given the influence of sleep on various aspects and the current controversy about its relationship with serious illnesses such as OCD, a systematic review (SR) was needed to clarify the issue and allow a better prognosis and quality of life for patients with OCD. Although a systematic review was conducted recently in order to resolve that question [8], the inclusion of studies in which participants with OCD were not compared to a control group does not allow to obtain definitive conclusions. In addition, some of the studies included in that SR did not provide data regarding comorbidities or medication. This, neither enable to know if people with OCD really suffer from sleep disturbances, nor that there are other conditioning factors in this relationship that have not been taken into account. Above all, the influence of depression comorbidity in sleep disturbances of people with OCD could not be elucidated. As a result, it was necessary to conduct an SR analysing available studies from a more specific approach in order to answer this question. Particularly, there was a need to compare people with OCD and people without OCD (and any other mental disorder) in sleep,

taking into account comorbid depression as well as any other variable that may have an impact on the sleep disturbances found between both groups of people.

Considering this, the overall objective of this SR or theoretical study [22] was to determine, following the criteria established by Perestelo-Perez [23], whether there are differences in sleep between people with OCD and people without OCD and, if so, whether such differences are associated with comorbid depression or other conditioning factors.

2. Methods

2.1. Search strategy

We conducted a literature search for articles published until March 2013 in PubMed, Web of Knowledge, PsycINFO, Scopus, Trip Database, Dissertation Abstracts and OpenSIGLE. We used the following search terms: <<sleep* OR polysomnography OR actigraphy OR sleep, REM OR wak* OR circadian rhythm OR biological clocks OR circadian clocks OR sleep* stages OR sleep* deprivation OR sleep dis* OR dys?omnias OR parasomnias OR sleep* initiation and maintenance dis* OR dis* of excessive somnolence OR REM sleep* parasomnias OR sleep* dis*, circadian rhythm OR chronobiology dis* OR sleep* dis*, intrinsic OR sleep-wak* transition dis* OR sleep* arousal dis* AND obsessive compulsive dis*>>. The search terms were in Spanish or in English depending on the database and were limited to title, abstract and keyword fields. We did not set any search limits regarding language or publication year in order to be comprehensive in the information retrieval. Subsequently, we also conducted a manual search, analyzing each of the journals where the selected articles had been published and reviewing the references of each article in case they included another study of interest that had not been identified.

2.2. Selection criteria

Studies were selected if they 1) included patients with OCD –according to the Diagnostic and statistical manual of mental disorders (DSM), the International classification

of diseases (ICD) or any other diagnostic manuals– in whom the disorder was not due to the direct physiological effects of a substance or a medical illness; if patients had another disorder, the content of their obsessions or compulsions should not be limited to the other disorder; 2) were comparative studies (randomized or non-randomized) in which the control group was composed of people without OCD or any other psychiatric disorder and the evaluation had been performed simultaneously in both groups by the research team itself; 3) considered the existence or nonexistence of differences in sleep and the type of differences as outcome measures; 4) provided data on age, sex, severity of disease, medication and concomitant diseases of participants; 5) were not just abstracts or conference papers.

2.3. Study selection

The titles and abstracts of the studies identified were screened to verify whether they met all the selection criteria discussed above. When there were any doubts, the full text of the study was reviewed.

2.4. Assessment of risk of bias and methodological quality

We assessed the risk of bias of studies identified using the Scottish intercollegiate guidelines network (SIGN 50) checklist developed for cohort studies [24], whose efficiency has been demonstrated by Bai, Shuckla, Bak and Wells [25]. To avoid any bias, the identifying data of studies were removed and studies were assigned a number by an external person prior to the assessment. According to the degree of compliance of their items, studies were classified into three groups: 1) high quality, low risk of bias; 2) medium quality, moderate risk of bias; and 3) low quality, high risk of bias. As some items were not applicable to the type of studies selected, we obtained a weighted score by subtracting one degree of quality from the score obtained. We only included studies classified into the second group according to the weighted score.

2.5. Data collection and statistical analysis

After selecting the articles, we obtained relevant information from each one using a form that included data concerning the article itself, the methodology used, the most important characteristics of participants and the main differences found between both groups.

Next, we performed a meta-analysis following the steps proposed by Botella and Gambara [26], and including only those studies in which the same assessment measure of sleep had been employed: polysomnography. We selected the variables to be analyzed considering the most common variables among the studies and others that were significant or of interest in some studies and could be inferred from other variables in studies where they were missing. We explored the relationship between exposure to OCD as a risk factor and the following sleep parameters: sleep period time, total sleep time, sleep latency, sleep efficiency, time awake, stage 1 sleep, stage 2 sleep, slow-wave sleep, rapid eye movement (REM) sleep and REM latency.

We conducted the meta-analysis using Review Manager 5.2 software, with a fixed-effects model and a 95% confidence interval (CI). We calculated the following: 1) the standardized mean difference (SMD) as a measure of effect size or summary statistic, with the correction proposed by Hedges [27] to avoid bias due to sample size; 2) the pooled SMD or weighted mean effect size according to the inverse variance method; 3) the Chi^2 and I^2 statistics [28], to assess and quantify the heterogeneity between the studies; and 4) the Z statistic, to verify the statistical significance of the overall SMD.

Later, in order to verify whether sleep disturbances were due to OCD or only to the presence of a comorbid depression, we performed a second meta-analysis following the same procedure. This time we only included studies in which participants with OCD did not have comorbid depression in order to compare the results of both meta-analyses.

Finally, we did not conduct the sensitivity and publication bias analyses recommended by Higgins and Green [29] due to the small number of studies included.

3. Results

3.1. Studies included

Of the 9,658 records retrieved after removing duplicates, six studies fulfilled the minimum inclusion criteria and satisfactorily passed the assessment of risk of bias (**Fig. 1**). Two studies were excluded from the meta-analysis –one because it was the only non-polysomnographic study [30] and the other one because its inclusion increased the degree of heterogeneity between the studies [31] and it was not recommendable to perform a meta-regression or to follow a random-effects model because of the low number of available studies [29].

3.2. Study characteristics

The most relevant characteristics of the studies included in the SR are summarized in **Table 1**. Three studies [30,32,33] were divided into two parts based on the sample characteristics and the results reported by the authors. They were all cross-sectional studies with medium methodological quality according to the weighted score of risk of bias, and were all polysomnographic except for one [30]. As regards the studies included in the meta-analysis, the total sample consisted of 252 participants, including 111 patients with OCD, with a mean score of 25.78 in the Yale-Brown obsessive-compulsive scale (Y-BOCS) and a standard deviation (SD) of 2.4, and 141 controls. Percentages of males and females were 51.59% and 48.41% respectively, and mean age was 35.05 (SD = 3.54).

3.3. Meta-analysis

In the first meta-analysis, four variables approached statistical significance: total sleep time (pooled SMD = -0.51, 95% CI = -0.77 to -0.25, p-value < 0.001), time awake (pooled SMD = 0.50, 95% CI = 0.24-0.76, p-value < 0.001), sleep efficiency (pooled SMD = -0.45, 95% CI = -0.71 to -0.19, p-value = 0.001), and stage 2 sleep (pooled SMD = -0.39, 95% CI = -0.64 to -0.13, p-value < 0.05) (**Table 2**, **Fig. 2**).

In the second meta-analysis, which included two studies [9,12] and a part of another study [32], only the sleep latency variable was statistically significant (pooled SMD = 0.02, 95% CI = -0.46-0.50, *p*-value = 0.04) (**Table 3**, **Fig. 3**). None of the previous four variables were significant. The sample was composed of 75 participants (30 patients and 45 controls), of whom 50.67% were males and 49.33% females, with a mean age of 34.92 (SD = 5.48). The mean score of patients in the Y-BOCS was 24.40 (SD = 3.37).

4. Discussion

The main goal of this SR was to determine whether there are differences in sleep between people with OCD and people without OCD and, if so, whether such differences are related to comorbid depression or other conditioning factors. In relation to this objective, the results of the first meta-analysis showed the existence of significant differences in some parameters related to sleep continuity and architecture. Specifically, according to the results of that meta-analysis, people with OCD show a lower amount of total sleep time and a higher amount of time awake than people without this disorder. OCD also appears to be related to poorer sleep efficiency and a higher amount of time spent in stage 2 sleep. However, the results of the second meta-analysis suggested that the presence of comorbid depression was a key factor in the existence of those differences in sleep observed in the first meta-analysis. Given that, when that confounding variable was controlled, as we did in the second meta-analysis by means of the exclusion of participants with comorbid depression, there were much fewer differences between both groups and the differences were not the same. People with OCD and without comorbid depression only displayed a higher sleep latency than controls. Therefore, on the basis of our results, although OCD is related to sleep disturbances in people with this disorder, comorbid depression also influences the occurrence of those disturbances, leading to their increase and to changes in their main features.

Apart from the studies included in the meta-analyses, this SR includes other two studies whose results are needed to be also discussed. Particularly, we observe that Xueli et al. [31] found more differences between patients with OCD and controls than we did in the present study and Bobdey et al. [30] observed significant differences between them only when patients with OCD also had comorbid depression. In relation to the first study, the increase in the number of differences found between both groups may have been due to the fact that some patients had comorbid depression and the authors did not perform a differential analysis of the sample with regard to that comorbidity. In the case of the second study, although its results appear to confirm the important role of comorbid depression in sleep disturbances in people with OCD, the lack of differences when patients did not have comorbid depression, in contrast to the larger differences when they did, may have been due to the lack of objective sleep measures or the medication taken by patients.

Regarding to the relationship between sleep and depression, several studies conducted on this topic have revealed a decrease in total sleep time, sleep efficiency, REM sleep and REM latency in patients [34]. However, our first meta-analysis showed significant differences only in the first two variables. This may be due to the fact that not all patients included had secondary depression or to a difference between the influence of primary and secondary depression on sleep, which is still a focus of debate in research [34]. In addition, since 1971 researchers have reported a possible short-term therapeutic benefit of sleep deprivation in patients with depression [35]. In our study, by contrast, differences in total sleep time were observed only in the first meta-analysis. In other words, a lower amount of sleep was not associated with a decrease in depressive symptoms in participants. This may be due to the inefficacy of sleep deprivation therapy in OCD [36] or to its low long-term efficacy in depression, which has already been pointed out by various authors although without definitive conclusions [37].

A large number of studies have been also carried out about sleep and anxiety, and some authors have found lower sleep efficiency in patients with anxiety disorders [38]. However, we did not find that disturbance in the second meta-analysis, despite being OCD an anxiety disorder. Nevertheless, some confounding variables such as age and medication have not been controlled in all the studies on sleep [34]. Other authors, in a study conducted in a community sample, reported a relationship between sleep latency and most of anxiety disorders assessed [39]. Interestingly enough, the only disorder that was not found to be related to that sleep variable was OCD, contrary to what we have found in this study by means of the second meta-analysis. However, the results of a recent study appear to suggest differences in sleep disturbances depending on the type of symptoms predominant in people with OCD [11]. Particularly, whereas no association between sleep and compulsions was found, it was between sleep and obsessions. In this sense, it is important to notice that in none of the studies included in this SR, data regarding to predominant symptomatology or type of obsessions displayed by participants with OCD were not provided. Therefore, to analyze sleep patterns in people with OCD distinguishing between their predominant symptoms would be other question of interest to be considered in future studies on this topic, along with the impact of comorbid depression.

One of the limitations of the results obtained in this SR is the difficulty to establish a causal relationship in our findings because of the type of studies included, the correlational methodology used and the low number of studies included. Because of this, caution should be exerted when generalizing results, particularly regarding the type of population and its age range, as the studies included covered only clinical and adult populations.

The strengths of this SR lie in the implementation of a previous protocol, a comprehensive automated and manual literature search, a blind assessment of risk of bias, the inclusion of a control group and the consideration in the inclusion criteria of possible

confounding variables that were found to be significant in other studies [10,14,16,33] (i.e., age, sex, severity of OCD, medication and comorbid diseases). Later, we performed a differential meta-analysis based only on comorbidity because the remaining variables did not show great differences between participants. The only comorbidity considered was comorbid depression even though some patients had other secondary anxiety disorders in the study of Robinson et al. [12] because this was a key issue already noted in another SR [8].

5. Conclusions

The results obtained suggest that, although there are differences in sleep between people with OCD and people who do not have OCD, the presence of comorbid depression is a key issue in the amount and the type of differences. However, besides controlling for that comorbidity, future studies should include monitoring and broaden the age range of participants and the type of sample. This would contribute to a greater generalization of the results and help establish a causal relationship that would enable better interventions and prevention of sleep disturbances in this disorder, taking into account their influence on patients' quality of life and the course of the disease.

Conflicts of interest

None.

Acknowledgements

This review was not supported by any grant or any other funding source. There are no conflicts of interest to be declared.

References

References marked with an asterisk indicate studies included in the meta-analyses.

[1]. Abramowitz JS, Taylor S, McKay D. Obsessive-compulsive disorder. Lancet 2009;374:491-9.

[2]. Graybiel AM, Rauch SL. Toward a neurobiology of obsessive-compulsive disorder. Neuron 2000;28:343-7.

[3]. Heyman I, Mataix-Cols D, Fineberg NA. Obsessive-compulsive disorder. BMJ 2006;333:424-9.

[4]. Kalra SK, Swedo SE. Children with obsessive-compulsive disorder: are they just "little adults"? J Clin Invest 2009;119:737-46.

[5]. Kessler RC, Berglund P, Demler O, Jin R, Merikangas KR, Walters EE. Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. Arch Gen Psychiatry 2005;62:593-602.

[6]. Alfano CA, Kim KL. Objective sleep patterns and severity of symptoms in pediatric obsessive compulsive disorder: a pilot investigation. J Anxiety Disord 2011;25:835-9.

[7]. Ivarsson T, Skarphedinsson G. Sleep problems and cognitive behavior therapy in pediatric obsessive-compulsive disorder have bidirectional effects. J Anxiety Disord 2015;30:28-33.

[8]. Paterson JL, Reynolds AC, Ferguson SA, Dawson D. Sleep and obsessive-compulsive disorder (OCD). Sleep Med Rev 2013;17:465-74.

[*9]. Kluge M, Schussler P, Dresler M, Yassouridis A, Steiger A. Sleep onset REM periods in obsessive compulsive disorder. Psychiatry Res 2007;152:29-35.

[10]. Coles ME, Schubert JR, Sharkey KM. Delayed bedtimes and obsessive-compulsive symptoms. Behav Sleep Med 2012;10:258-65.

[11]. Timpano KR, Carbonella JY, Bernert RA, Schmidt NB. Obsessive compulsive symptoms and sleep difficulties: exploring the unique relationship between insomnia and obsessions. J Psychiatr Res 2014;57:101-7.

[*12]. Robinson D, Walsleben J, Pollack S, Lerner G. Nocturnal polysomnography in obsessive-compulsive disorder. Psychiatry Res 1998;80:257-63.

[13]. Wulff K, Gatti S, Wettstein JG, Foster RG. Sleep and circadian rhythm disruption in psychiatric and neurodegenerative disease. Nat Rev Neurosci 2010;11:589-99.

[14]. Baldwin CM, Griffith KA, Nieto FJ, O'Connor GT, Walsleben JA, Redline S. The association of sleep-disordered breathing and sleep symptoms with quality of life in the Sleep Heart Health Study. Sleep 2001;24:96-105.

[15]. Baldwin CM, Ervin AM, Mays MZ, Robbins J, Shafazand S, Walsleben J, et al. Sleep disturbances, quality of life, and ethnicity: the Sleep Heart Health Study. J Clin Sleep Med 2010;6:176-83.

[16]. Faubel R, Lopez-Garcia E, Guallar-Castillon P, Balboa-Castillo T, Gutierrez-Fisac JL, Banegas JR, et al. Sleep duration and health-related quality of life among older adults: a population-based cohort in Spain. Sleep 2009;32:1059-68.

[17]. McCall WV, Blocker JN, D'Agostino R Jr, Kimball J, Boggs N, Lasater B, et al. Treatment of insomnia in depressed insomniacs: effects on health-related quality of life, objective and self-reported sleep, and depression. J Clin Sleep Med 2010;6:322-9.

[18]. Roberts RE, Roberts CR, Duong HT. Chronic insomnia and its negative consequences for health and functioning of adolescents: a 12-month prospective study. J Adolesc Health 2008;42:294-302.

[19]. Schubert CR, Cruickshanks KJ, Dalton DS, Klein BE, Klein R, Nondahl DM. Prevalence of sleep problems and quality of life in an older population. Sleep 2002;25:889-93.

[20]. Silva GE, An MW, Goodwin JL, Shahar E, Redline S, Resnick H, et al. Longitudinal evaluation of sleep-disordered breathing and sleep symptoms with change in quality of life: the Sleep Heart Health Study (SHHS). Sleep 2009;32:1049-57.

[21]. Manocchia M, Keller S, Ware JE. Sleep problems, health-related quality of life, work functioning and health care utilization among the chronically ill. Qual Life Res 2001;10:331-45.

[22]. Montero I, Leon OG. A guide for naming research studies in Psychology. Int J Clin Health Psychol 2007;7:847-62.

[23]. Perestelo-Perez L. Standards on how to develop and report systematic reviews in Psychology and Health. Int J Clin Health Psychol 2013;13:49-57.

[24]. Scottish Intercollegiate Guidelines Network. SIGN 50. A guideline developer's handbook [Internet]. 2011 [cited 2013 Feb 4]. Available from: http://www.sign.ac.uk/guidelines/fulltext/50/index.html

[25]. Bai A, Shukla VK, Bak G, Wells G. Quality assessment tools project report. Ottawa: Canadian Agency for Drugs and Technologies in Health, 2012.

[26]. Botella J, Gambara H. Doing and reporting a meta-analysis. Int J Clin Health Psychol 2006;6:425-40.

[27]. Hedges LV. Distribution theory for Glass's estimator of effect size and related estimators. J Educ Stat 1981;6:107-28.

[28]. Higgins JP, Thompson SG. Quantifying heterogeneity in a meta-analysis. Stat Med 2002;21:1539-58.

[29]. Higgins JP, Green S, eds. Cochrane handbook for systematic reviews of interventions version 5.1.0 [Internet]. Cochrane Collaboration, 2011 [cited 2013 Jan 29]. Available from: http://handbook.cochrane.org

[30]. Bobdey M, Fineberg N, Gale TM, Patel A, Davies HA. Reported sleep patterns in obsessive compulsive disorder (OCD). Int J Psychiatry Clin Pract 2002;6:15-21.

[31]. Xueli S, Yanchun Y, Xiehe L. An experimental study of polysomnogram on obsessive and compulsive disorder. Chin J Psychiatry 1998;31:163-5.

[*32]. Hohagen F, Lis S, Krieger S, Winkelmann G, Riemann D, Fritsch-Montero R, et al. Sleep EEG of patients with obsessive-compulsive disorder. Eur Arch Psychiatry Clin Neurosci 1994;243:273-8.

[*33]. Voderholzer U, Riemann D, Huwig-Poppe C, Kuelz AK, Kordon A, Bruestle K, et al. Sleep in obsessive compulsive disorder: polysomnographic studies under baseline conditions and after experimentally induced serotonin deficiency. Eur Arch Psychiatry Clin Neurosci 2007;257:173-82.

[34]. Cano-Lozano MC, Espinosa-Fernandez L, Miro E, Buela-Casal G. A review of sleep disorders in depression. Rev Neurol 2003;36:366-75.

[35]. Landsness EC, Goldstein MR, Peterson MJ, Tononi G, Benca RM. Antidepressant effects of selective slow wave sleep deprivation in major depression: a high-density EEG investigation. J Psychiatr Res 2011;45:1019-26.

[36]. Cano-Lozano MC, Miro E, Fernandez-Espinosa L, Buela-Casal G. Efectos terapeuticos de la privacion de sueno en la depresion. Int J Clin Health Psychol 2003;3:541-63.

[37]. Kundermann B, Strate P, Hemmeter-Spernal J, Huber MT, Krieg JC, Lautenbacher S. Mid-term effects of serial sleep deprivation therapy implemented in cognitive-behavioral treatment on the neuroendocrine response to clomipramine in patients with major depression. J Psychiatr Res 2009;43:711-20.

[38]. Benca RM, Obermeyer WH, Thisted RA, Guillin JC. Sleep and psychiatric disorders: a meta-analysis. Arch Gen Psychiatry 1992;49:651-68. Cited by: Sierra JC, Zubeidat I,

Ortega V, Delgado-Dominguez CJ. Evaluacion de la relacion entre rasgos psicopatologicos de la personalidad y la calidad del sueno. Salud Ment 2005;28:13-21.

[39]. Ramsawh HJ, Stein MB, Belik SL, Jacobi F, Sareen J. Relationship of anxiety disorders, sleep quality, and functional impairment in a community sample. J Psychiatr Res 2009;43:926-33.

Table 1

Characteristics of included studies [a]

Study, year	Country [b]	Participants				Measure [d]	Differences found [e]
		Sex, mean age ± SD	Diagnosis, severity [c]	Medication	Comorbidity		
Bobdey et al., 2002[30] (part 1)	UK	OCD = 8M, 4F, 35.0 ± 13.0 C = 18M, 39F, 41.0 ± 13.0	DSM-IV, 21.4 ± 3.9	SSRIs	No	PSQI	None
Bobdey et al., 2002[30] (part 2)	UK	OCD = 2M, 10F, 41.0 ± 13.0 C = 18M, 39F, 38.6 ± 13.0	DSM-IV, 23.7 ± 4.9	SSRIs	Depression	PSQI	Sleep quality, time taken to fall asleep, time spent asleep
*Hohagen et al., 1994[32] (part 1)	Germany	OCD = 4M, 3F, 38.1 ± 14.6 C = 12M, 10F, 38.6 ± 13.0	DSM-III-R, 22.0 ± 7.6	No	No	PSG	-
*Hohagen et al., 1994[32] (part 2)	Germany	OCD = 2M, 5F, 36.1 ± 10.7 C = 12M, 10F, 38.6 ± 13.0	DSM-III-R, 30.4 ± 3.1	No	Depression	PSG	-
*Kluge et al., 2007[9]	Germany	OCD = 7M, 3F, 34.5 ± 12.7 C = 7M, 3F, 34.4 ± 12.8	DSM-IV, 27.8 ± 4.6	No	No	PSG	Stage 4 sleep
*Robinson et al., 1998[12]	USA	OCD = 4M, 9F, 33.1 ± 14.1 C = 4M, 9F, 30.8 ± 13.1	DSM-III-R, 23.4 ± 4.8	No	Variable anxiety	PSG	None
*Voderholzer et al., 2007[33] (part 1)	Germany	OCD = 33M, 29F, 35.6 ± 11.2 C = 33M, 29F, 35.8 ± 11.0	DSM-III-R, 27.3 ± 6.5	No	Variable depressive symptoms	PSG	Total sleep time, sleep efficiency, time awake, stage 1 REM density

(continued on next page)

Table 1 (continued)

Study, year	Country [b]	Participants: Sex, mean age ± SD	Participants: Diagnosis, severity [c]	Participants: Medication	Participants: Comorbidity	Measure [d]	Differences found [e]
*Voderholzer et al., 2007[33] (part 2)	Germany	OCD = 6M, 6F, 31.0 ± 11.0 C = 6M, 6F, 34.0 ± 9.0	DSM-III-R, 23.8 ± 7.2	No	Variable depressive symptoms	PSG	-
Xueli et al., 1998[31]	China	OCD = 18M, 12F, 25.0 ± 6.0 C = 16M, 14F, 28.0 ± 6.0	CCMD-2-R, 29.5 ± 5.8	No	Variable depressive symptoms	PSG	Sleep latency, time awake, sleep rate, stage 1, REM sleep (activity, density, intensity, stage 1 sleep and latency)

Abbreviations: SD, standard deviation; OCD, obsessive-compulsive disorder group; C, control group; M, males; F, females; DSM-IV, Diagnostic and statistical manual of mental disorders, fourth edition; DSM-III-R, Diagnostic and statistical manual of mental disorders, third edition revised; CCMD-2-R, Chinese classification of mental disorders, second edition revised; SSRIs, selective serotonin reuptake inhibitors; PSQI, Pittsburgh sleep quality index; PSG, polysomnography; REM, rapid eye movement.

[a] Asterisks denote studies included in the meta-analysis

[b] Published in English except for Xueli et al.[31], published in Chinese.

[c] Mean score ± SD in the Yale-Brown obsessive compulsive scale.

[d] Cross-sectional design in each study.

[e] 95% confidence interval (90% in Robinson et al.[12]). Dashes indicate that such comparison was not performed.

Table 2

Results of the first meta-analysis (N = 252)

Variable	SMD (95% CI) [a]	Chi^2	*p*-value	I^2	Z	*p*-value
Sleep period time	-0.20 (-0.46, 0.05)	4.91	0.43	0	1.56	0.12
Total sleep time	-0.51 (-0.77, -0.25)	4.12	0.53	0	3.83	< 0.001
Sleep latency	-0.03 (-0.29, 0.23)	5.72	0.33	13	0.24	0.81
Sleep efficiency	-0.45 (-0.71, -0.19)	7.51	0.19	33	3.40	< 0.001
Time awake	0.50 (0.24, 0.76)	5.45	0.36	8	3.75	< 0.001
Stage 1 sleep	-0.17 (-0.43, 0.08)	6.96	0.22	28	1.32	0.19
Stage 2 sleep	-0.39 (-0.64, -0.13)	0.97	0.96	0	2.93	< 0.01
Slow wave sleep	-0.09 (-0.35, 0.16)	3.25	0.66	0	0.72	0.47
REM sleep	0.11 (-0.14, 0.37)	3.20	0.67	0	0.87	0.38
REM latency	-0.16 (-0.42, 0.09)	1.27	0.94	0	1.26	0.21

Abbreviations: REM, rapid eye movement; SMD, pooled standardized mean difference; CI, confidence interval; Chi^2, heterogeneity test; I^2, heterogeneity index (%); Z, test for overall standardized mean difference.

[a] A negative SMD indicates that this variable was higher in the control group.

Table 3

Results of the second meta-analysis (N = 75).

Variable	SMD (95% CI) [a]	Chi^2	*p*-value	I^2	Z	*p*-value
Sleep period time	-0.11 (-0.59, 0.38)	3.13	0.21	36	0.42	0.67
Total sleep time	-0.16 (-0.64, 0.32)	0.14	0.93	0	0.66	0.51
Sleep latency	-0.52 (-1.01, -0.03)	0.33	0.85	0	2.08	0.04
Sleep efficiency	0.02 (-0.46, 0.50)	0.83	0.66	0	0.08	0.93
Time awake	0.17 (-0.31, 0.65)	1.17	0.56	0	0.71	0.48
Stage 1 sleep	-0.24 (-0.72, 0.25)	1.50	0.47	0	0.96	0.33
Stage 2 sleep	-0.32 (-0.81, 0.16)	0.79	0.67	0	1.31	0.19
Slow wave sleep	-0.15 (-0.63, 0.33)	0.50	0.78	0	0.61	0.54
REM sleep	0.12 (-0.37, 0.60)	2.70	0.26	26	0.48	0.63
REM latency	-0.38 (-0.86, 0.10)	0.18	0.91	0	1.54	0.12

Abbreviations: REM, rapid eye movement; SMD, pooled standardized mean difference; CI, confidence interval; Chi^2, heterogeneity test; I^2, heterogeneity index (%); Z, test for overall standardized mean difference.

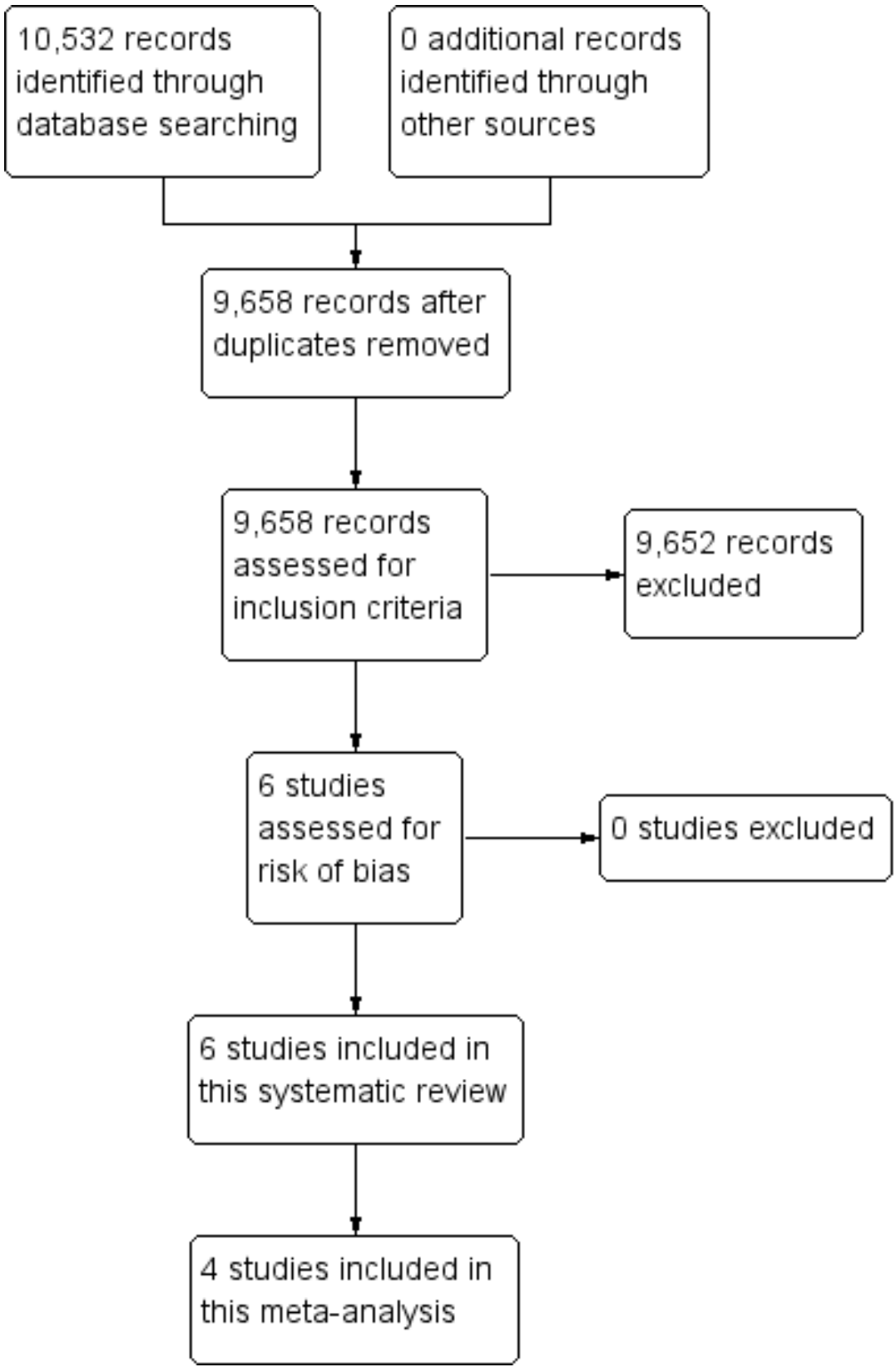
[a] A negative SMD indicates that this variable was higher in the control group.

Figure captions

Fig. 1. Results of the search and selection of studies.

Fig. 2. Forest plots of the standardized mean differences (SMD) obtained in the first meta-analysis for: **A)** total sleep time, **B)** sleep efficiency, **C)** time awake, and **D)** stage 2 sleep. IV, inverse variance method; Fixed, fixed-effects model; CI, confidence interval; Chi^2, heterogeneity test; df, degrees of freedom; P, *p*-value; I^2, heterogeneity index; Z, test for overall standardized mean difference; OCD, obsessive-compulsive disorder.

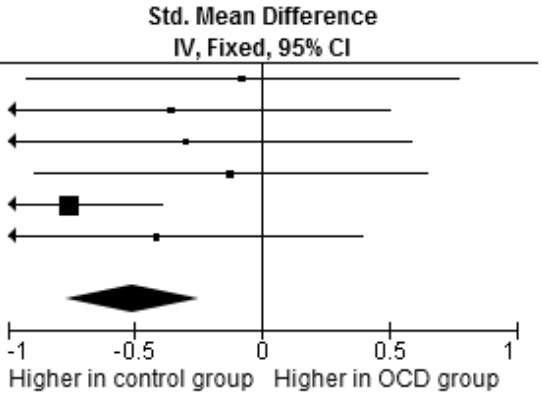
Fig. 3. Forest plot of the standardized mean differences (SMD) obtained in the second meta-analysis for sleep latency. IV, inverse variance method; Fixed, fixed-effects model; CI, confidence interval; Chi^2, heterogeneity test; df, degrees of freedom; P, *p*-value; I^2, heterogeneity index; Z, test for overall standardized mean difference; OCD, obsessive-compulsive disorder.


10,532 records identified through database searching
0 additional records identified through other sources
9,658 records after duplicates removed
9,658 records assessed for inclusion criteria
9,652 records excluded
6 studies assessed for risk of bias
0 studies excluded
6 studies included in this systematic review
4 studies included in this meta-analysis

A)

Study or Subgroup	Std. Mean Difference IV, Fixed, 95% CI
Hohagen 1994 (part 1)	-0,08 [-0,93, 0,77]
Hohagen 1994 (part 2)	-0,36 [-1,21, 0,50]
Kluge 2007	-0,30 [-1,18, 0,58]
Robinson 1998	-0,12 [-0,89, 0,65]
Voderholzer 2007 (part 1)	-0,76 [-1,12, -0,39]
Voderholzer 2007 (part 2)	-0,41 [-1,22, 0,40]
Total (95% CI)	**-0,51 [-0,77, -0,25]**

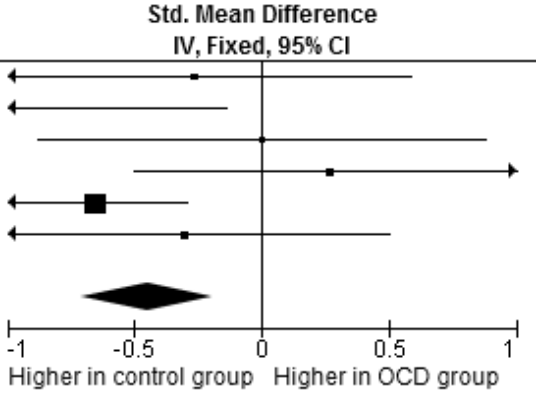
Heterogeneity: Chi² = 4,12, df = 5 (P = 0,53); I² = 0%
Test for overall effect: Z = 3,83 (P = 0,0001)



B)

Study or Subgroup	Std. Mean Difference IV, Fixed, 95% CI
Hohagen 1994 (part 1)	-0,26 [-1,12, 0,59]
Hohagen 1994 (part 2)	-1,03 [-1,93, -0,14]
Kluge 2007	0,00 [-0,88, 0,88]
Robinson 1998	0,27 [-0,50, 1,04]
Voderholzer 2007 (part 1)	-0,65 [-1,02, -0,29]
Voderholzer 2007 (part 2)	-0,30 [-1,11, 0,50]
Total (95% CI)	**-0,45 [-0,71, -0,19]**

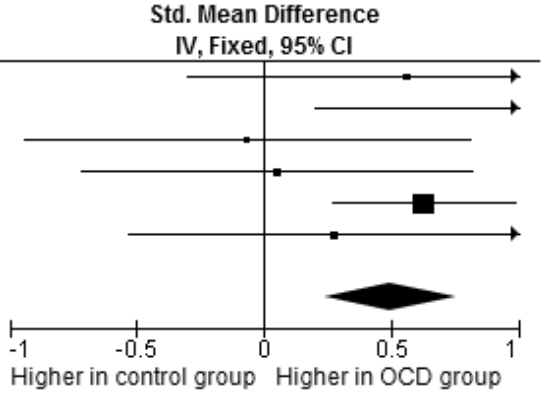
Heterogeneity: Chi² = 7,51, df = 5 (P = 0,19); I² = 33%
Test for overall effect: Z = 3,40 (P = 0,0007)



C)

Study or Subgroup	Std. Mean Difference IV, Fixed, 95% CI
Hohagen 1994 (part 1)	0,56 [-0,30, 1,43]
Hohagen 1994 (part 2)	1,11 [0,20, 2,01]
Kluge 2007	-0,07 [-0,95, 0,81]
Robinson 1998	0,05 [-0,72, 0,82]
Voderholzer 2007 (part 1)	0,63 [0,27, 0,99]
Voderholzer 2007 (part 2)	0,28 [-0,53, 1,08]
Total (95% CI)	**0,50 [0,24, 0,76]**

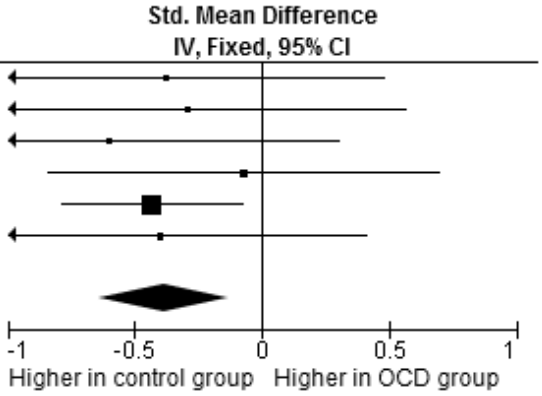
Heterogeneity: Chi² = 5,45, df = 5 (P = 0,36); I² = 8%
Test for overall effect: Z = 3,75 (P = 0,0002)

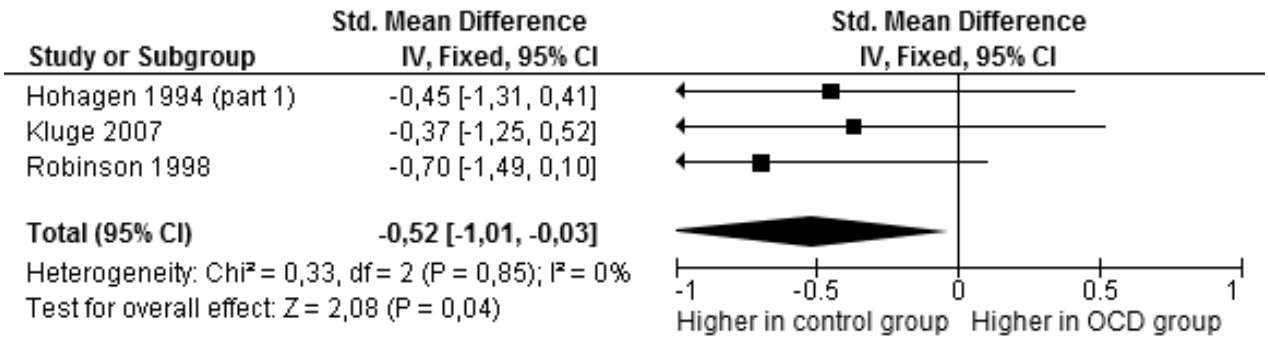


D)

Study or Subgroup	Std. Mean Difference IV, Fixed, 95% CI
Hohagen 1994 (part 1)	-0,38 [-1,24, 0,48]
Hohagen 1994 (part 2)	-0,29 [-1,15, 0,56]
Kluge 2007	-0,60 [-1,50, 0,30]
Robinson 1998	-0,07 [-0,84, 0,70]
Voderholzer 2007 (part 1)	-0,43 [-0,79, -0,08]
Voderholzer 2007 (part 2)	-0,40 [-1,21, 0,41]
Total (95% CI)	**-0,39 [-0,64, -0,13]**

Heterogeneity: Chi² = 0,97, df = 5 (P = 0,96); I² = 0%
Test for overall effect: Z = 2,93 (P = 0,003)




Std. Mean Difference
Study or Subgroup
IV, Fixed, 95% CI
Hohagen 1994 (part 1) -0,45 [-1,31, 0,41]
Kluge 2007 -0,37 [-1,25, 0,52]
Robinson 1998 -0,70 [-1,49, 0,10]
Total (95% CI) -0,52 [-1,01, -0,03]
Heterogeneity: Chi² = 0,33, df = 2 (P = 0,85); I² = 0%
Test for overall effect: Z = 2,08 (P = 0,04)
Std. Mean Difference
IV, Fixed, 95% CI
-1
-0.5
0
0.5
1
Higher in control group
Higher in OCD group