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Review Article

Depression and anxiety in obstructive sleep apnea syndrome: a review

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Objective – To provide an update on recent research on depression and anxiety in obstructive sleep apnea syndrome (OSAS). *Methods* – A review was carried out on reports drawn from MEDLINE and PSYCHLIT (January 1995–June 2006) and identified from their list of references. The selection criteria were met by 55 articles. *Results* – Sample sizes in the reviewed studies varied widely and consisted mainly of working age men. Depression and anxiety were mostly evaluated with commonly used mood scales; only a few studies provided a psychiatric diagnosis. Prevalence figures fluctuated considerably for both depression (7–63%) and anxiety (11–70%). The effect of the continuous positive airway pressure (CPAP) on mood was inconsistent. *Conclusions* – Variations in the prevalence of depression and anxiety are affected by patient characteristics, mood assessment methods, and overlap between mood alterations and OSAS-related symptoms. CPAP might improve mood alterations but more long-term follow-up studies are needed to verify the effectiveness.

T. Saunamäki[1,2], M. Jehkonen[1]

[1]Department of Neurology and Rehabilitation, Tampere University Hospital, Tampere, Finland; [2]Department of Psychology, University of Tampere, Tampere, Finland

Key words: anxiety; continuous positive airway pressure; depression; mood scales; obstructive sleep apnea syndrome

Tiia Saunamäki, Tampere University Hospital, PO Box 2000, 33521 Tampere, Finland
Tel.: +358 3 3116 3154
Fax: +358 3 3116 3014
e-mail: tiia.saunamaki@uta.fi

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Introduction

Obstructive sleep apnea syndrome (OSAS) is the most common type of sleep apnea. It is characterized by repetitive complete (apnea) and partial (hypopnea) obstruction of the upper airway during sleep and results in oxygen desaturation and arousals from sleep (1). Up to 4% of men and 2% of women have clinically important sleep apnea (2). The severity of OSAS varies. The frequency of respiratory breathing events during sleep correlates poorly with the severity of daytime symptoms (1). The most common treatment for OSAS is continuous positive airway pressure (CPAP) (3), which improves oxygen saturation and reduces sleep fragmentation.

Depression has been reported to be the most common mood disorder associated with OSAS (4–7), although not all studies have found a correlation (4–6, 8). It is unclear if depression in OSAS is a primary consequence or if it occurs secondary to OSAS-related symptoms (sleepiness, sleep problems, irritability, social withdrawal) or to other factors related to OSAS (e.g., obesity, hypertension) (4–7). Because of the complex relationship between OSAS and depression, the current recommendation is that a mood disorder should be considered as secondary to the medical disorder and not as a distinct psychiatric entity (4, 7). This should also be applied the other way round: if the patient suffers from depression, fatigue, and sleeping problems, the first step is to establish whether OSAS lies behind these symptoms (9). Earlier reviews also draw a link between anxiety and OSAS (5–7, 10), but the evidence is far from conclusive (5). The severity of depression and anxiety seem to correlate more with excessive daytime sleepiness than with hypoxemia (6, 7). Specific attention should be paid to the evaluation of mood disorders in OSAS, because some of the methods used may in fact reflect sleep quality and daytime sleepiness rather than mood state (5, 10, 11). The most commonly used mood scales for assessing depression and anxiety are presented in Table 1. The view that depression in OSAS can be

explained by common symptoms is also supported by the positive impacts of CPAP treatment on the depressive state (5, 7). The treatment of OSAS may also reveal, if there exists a primary depressive disorder and if the focus of treatment should be turned on that (9). There are no earlier reports of CPAP having clear effect on anxiety.

There are only a few earlier reviews on OSAS and mood alterations, and none of these are systematic (4–8). Our review offers an update on recent research findings over the past 10 years (from January 1995 to June 2006) with respect to the most common mood alterations in OSAS, namely depression and anxiety. Our focus is on the prevalence of depression and anxiety, and on how mood has been examined in OSAS. In particular, we address the following questions: (i) what generalizations can be drawn from previous studies based on the number, age and gender of the subjects, and the severity of OSAS; (ii) what methods have been used to assess mood; (iii) what is the prevalence of depression and anxiety in OSAS; and (iv) does CPAP treatment have a long-term effect on mood?

Materials and methods

Main terms used in the search

Obstructive sleep apnea syndrome is described in the literature by a variety of concepts: obstructive sleep apnea, obstructive sleep apnea syndrome, obstructive sleep apnea-hypopnea syndrome, sleep apnea-hypopnea syndrome, and obstructive sleep-disordered breathing. Because the term 'obstructive sleep apnea' seems to appear most frequently, this is what we used in our search. To identify specific aspects of mood, the terms 'depression' and 'anxiety' were used.

Selection of the articles

We began by searching the Cochrane Library database to see whether there were any recent or ongoing reviews on this subject, but we found none. We then searched MEDLINE and PSYCHLIT for articles published between January 1995 and June 2006 using the terms 'obstructive sleep apnea and depression' and 'obstructive sleep apnea and anxiety'. We found a total of 203 articles. Following the exclusion of non-English articles, and studies of non-human subjects, we had 149 remaining articles. Next, we excluded case reports, reviews, experimental studies, letters, commentaries, abstracts, and chapters of edited volumes. This left us with 100 articles. The abstracts of these articles were reviewed.

As we were specifically interested in adult OSAS patients and mood alterations, and in the impact of CPAP treatment on mood alterations, we imposed the following exclusion criteria: (i) studies including children and/or adolescents, defined as participants under 18 years of age (10 articles were excluded); (ii) studies focusing on medical effects (11 articles were excluded); (iii) studies including special medical populations only (e.g., dementias, insomnias, asthma) or in addition to OSAS (14 articles were excluded); (iv) studies in which OSAS was not verified by polysomnography or OSAS was not a diagnostic criterion (eight articles were excluded); (v) studies not including an evaluation of mood or not reporting the results of mood assessment methods in OSAS (15 articles were excluded); and (vi) studies not including patient data (one article was excluded). We now had 41 articles which were fully reviewed. The lists of references of these studies were searched; this yielded 14 additional articles for our review. The total number of articles reviewed for this study was thus 55 articles.

Results

A selected group of patients was recruited in 34 out of 55 studies (21–54). In 21 studies (55–75) the patient sample was drawn from consecutive series. The number of patients ranged from 8 to 1635 (median: 54). The mean age of patients ranged from 44 to 69 years (median: 49 years). Eight studies (26, 28, 34, 38, 51, 58, 65, 71) did not report the mean age for the patient group. The proportion of men in the study samples ranged from 13% to 100% (median: 83%). In 10 studies (26–28, 39, 46, 51, 58, 63, 65, 71) the gender breakdown was not specified for the OSAS patient group. The severity of sleep apnea was mostly reported using the respiratory disturbance index or the apnea hypopnea index (AHI), indicating the frequency of apneas and hypopneas per hour of sleep. The mean severity of OSAS ranged from 10 to 99 apneas and hypopneas per hour (median: 48 apneas and hypopneas per hour), and the standard deviations varied widely. One study (42) reported the range and the median of AHI, one study (59) specified severity using the desaturation index indicating ≥4% decrease in minimum oxygen saturation at least five times per hour or at least 30 saturations during 7 h sleep, and one study (31) using the apnea index indicating the frequency of apneas per hour of sleep and apneic episodes per night. In two studies (34, 58) severity was reported categorically (mild, moderate, severe) without specifying the mean number of apneas and hypopneas per hour. In four studies (51, 65, 68, 71)

Table 1 Overview of the mood scales most commonly used in assessing depression and anxiety in obstructive sleep apnea syndrome

Mood scale	Description of the scale
Beck Depression Inventory (BDI; 12)	A 21-item scale consisting of statements focusing on particular aspects of depression-related symptoms (e.g., mood, sense of failure, appetite, sleeping). The subject rates the intensity of the items on a 4-point scale (0–3). The total score ranges from 0 to 63
Zung Self-Rating Depression Scale (Zung SDS; 13)	A 20-item questionnaire in which scores can be interpreted in four symptom groups: affect, physiological disturbances, psychomotor disturbance, psychological disturbance, and additionally overall self-rated depression. The subject rates the appearance of symptoms using a 4-point scale (1–4) and the items are balanced for yes/no tendencies. The total raw score ranges from 20 to 80; the final score is often reported by multiplying raw scores by 1.25 to yield results between 25 and 100
Center for Epidemiological Studies Depression Scale (CES-D; 14)	A 20-item self-report questionnaire taps cognitive/affective aspects of depression in seven components: depressed mood, feelings of guilt, helplessness, worthlessness, loss of appetite, psychomotor retardation, and sleep disturbance. The subject rates the appearance of mood-related aspects on a 4-point scale (0–3). The total score ranges from 0 to 60
Hospital Anxiety and Depression Scale (HADS; 15)	A 14-item scale which consists of seven items assessing anhedonic state associated with depression, and seven items focusing on psychic manifestations of anxiety neurosis. It is developed to detect depression and anxiety free from somatic referents. The subject rates the items on a 4-point scale (0–3). The total scores on both subscales range from 0 to 21
State-Trait Anxiety Inventory (STAI; 16)	A 40-item scale including two subscales: state anxiety and trait anxiety. Both subscales consist of 20 items and the subject rates his feelings on a 4-point intensity scale and on a 4-point frequency scale (1–4). The total scores on both subscales range from 20 to 80
Profile of Mood States (POMS; 17)	A 65-item adjective rating scale on six subscales: fatigue-inertia, depression-dejection, vigor-activity, anger-hostility, tension-anxiety and confusion-bewilderment. The subject rates the items on a 5-point scale (0–4)
Minnesota Multiphasic Personality Inventory (MMPI; 18, 19)	A 550-item personality test spanning a broad variety of psychiatric symptoms, personality features, and psychological difficulties on 10 subscales: hypochondriasis, depression, hysteria, psychopathic deviate, masculinity/femininity, paranoia, psychasthenia, schizophrenia, hypomania, and social introversion. The subject rates the items on true/false responses
Symptom Distress Check List (SCL-90; 20)	A 90-item scale is used to evaluate self-reported behavioral and psychiatric distress on nine subscales: somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, psychoticism, and general severity index. The subject rates the occurrence and intensity of distress symptoms on a 5-point scale (0–4)

the severity of sleep apnea was not reported for the OSAS group.

Assessment of mood

The scales used most often to assess mood in OSAS patients are presented in Table 2. Different versions of the Beck Depression Inventory (BDI) were applied and one study (61) used the Beck questionnaires (76) including both evaluations of both depression and anxiety. It remained unclear if one study (31) also used a Japanese version of Zung SDS (77). Three studies (39, 49, 59) used the Structured Clinical Interview for DSM-IV (78), DSM-III-R (79) or DSM-III (80). In six studies (25–28, 66, 70) the patients were interviewed by a psychiatrist, and in one study (36) an interview on psychological wellbeing was conducted without specifying the protocol. History of depression was assessed retrospectively in one study (25) to identify any diagnoses the OSAS patients might have before the diagnosis of sleep apnea, and one study (54) used medical history, medication usage and a general questionnaire. Depressive state was also diagnosed on the basis of self-reported symptoms (68) and discourse analysis (42). The following

Table 2 Mood scales most often used in assessing depression and anxiety in obstructive sleep apnea syndrome in the studies reviewed

Mood scale	No. studies using the scale
Beck Depression Inventory (BDI; 12)	19 (21, 36, 38, 44–50, 52, 53, 61, 64–66, 69, 70, 75)*
Hospital Anxiety and Depression Scale (HADS; 15)	11 (23, 30, 39, 55–57, 60, 62, 63, 73, 74)
Profile of Mood States (POMS; 17)	10 (24, 29, 32, 35, 38, 41, 43, 46, 47, 50)
Center for Epidemiological Studies Depression Scale (CES-D; 14)	6 (29, 33, 35, 41, 43, 71)
State-Trait Anxiety Inventory (STAI; 16)	4 (29, 31, 36, 41)
Zung Self-Rating Depression Scale (Zung SDS; 13)	3 (34, 37, 72)
Minnesota Multiphasic Personality Inventory (MMPI; 18, 19)	3 (25, 26, 28)
Symptom Distress Check List (SCL-90; 20)	3 (27, 58, 64)

*Numbers in parentheses refer to the original articles reviewed.

scales were used to assess depression and/or anxiety in one or two studies each (21, 22, 29, 31, 36, 51, 67): the Hamilton Rating Scale for Anxiety (HRSD; 81), the Hamilton Rating Scale for Depression (HRSD; 82), the Mental Health Scale (MH-5; 83), the Montgomery-Asperg Depression Rating Scale (MADRS; 84), and the Taylor's Manifest Anxiety Scale (MAS; 85). Other scales used in the studies reviewed (21, 24, 29, 31, 35, 39, 41, 59) were the Comprehensive Psychopathological Rating Scale (CPRS; 86), the Positive and Negative Affect Scale (PANAS; 87), the Temperament and Character Inventory (TCI; 88), the Ways of Coping Questionnaire (WC; 89), the Buss-Durkee Hostility Scale (BD; 90), the Cook-Medley Hostility Scale (CM; 91), a Japanese version of Cornell Medical Index (CMI; 92), a Japanese version of the Yatabe-Guilford Test (Y-G test; 93), and Tylka's Psychological Evaluation of the Effectiveness of Rehabilitation, which is a Polish modification of Cattell's Scale (SOPER; 94).

Pretreatment depression and anxiety in OSAS

The results on the prevalence of depression and/or anxiety and the respective assessment methods used in the studies reviewed are listed in Table 3. Prevalences are only reported when directly available from the original study or when they could be calculated from the results. Figures for the prevalence of depression were available from 24 studies (21, 25–28, 31, 33–35, 37–40, 43, 45, 47, 54, 59, 62, 65, 68, 69, 73, 75) and figures for the prevalence of anxiety from seven studies (21, 27, 30, 31, 39, 62, 73). The prevalence of depression ranged from 7% to 63%. Where the intensity of depressive symptoms was reported, most of the patients had mild depression (31, 45, 59, 65, 69). The prevalence of anxiety ranged from 11% to 70%.

Impact of CPAP treatment on depression and anxiety in OSAS

Twenty-seven of the fifty-five studies reviewed (49%) included evaluations of some aspects of mood and CPAP treatment (21–24, 30, 32, 34, 36, 38, 41, 42, 45, 47–49, 55, 56, 60–64, 70, 72–75). Two of the CPAP studies did not include post-treatment measurements, but one of these studies (42) reported the effects of CPAP treatment on quality of life, and the other (73) assessed how anxiety and depression are related to CPAP use based on self-report questionnaires completed by patients. In 25 studies (21–24, 30, 32, 34, 36, 38, 41, 45, 47–49, 55, 56, 60–64, 70, 72, 74, 75) including post-treatment measurements after CPAP, treatment time ranged from 1 week to 2 years (median: 8 weeks). Twenty of these studies (23, 24, 30, 32, 34, 38, 41, 45, 47–49, 55, 58, 62–64, 70, 72, 74, 75) conducted one follow-up, and five studies (21, 22, 36, 56, 61) conducted two follow-ups. In the studies (22–24, 30, 32, 36, 38, 41, 45, 47, 55, 56, 60–63, 74) that reported objective compliance with CPAP therapy, compliance ranged from 3.1 to 7.0 h per night (median: 5.2 h). One study reported the overall compliance results in percent (34). Three studies (70, 72, 75) reported the minimum demanded using hours per night and/or the minimum using nights per week. Four studies (21, 48, 49, 64) did not specify compliance. Seven studies (23, 30, 32, 38, 47, 55, 74) were placebo-controlled, and one study (24) had a control group of OSAS patients receiving conservative treatment. Five studies (22, 41, 49, 56, 63) did not report the effects of CPAP treatment on mood alterations. Of these five studies, one (49) focused on how autobiographical memory can predict affective disorders; two (41, 63) were interested in the relationship between mood and CPAP use; one (56) assessed how alteration in CPAP requirement affects mood; and one (22) focused on auditory event-related potentials.

We concentrated on the studies with the treatment time ≥3 months (21, 34, 36, 45, 47, 60, 61), because changes in mood cannot be expected during a short period. Only one of these studies (47) was placebo-controlled. The effect of CPAP treatment on depression was evaluated in all of these seven studies and on anxiety in four (21, 36, 60, 61) out of seven studies. Depression declined in four (34, 36, 45, 60) out of seven studies and anxiety in two (36, 60) out of four studies. The results on the effect of CPAP treatment on depression and anxiety in OSAS patients are presented in Table 4.

Discussion

This review provides an update on recent research findings over the past 10 years on depression and anxiety in OSAS with special reference to the following aspects: the generalizability of earlier studies based on patient characteristics, the methods used in the assessment of depression and anxiety, the overlap of sleepiness and mood alterations, the prevalence of depression and anxiety, and the possible long-term impact of CPAP treatment on these mood disorders.

The number of subjects in the studies reviewed ranged from 8 to 1635. This wide disparity in sample size clearly undermines the comparability of the studies. Most of the studies (62%) recruited patient groups from selected samples, although many studies failed to describe their patient selection. Consecutive selection is a more reliable method for

Table 3 Prevalence of depression and anxiety in obstructive sleep apnea syndrome in the studies reviewed

Reference	Patient characteristics: (a) Number of subjects (b) Gender (c) Age (years): mean (SD) (d) Severity of OSAS: mean (SD)	Mood scale (scoring: range)	Prevalence of depression and anxiety
Aloia et al. (69)	(a) 93 (b) 61 M; 32 F (c) 52 (11) (d) RDI: 42 (24)	BDI-II (range: 0–63)	24% of the patients had mild depression, 5% moderate depression, and 4% severe depression. BDI mean score (SD) for the whole study group was 11 (7)
Kjelsberg et al. (73)	(a)178 (b) 135 M; 43 F (c) 55 (11) (d) AHI: 29 (21)	HADS (range: depression subscale: 0–21; anxiety subscale: 0–21)	11% of the patients had high depression and 11% had high anxiety HADS depression mean score (SD) for the whole patient group was 4.8 (4.0) HADS anxiety mean score (SD) for the whole patient group was 5.4 (4.4)
Schwartz et al. (75)	(a) 50 (of which 31 on antidepressant medication) (b) 33 M; 17 F (c) 48 (9) (d) RDI: 56 (34)	BDI (7 items) (range: 0–21)	50% of the patients had mild to severe depression. BDI mean score (SD) for patients with antidepressant medication was 5.6 (4.3) and for patients with no antidepressant medication 3.2 (2.9)
Shepertycky et al. (54)	(a) 260 (b) 130 M; 130 F (c) 48 (1) (d) AHI: 37 (3) for men; 36 (3) for women	History of depression	7% of men and 21% of women had history of depression. Women had diagnosis of depression more often and were more likely to be treated for depression
Barnes et al. (47)	(a) 114 (b) 91 M; 23 F (c) 47 (1) (d) AHI: 21 (1)	BDI (range: 0–63) POMS*	40% of patients had depression based on BDI. BDI mean score (SD) for the patient group was 9.2 (0.5). POMS total mean score (SD) for the patient group was 15.5 (2.0)
Quintana-Gallego et al. (68)	(a) 1166 (b) 970 M; 196 F (c) 53 (11) for men; 58 (10) for women (d) RDI ≥10	Self-reported depression	13% of men and 36% of women reported depression Women with OSAS had more depression
Bardwell et al. (43)	(a) 60 (b) 51 M; 9 F (c) 49 (8) (d) RDI: 49 (27)	CES-D (range: 0–60) POMS*	33% of the patients had mood disorder based on CES-D. CES-D mean score (SD) for the patient group was 12.6 (11.3). POMS depression mean score (SD) for the patient group was 9.3 (11.6)
Doherty et al. (62)	(a) 45 (b) 44 M; 1 F (c) 51 (range: 44–58) (d) AHI: 32 (range: 21–57)	HADS (range: depression subscale: 0–21; anxiety subscale: 0–21)	44% of the patients exhibited depression and 50% of the patients exhibited anxiety HADS depression mean score for the patient group was 5 (range: 3–8) HADS anxiety depression mean score for the patient group was 8 (range: 5–9)

Table 3 (*Continued*)

Reference	Patient characteristics: (a) Number of subjects (b) Gender (c) Age (years): mean (SD) (d) Severity of OSAS: mean (SD)	Mood scale (scoring: range)	Prevalence of depression and anxiety
Means et al. (45)	(a) 39 (b) 35 M; 4 F (c) 58 (11) (d) RDI: 47 (34)	BDI (range: 0–63)	26% of patients had mild depression, 8% had moderate depression, and 3% had severe depression. BDI mean score (SD) for the patient group was 9.6 (7.6)
Vandeputte and De Weerd (64)	(a) 167 (b–d not reported)	BDI (range: 0–63)	41% of patients had some form of depression; 2% of patients had moderate to severe depression. BDI mean score (SD) for the patient group was 10.0 (0.6)
Akashiba et al. (37)	(a) 60 (b) 58 M; 2 F (c) 48 (11) (d) AHI: 52 (27)	Zung SDS (range: 25–100)	48% of the patients were depressive. Zung SDS mean score (SD) for the patient group was 50.5 (11.4)
Barnes et al. (38)	(a) 42 (b) 35 M; 7 F (c) middle-aged (d) AHI: 13 (6)	BDI (range: 0–63) POMS*	16% of patients had mild to severe depression based on BDI 56% had a total mood disorder score above the predicted range in POMS
Sforza et al. (39)	(a) 44 (b) not reported (c) 53 (2) (d) AHI: 45 (4)	HADS (range: depression subscale: 0–21; anxiety subscale: 0–21) Structured Clinical Interview based on DSM-III	7% of patients had depression and 16% of patients had anxiety. HADS depression mean score (SD) for the patient group was 4.4 (0.6). HADS anxiety mean score (SD) for the patient group was 7.0 (0.5)
Smith et al. (40)	(a) 773 (b) 599 M; 174 F (c) 47 (0.5) for men; 51 (1) for women (d) AHI: 42 (1) for men; 28 (2) for women	Based on former diagnosis prior to sleep apnea	14% of patients had diagnosis of depression. Female OSAS patients were more than twice as likely as male patients to have diagnosis of depression
Bardwell et al. (35)	(a) 64 (b) 54 M; 10 F (c) 49 (8) (d) RDI: 52 (29)	CES-D (range: 0–60) POMS*	33% of patients had mood disorder based on CES-D 30% of patients had depressive state based on POMS
Bardwell et al. (33)	(a) 67 (of which 45 had low score in CES-D and 22 had high score in CES-D) (b) 57 M; 10 F (c) 49.3 (not reported) (d) RDI: 51 (29)	CES-D (range: 0–60)	33% of patients had dysthymia or major depression. CES-D mean score (SD) for high score patients was 25.0 (7.2) and for low score patients 6.2 (4.2)
Dahlöf et al. (59)	(a) 53 (b) 53 M (c) 50 (9) (d) AHI: 56 (24)	CPRS* Structured Clinical Interview for DSM-III-R	34% of patients had depressive episodes: 23% had major depression, 9% dysthymia, and 2% a depressive disorder not otherwise specified. One patient had a generalized anxiety disorder

Table 3 (*Continued*)

Reference	Patient characteristics: (a) Number of subjects (b) Gender (c) Age (years): mean (SD) (d) Severity of OSAS: mean (SD)	Mood scale (scoring: range)	Prevalence of depression and anxiety
Yamamoto et al. (34)	(a) 41 (b) 41 M (c) Not reported d) AHI: severe	Zung SDS (range: 25–100)	63% had score indicating depressive state. Zung SDS mean score (SD) for the patient group was 42.9 (7.8)
Aikens et al. (28)	(a) 30 (b) Not reported (c) Not reported (d) AHI: 58 (46)	MMPI*	Depression subscale of the MMPI was elevated in 25% of the patients
Aikens et al. (25)	(a) 178 (b) 155 M; 23 F (c) 48 (11) (d) AHI: 59 (37)	MMPI*	Depression subscale of the MMPI was elevated in 32% of the patients
Aikens et al. (26)	(a) 49 (b) Not reported (c) Not reported (d) AHI: 55 (37)	MMPI*	Depression subscale of the MMPI was elevated in 49% of the patients
Aikens et al. (27)	(a) 11 (b) Not reported (c) 55 (12) (d) AHI: 20 (15)	SCL-90*	46% of OSAS patients could be classified with a probable psychiatric disorder. Depression subscale was elevated in 36% of the patients and anxiety subscale was elevated in 27% of the patients
Engleman et al. (30)	(a) 34 (b) 21 M; 13 F (c) 44 (8) (d) AHI: 10 (3)	HADS (range: depression subscale: 0–21; anxiety subscale: 0–21)	41% of the patients had depressive state and 67% of the patients had anxiety HADS depression mean score (SD) for the patient group was 7.4 (4.1). HADS anxiety mean score (SD) for the patient group was 9.0 (4.2)
Nambu et al. (31)	(a) 20 (b) 12 M; 8 F (c) 51 (10) (d) AI: 19 (15.6); apneic episodes/night 167 (131)	STAI (range: not reported) SDS (range: not reported)	47% of the patients had depressive state: 21% had mild depression and 26% moderate depression. State anxiety was above normal limits in 63% of the patients, and trait anxiety was above normal limits in 47% of the patients. SDS mean score (SD) for the patient group was 39.2 (11.0). STAI state anxiety mean score (SD) for the patient group was 44.6 (12.1). STAI trait anxiety mean score (SD) for the patient group was 46.2 (13.4)
Borak et al. (21)	(a) 20 (b) 20 M (c) 46 (6) (d) AHI: 67 (16)	BDI (range: 0–63) MAS*	55% of the patients presented with depressive symptoms. 70% of the patients presented with anxiety. BDI mean score (SD) for the patient group was 7.5 (7.8). MAS mean score (SD) for the patient group was 55.3 (15.8)

M, men; F, female; SD, standard deviation; AHI, apnea hypopnea index; RDI, respiratory disturbance index; AI, apnea index; BDI, Beck Depression Inventory; CES-D, Center for Epidemiological Studies Depression Scale; Zung SDS, Zung Self-Rating Depression Scale; HADS, Hospital Anxiety and Depression Scale; POMS, Profile of Mood States; SCL-90, Symptom Distress Check List; STAI, State-Trait Anxiety Inventory; CPRS, Comprehensive Psychopathological Rating Scale; MMPI, Minnesota Multiphasic Personality Inventory; SDS, Self-Rating Depression Scale; MAS, Taylor's Manifest Anxiety Scale.

*POMS, SCL-90, and MMPI are scales which also evaluate aspects of mood other than depression and anxiety, and therefore no exact range for these scales is reported. Some other rarely used scales (CPRS, MAS) did not report the range for depression and anxiety scales either.

Table 4 Main results on the effect of CPAP treatment (treatment time ≥3 months) on depression and anxiety in patients with obstructive sleep apnea syndrome

Reference	Mood scale	CPAP: (a) Treatment time (b) Compliance	Main results
Barnes et al. (47)	BDI POMS	(a) 3 months (b) 3.6 h/night	BDI scores did not decline with CPAP over placebo-treatment. Total POMS score declined more with CPAP than with placebo treatment
Means et al. (45)	BDI	(a) 3 months (b) 4.3 h/night	Significant decline in depression. Somatic symptoms of depression did not improve more than affective/cognitive symptoms
Sánchez et al. (36)	BDI STAI	(a) 1 and 3 months (b) 5.5 h and 5.8 h/night	Significant decline in depression after 1 and 3 months treatment. State of anxiety did not decline after 1 month, but declined after 3 months of treatment. Trait anxiety declined at both time-points. Improvement in emotional stability can also be explained with overall improvement in quality of life
Kingshott et al. (60)	HADS	(a) 6 months (b) 4.8 h/night	Significant decline was found both in depression and in anxiety.
Munoz et al. (61)	Beck tests	(a) 3 and 12 months (b) 5.8 h/night	No significant decline in depression or anxiety
Yamamoto et al. (34)	Zung SDS	(a) 2 years (b) 97.8%	Significant decline in depression. Half of the patients who had depressive state at baseline improved to the normal level
Borak et al. (21)	BDI MAS	(a) 3 and 12 months (b) Not reported	No improvement in emotional status

CPAP, continuous positive airway pressure treatment; BDI, Beck Depression Inventory; POMS, Profile of Mood States; STAI, State-Trait Anxiety Inventory; HADS, Hospital Anxiety and Depression Scale; Zung SDS, Zung Self-Rating Depression Scale; MAS, Taylor's Manifest Anxiety Scale.

purposes of evaluating the prevalence of depression and anxiety. The mean age of the patients ranged from 44 to 69 years. Age may play a role in the appearance of mood disorders; among women in particular, depressive symptoms are more common in menopausal age. Although the proportion of men varied widely (13–100%), the majority of the studies consisted mainly of men (median: 83%). The imbalance in the distribution of genders may significantly affect the results for the prevalence of depression: it has been reported that women with OSAS may have more depressive symptoms than men (40, 54, 58, 68), although conflicting results have also been reported (69). The estimated prevalence of depression would probably have been higher had the study samples been gender-balanced. According to Pillar and Lavie (58), the differences between men and women in mood alterations arise from basic differences in gender personality characteristic and are unrelated to OSAS.

The mean severity of OSAS in the studies reviewed varied from mild to severe. Most studies consisted of heterogeneous patient groups including patients with mild to severe sleep apnea or patients with moderate to severe sleep apnea. Most of the reported prevalence figures for depression or anxiety were from studies with heterogeneous study groups in terms of OSAS severity. In an analysis of the few homogeneous patient groups, the mean severity of OSAS did not seem to correlate linearly with the prevalence of depression. Even in those studies (30, 38) that focused on patients with mild OSAS, the reported prevalence of depression varied from 16% to 41%. The prevalence of anxiety was also high (67%) in the study by Engleman et al. (30), although OSAS severity was mild.

Depression and anxiety were mostly evaluated with the BDI, HADS, POMS, CES-D, Zung SDS, MMPI and SCL-90, and their different versions (particularly the BDI). POMS, MMPI, and SCL-90 also include assessments of psychological conditions other than depression and anxiety. Comparison between the studies was difficult because the cut-off scores varied for the same mood scale or no cut-off score was defined. In three studies the evaluation of depression was based on the Structured Clinical Interview for DSM-IV, DSM-III-R or DSM-III. A few other studies used psychiatric interviews but did not report their results in any detail. The diagnosis of depression or anxiety cannot be based on the mood scales only, without a structured psychiatric interview following the international criteria of DSM-IV or ICD-10. It follows that most of the studies reviewed do not evaluate depression or anxiety as a clinical entity, but instead report symptoms of depression or anxiety on the basis of different scales, such as the BDI or HADS. In addition, the most reliable figures for the prevalence of depression and anxiety *as clinical entities* are provided by studies using psychiatric evaluation based on international criteria, while results for the prevalence of depressive and anxious *symptoms* can be drawn from studies using mood scales. The studies reviewed showed a marked variety in the prevalence of both

depression (7–63%) and anxiety (11–70%). When reported, the severity of depression was usually rated as mild. Prevalence figures for depression and anxiety varied widely, even between studies using the same method of assessment: for example, the prevalence of depressive symptoms based on different versions of BDI ranged from 16% to 55% (21, 38, 45, 47, 65, 69, 75). Nevertheless, mood scales may well be adequate for assessing mood in OSAS patients if the depressive and anxious state is seen as secondary to the medical disorder, and if the mood disorders are improved with the treatment. A psychiatric consultation is necessary if the treatment of OSAS does not result in mood improvement.

There is no clear consensus between the compliance and the treatment time of CPAP and the effectiveness of treatment. Stepnowsky and Moore (95) stated in their review that longer CPAP use leads to better treatment outcome. In the studies reviewed, compliance ranged from 3.1 to 7.0 h per night and the treatment time ranged from 1 week to 2 years (median: 8 weeks). The compliance time less than 4 h per night and the treatment time less than 3 months might be too short to have any effects on mood. Therefore, we focused to clarify the effect of CPAP treatment on mood in the studies with the treatment time at least 3 months. Depressive symptoms declined in four out of seven studies and anxiety in two out of four studies. Thus, the results of the effect of CPAP treatment on mood are not conclusive.

According to Means et al. (45) persisting mood disorder confirms that OSAS also involves a mood component. Furthermore, Muñoz et al. (61) also pointed out that anxious and depressive symptoms may develop despite effective treatment because of chronic CPAP use and awareness that the treatment is only symptomatic, not curative. Furthermore, patients' behavioral and personality characteristics (e.g., choice of coping strategies) may have a major influence on which OSAS patients will experience greater disturbance of mood (35).

One limitation of this review is that it does not extend to correlations between mood disorders and nocturnal sleep variables. Earlier studies report differing results on these correlations, but a systematic analysis of these relationships could make intelligible the overall relationship between mood alterations and OSAS as well as the impact of CPAP treatment on mood. Secondly, the focus of our review was confined to the most common mood alterations in OSAS, namely depression and anxiety. However, other less common psychiatric states in OSAS have been linked to somatization, obsession-compulsion, hostility, chronic dysphoria, somatic concern, nocturnal panic attacks, and psychotic episodes (6, 7, 10). A third limitation is that we excluded studies that concentrated on quality of life, yet some methods for assessing quality of life may involve mood aspects as well.

The main focus of our ongoing study is on executive dysfunction in OSAS (96) as well as on the assessment of mood disorders and quality of life. On the basis of this review and the preliminary findings of our ongoing study, some recommendations for further research can be offered. First, more careful attention should be paid to the background variables of subject selection. The age and gender of subjects may have a significant impact on mood results; women in postmenopausal age and women overall are more vulnerable to mood alterations. Secondly, it is important to take note of the limitations of mood scales, which are not proper diagnostic tools for the detection of depression or anxiety; they only represent depressive and anxious symptoms. Diagnosis of the clinical entity requires a psychiatric consultation. Thirdly, before any treatment is initiated for mood disorders, it is necessary to establish whether OSAS lies behind depressive symptoms in middle-aged, obese patients with sleep problems as Kaplan (9) has recommended. Fourthly, the evaluation of mood is essential when the clinical assessment or research focuses on the cognitive effects of OSAS, because mood disorders may be indicative of some deficits in cognitive processing.

In conclusion, the wide variance in the prevalence of depression and anxiety may be due to different reasons: study selection, patient characteristics (gender, age, personal differences), the methods used to assess depression and anxiety, and the overlap between mood alteration and OSAS-related symptoms. In many cases it seems that depression and anxiety are secondary to the medical disorder, but it is possible that a primary emotional component is also involved in the mood alterations seen in OSAS patients. CPAP may improve depressive and anxious symptoms but there are only a few long-term follow-up studies concerning the effectiveness of CPAP on mood.

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