DOI: 10.26387/bpa.291.1

Coping strategies in mild-to-severe OSA patients: The role of job crafting in work-related behaviors

Luigi Macchitella[1, 2], Fulvio Signore[1], Emanuela Ingusci[1], Domenico Maurizio Toraldo[3], Michele Arigliani[3], Michele De Benedetto[3], Claudio Giovanni Cortese[4], Paola Angelelli[2]

[1] History, Society and Human Studies Department, University of Salento, Lecce, Italy
[2] Center for Neurodegenerative Diseases and the Aging Brain, Department of Clinical Research in Neurology, University of Bari 'Aldo Moro', 'Pia Fondazione Cardinale G. Panico', Tricase, Lecce, Italy
[3] 'V. Fazzi' Hospital, ENT, ASL, Lecce, Italy
[4] Psychology Department, University of Turin, Turin, Italy

paola.angelelli@unisalento.it

ABSTRACT. I pazienti con apnea ostruttiva del sonno (OSA) sperimentano deficit neurocognitivi ed eccessiva sonnolenza diurna con conseguenti limitazioni al lavoro. Lo scopo dello studio è approfondire le strategie dei pazienti con OSA alla base del job crafting, un approccio proattivo per migliorare la gestione del lavoro, in un campione di 25 pazienti e 27 partecipanti di controllo. I risultati suggeriscono che le strategie di job crafting sono adottate con uguale frequenza, seppur con differenze di tipologia. Il job crafting potrebbe avere un impatto positivo sulle prestazioni lavorative percepite dai pazienti e tale impatto diventerebbe maggiore in funzione della gravità dell'OSA.

SUMMARY. Patients with obstructive sleep apnea (OSA) constitute an economic burden on most health occupational systems. They, in fact, experience several neurocognitive deficits, excessive daytime sleepiness and fatigue and work-related limitations. Although the clinical relevance, only recently some authors focused on the relationship between OSA and a wider range of work-related variables. The aim of this study is to deepen the OSA's strategies underlying job-crafting, a proactive bottom-up strategy that workers implement to redesign their job tasks to improve their job management. We assessed 25 previously untreated mild to severe OSA patients with a mean age of 52.2 (±9.80 years) and a mean apnea-hypopnea index (AHI) of 43.89 (±19.1). A control group of 27 healthy participants was also enrolled. Data suggest job crafting strategies are adopted with the same frequency in the two groups, although the differences lie on the typology of strategy used. Moreover, job crafting could positively impact self-perceived job performance in OSA patients. The impact of job crafting on performance becomes higher as a function of OSA severity (i.e., AHI), while sleepiness does not moderate the relation between job crafting and self-perceived job performance. OSA patients do not adopt job crafting strategies to cope with their sleepiness, but to balance cognitive failures, mainly related to hypoxia. Results are discussed in terms of possible compensation mechanisms adopted by OSA patients: job crafting strategies may be conceived as a self-determined way to cope with their difficulties and to support their work performances.

Keywords: *Obstructive sleep apnea (OSA), Apnea-hypopnea index (AHI), Occupational outcomes, Job crafting, Job performance*

INTRODUCTION

Obstructive sleep apnea syndrome (OSA) is one of the most frequent (but at the same time underdiagnosed) sleep breathing disorder characterized by repetitive episodes of a partial or complete collapse of the upper airway during sleep, resulting in apnea or hypopnea respectively, that in turn, causes intermittent hypoxia and sleep fragmentation with excessive daytime sleepiness and fatigue (Dempsey et al., 2010). OSA had several and important adverse consequences. OSA literature reports a higher risk of cardiac and cerebrovascular diseases, and mortality (Kendzerska, Gershon, Hawker, Leung & Tomlinson, 2014), structural and functional alterations in several brain regions (e.g. Huang, Tang, Lyu, Yang & Chen, 2019 for meta-analysis) leading to a wide range of cognitive impairment (including attentional and executive deficit, Angelelli et al., 2020; Macchitella et al., 2021; for meta-analysis and meta-review see e.g. Olaithe, Bucks, Hillman & Eastwood, 2018) and also increased risk for motor and work accidents (e.g. Garbarino, Guglielmi, Sanna, Mancardi & Magnavita, 2016; Morsy et al., 2019; Tregear, Reston, Schoelles & Phillips, 2010). Moreover, OSA patients reported decreased quality of life (Bue, Salvaggio, Isidoro, Romano & Insalaco, 2019), suffered from mood and anxiety disorders and poor social interpersonal relationships (Morsy et al., 2019). Note worthily, between neuropsychological sequelae of OSA patients, also sociocognitive deficits were reported (Macchitella et al., 2021). Social cognition and mind-reading skills are essential to every adaptive and appropriate social interaction, from the family to the working context. Finally, the association between OSA and work-related limitations has also been documented (e.g. Mulgrew et al., 2007). It is worth noting that the work consequences of OSA receive an increasing interest since OSA patients constitute an economic burden on most health occupational systems (Morsy et al., 2019). Notably, some studies stressed that OSA treatment reduces daytime consequences and, in turn, their economic and health impact (Balbi et al., 2014; Morsy et al., 2019; Mulgrew et al., 2007; Tregear et al., 2010). However, only recently some authors focused on the relationship between OSA and a wider range of work-related variables. For example, several studies investigated the relationship between OSA and absenteeism, work productivity and performance, job satisfaction, job stress and job burnout (Guglielmi, Jurado-Gàmez, Gude & Buela-Casal, 2014, 2015; Msaad, Kammoun, Hajjaji, Kalle & Bahloul, 2018; Swanson et al., 2011). The impact of OSA on work activity and behaviour has been conceptualized as due to sleepiness, fatigue, mood disorders or neurocognitive deficit associate with OSA (e.g. Guglielmi et al., 2014; Msaad et al., 2018; Mulgrew et al., 2007; Swanson et al., 2011; Stepnowsky et al., 2019). Nevertheless, few studies focused on strategies that OSA could adopt to improve their work performance based on their clinical and psychological situation. In this study, we investigated the OSA's behaviours aimed at using proactive strategies and at crafting autonomously their job (i.e., job crafting; see below for details), reducing stress impact on work-life and improving job performance and, in general, increasing their well-being at work.

Considering that OSA patients are characterized by sleepiness and several neurocognitive dysfunctions, it is possible to hypothesize that OSA patients could manifest difficulties in developing strategies underlying job-crafting. Remarkably, the reverse may also be possible: they could, in fact, "craft their jobs" with the aim of improving their well-being and aligning the work with clinical and psychological needs. Regarding this issue, there is no current literature. OSA patients could use strategies of job crafting such as a compensative way to face the cognitive impairment. Moreover, as stressed above, different studies showed that there is an evident association between job crafting and job performance (Tims, Bakker & Derks, 2015). Thus, the propensity of OSA patients to develop job crafting related strategy could, in turn, influence self-perceived job performance. Therefore, the aim of the present study is to investigate for the first time the job crafting construct, self-perceived job performance and their relationship in mild-to-severe OSA patients. Moreover, a further aim is to explore the moderating role of OSA related factors such as gravity, measured as the number of apnea and hypopnea events (i.e. the apnea-hypopnea index, AHI) and daytime sleepiness in the relationship between job crafting and self-perceived job performance in OSA patients.

Conceptual framework and research hypotheses development
OSA patients as workers: The role of job crafting and job performance

As described above, OSA is a breathing disorder which affects several aspects of own life. Several studies showed

that the symptoms of OSA negatively affect patient's quality of work and private life, social and professional relations; thus, it is evident that OSA may produce a negative impact also on job performance and occupational health (Guglielmi et al., 2015). OSA patients can have difficulties to carry out job tasks, can experience hard situations at work, trying to maintain a performance level as well as healthy colleagues. So, there may be a gradual but progressive decline in job productivity and a worsening of interpersonal relationship in their workplace. From the perspective of occupational health and safety, it is essential to explore coping and proactive strategies which workers with OSA can carry out to redesign their job, considering their limitations, but also their resources. In the Work and Organizational Psychology literature, one of these constructs is job crafting. Job crafting has been defined as a change of proactive bottom-up strategy that workers implement to redesign their job tasks to increase and improve their job management. These changes can involve structural (physical and procedural), social and cognitive aspects. Tims, Bakker, and Derks (2012), extended the concept of job crafting within the theoretical framework of job demands-resources model (hereafter JD-R model) (Bakker & Demerouti, 2017), suggesting that job crafting involves the changes carried out by employees to balance the demands and the resources of their job with their abilities and needs. This model shows how well-being and efficiency in the workplace can be the result of two types of working conditions: requests (job demands) and resources (job resources). The interaction between the two is central to the development of well-being, job performance and burnout. Starting from the JD-R model, Tims et al. (2012) identified four main job crafting dimensions related to resources and to demands. As for job resources, Tims and colleagues (2012) recognised the dimensions of "increasing structural job resources" (e.g. creating opportunities for growth and development, autonomy and variety) and "increasing social job resources" (e.g. active capability in searching support from supervisors and colleagues, or feedback as opportunity of coaching). Within job demands, Tims et al. (2012) identified the dimensions of "increasing challenging job demands" (situations that workers have to overcome to learn and achieve goals) and "decreasing hindering job demands" (cognitive and emotive requests that focus on minimizing work stressors). Job resources play a crucial role in intrinsic motivation because they satisfy essential human needs for autonomy and competence. While research about OSA and work performance is widely developed (Msaad et al., 2018; Swanson et al., 2011), there is a lack of literature about job crafting and job performance in OSA patients. Job crafting, as a proactive and coping strategy in organizational contexts, has been explored mainly from a managerial point of view. In recent years, it has also been examined in the field of occupational health and safety, as a protective factor of stress and as a facilitator of well-being at work. Thus, job crafting leads to positive outcomes for the employee (person-job fit, enhanced meaning, job satisfaction, work engagement) as well as for the organization (commitment, high performance, reduced staff turnover) (Bakker & Demerouti, 2017; Ingusci et al., 2019). It is also interesting to note that beneficial outcomes could originate not from positive changes in job aspects but from being just immersed in job crafting activities, because it may increase employees' own work responsibilities. Moreover, Tims and colleagues (2015) analysed the relation between job crafting and job performance and suggest that employees can increase their own work engagement and job performance through job crafting.

Thus, moving from this theoretical background, our study aimed at answering the following questions: a) there are significant differences between OSA patients and healthy participants for the job crafting dimensions (increasing structural job resources, increasing social job resources, increasing challenging job demands, decreasing hindering job demands); b) job crafting is positively related to job performance in OSA patients compared to a control group.

The role of OSA severity and daytime sleepiness in the workplace

Among the several symptoms that OSA patients suffer from, one of the most detrimental is daytime sleepiness. Excessive sleepiness during the day can have important consequences in the workplace, leading to the loss of productivity and more generally to restricted ability to work (AlGanim, Comondore, Fleetham, Marra & Ayas, 2008). These are all indirect costs of OSA. Basically, most of the studies conducted on OSA patients in work contexts show that the effects of the syndrome mainly refer to the inability to concentrate, to carry out new tasks, to time management skills and to complete repetitive tasks (Accattoli et al., 2008); in general, OSA has negative consequences for job performance (Mulgrew et al., 2007; Omachi, Claman, Blanc

& Eisner, 2009). To determine the severity of OSA, the apnea-hypopnea index is used: it is an objective measurement of apnea-hypopnea events per hour of sleep. Mulgrew (Mulgrew et al., 2007), in his study highlighted how the productivity of OSA patients in work contexts is certainly linked to sleepiness but not to the severity of the syndrome expressed in terms of AHI. Fatigue levels are affected by many interrelated aspects, one of the causes being the lack of sleep. A self-rating method that measures how likely a person is to fall asleep during daytime activities is the *Epworth Sleepiness Scale* (*ESS*). This scale classifies the degree of sleepiness of a person evaluating the probability of falling asleep during many different situations, for example, while reading, listening to a conference, or having a conversation with someone; it also rates the perceived severity of sleepiness (Haghighi et al., 2013). According to Mulgrew (Mulgrew et al., 2007), the relationship between the severity of the syndrome and work limitations can depend on the type of work performed: the severity of OSA seems to greatly affect the limitations in time management and productivity of workers (Accattoli et al., 2008). Recently, Jurado-Gámez et al. (Jurado-Gàmez, Guglielmi, Gude & Buela-Casal, 2015) also showed a high percentage of absenteeism, psychological distress, and low productivity in patients with OSA compared to healthy participants. Considering the above literature, in addition to the previous questions, we were also interested in answering the following queries: c) AHI moderates the relationship between job crafting behaviours and job performance, such that the positive relationship remains when AHI is high but is neutralized when AHI is low; d) EES moderates the relationship between job crafting behaviours and job performance, such that the positive relationship remains when EES is low but is neutralized when EES is low.

METHOD

Participants

A total sample of 52 individuals, 25 suffering from OSA (48%) and 27 control participants (52%) entered the study. Most of the sample was male (96%), while only 4% was female. The mean age of the overall sample was 50.13 years, the mean of OSA patients was 52.2, the control group was 48.2. OSA patients were consecutively admitted to the Department of Otorhinolaryngology and the Respiratory Rehabilitation Care Unit of V. Fazzi Hospital Lecce (Italy) from October 2017 to November 2018. All patients received a diagnosis of OSA in accordance with the International classification of sleep disorders, which was verified with a full night polygraphic recording evaluation (Berry et al., 2012).

All patients underwent a clinical interview about their medical history and their medical records (charts) were carefully examined. To be included, patients had to perform normally on the Mini-Mental State Examination (according to Measso et al., 1993), a widely used instrument to measure the cognitive decline in adults. Patients were excluded from the sample if they: (i) were engaged in current treatment with continuous positive airway pressure (CPAP); (ii) had a significant co-morbid medical condition (e.g. diabetes mellitus, heart disease, or a tumour) or another neurological or sleep disorder (i.e. ictus or epilepsy); (iii) were taking medications that could adversely affect cognitive function (e.g. benzodiazepines or antidepressants), or presented clinically relevant depression according to the *Beck Depression Inventory* (*BDI*; Beck, Ward, Mendelson, Mock & Erbaugh, 1961). Ultimately, none of the patients presented a major depression disorder (BDI score >24 for the 21-item version).

Daytime sleepiness was measured by the *Epworth Sleepiness Scale* (*ESS*; Johns, 1991, 2000), which is the most extensively used questionnaire to estimate subjective daytime sleepiness and concentration disorders because of OSA. There is no uniform system for interpreting the ESS, but a score >10 indicates significant ESS, and a score >15 indicates serious sleepiness (Peppard et al., 2013). The subjects included in our sample showed an ESS mean of 12.3 and 26.1% of them presented a score higher than 15. The body mass index (BMI) was calculated as the ratio of weight/body height (in kilograms per square meter). Obesity was diagnosed at BMI ≥29.9 kg/m.

Ear, nose, and throat (ENT) investigations in the control group did not highlight any otorhinolaryngological disease. Furthermore, the control participants did not present any history of snoring, sleep complaints or related symptoms, or combinations of symptoms of OSA on a 5-point questionnaire investigating habitual snoring, morning fatigue, hypertension, neck size in centimetres (x = 16.64, *SD* = .5, range 15.5-17.5), and body mass index (x = 25.8, *SD* = 2.1, range 22.4-32). The questionnaire was a modified version of the known *STOP-Bang questionnaire* (Chung, Abdullah & Liao, 2016). None of the participants complained of daytime sleepiness on the ESS.

Clinical features of the OSA sample are reported in Table 1. In the OSA group mean BMI index is 32.8, the saturation is 92%, and the mean T90 is 22.8%. Moreover, 28% of the cases reported a mild diagnosis, while 72% severe (see paragraph below for OSA diagnosis and criteria of gravity). Table 2 shows that subjects of both groups did not differ in terms of mean age and Mini-Mental State Examination scores.

This study was approved by the Ethical Committee of V. Fazzi Hospital, Lecce (verbal N. 39, 28 July 2016). All subjects gave their written informed consent in accordance with the Declaration of Helsinki.

Measures

Assessment of patients with sleep-disorder breathing.

AHI is the number of apnea-hypopnea events per hour of sleep. OSA was confirmed by a recorded polygraphic evaluation with an apnea-hypopnea index (AHI) of >5 apneas/hour of sleep according to the diagnostic criteria of the American Academy of Sleep Medicine (Kapur et al., 2017). The definitions of AHI were based on the standard criteria (Berry et al., 2012). AHI scores per hour of sleep were indicative of mild (5≥AHI<15), moderate (15≥AHI<30), or severe (AHI≥30) OSA according to Berry et al. (2012).

Table 1 – Descriptive statistics of clinical features in OSA patients

	AHI Severity	**ESS**	**BMI**	***Mean* SO_2(%)**	**T90 (%)**
OSA	28% mild 72% severe	12.3	32.8	92	22.8
SD	19.1	3.0	5.3	3.1	23.4

Legenda. ESS = *Epworth Sleepiness Scale*; BMI = body mass index.

Table 2 – *t*-test comparisons on age and MMSE scores of OSA and control participants

		Age	Mini Mental State Examination
OSA	***Mean* OSA**	52.2	28.4
	SD	9.80	1.26
Control Group	***Mean* Control group**	48.2	28.2
	SD	6.14	.77
	p	.082 (Student's *t*-test)	.501 (Student's *t*-test)

Note. Welch's test was used in case of inequality of variance.

Portable monitoring (PM) is commonly used as an alternative to polysomnography for OSA diagnosis. For appropriately selected patients, there is evidence that PM is a reasonable substitute for in-laboratory polysomnography (Cooksey & Balachandran, 2016; Corral et al., 2017). Each recording was performed between 23:00 and 06:00. The signals, which were saved in a digital recorder, were then computer analysed and validated by the physician the morning after the recording.

Job crafting and self-perceived job performance.

Measures of job crafting and self-perceived performance were detected as follows.

- *Job crafting*: 21-item from *Job Crafting Dutch Scale* by Tims et al. (2012). Items were translated in Italian and comprised four dimensions: increasing structural job resources (5 items, e.g. "I try to develop my capabilities"); increasing social job resources (5 items, e.g. "I look to my supervisor for inspiration"); increasing challenging job demands (5 items, e.g. "If there are new developments, I am one of the first to learn about them and try them out"); decreasing hindering job demands (6 items, e.g. "I manage my work so that I try to minimize contact with people whose problems affect me emotionally"). The answer-Likert frequency scale is on 7-point.
- *Performance*: 13-item from *Individual Work Performance Questionnaire* by Koopmans et al. (2013). We considered two dimensions from the questionnaire, task performance, which is the competence through which individuals perform technical tasks to job (5 items, e.g. "I kept in mind the results that I had to achieve in my work") and contextual performance, or behaviours and actions supporting the organizational, psychological and social environment in which the technical core operates (8 items, e.g. "I was able to fulfill my responsibilities"). There is a 5-point Likert scale, where 1 is "strongly disagree" and 5 is "strongly agree".

Statistical methods

Moderation is a form of regression technique. Regression is a model which is based on a linear relationship between two quantitative variables. The statistical relationship is a unidirectional and asymmetric one, as the attention is on the dependence of one variable on the other one. Digging into this relationship allows to determine how much the variation of scores in one variable depends on the variation of another. Therefore, in the regression the focus is on the dependence between a variable Y, or dependent variable, from a variable X, called independent. Moderation is a form of regression technique in which the effect of an X independent variable (or more) on one or more Y dependent variables is moderated by a W variable. In this case, in fact, the size, sign or strength of the regression relationship depends on or can be predicted by W. If W is a moderator, then X and W interact in their impact on Y (Hayes, 2017).

Differently from simple regression techniques, moderation is based on the conditionality of X on W. If the effect of X on Y is moderated by a variable, consequently the X effect depends on that variable, or moderator. In simple regression, the situation is different: the effect of X on Y does not depend on other variables. The aim of a moderation analysis is, therefore, to test a linear interaction between X and W in a model of regression dependency with Y. A moderation analysis allows a researcher to describe the conditional nature of the relation whereby X transmits its effect on Y through the moderator W. The moderation process implies three causal paths: the effect of the independent variable (X) to the dependent variable (Y), the effect of the moderator (W) to the dependent variable (Y) and finally the effect of the interaction path (X*W) to the dependent variable. A relevant moderation occurs when the interaction term X*W is statistically significant.

In this study we performed a comparison between OSA and control group in self-perceived job performance. Moreover, to evaluate whether job crafting predict self-perceived job performance, we also assess (through regression analysis) the relationship between job crafting and performance in both OSA and control group. Finally, we performed moderation analysis to evaluate if the number of apnea and hypopnea events (i.e., AHI as measure of OSA severity) and sleepiness moderate the relationship between job crafting and self-perceived job performance.

Data analysis

Analyses were performed through Jamovi, version 1.2.2.0, and R Studio software (Version 1.2.5033) and carried out on a total sample of 52 individuals, 25 from OSA category (48%) and 27 from the control group (52%). Further models were performed by removing missing responses: as the sample was already small, it was decided not to carry out any missing data management operations and to directly remove observations

with missing responses greater than 50%. Thus, final dataset was composed by 22 individuals of OSA (88% of the initial sample) and 26 of control group (96.3% of the initial sample).

As a starting point, we performed a brief descriptive comparison between OSA and control group in the different subdimensions of job crafting, overall job crafting (according to Tims et al., 2012) and self-perceived performance (see Figure 1). The subdimensions of job crafting were, more specifically:

1) increasing structural resources, which define the creation of opportunities for growth and development, autonomy, and variety by the worker (hereafter STR);
2) increasing social resources, or the active capability in searching support from supervisors and colleagues, or feedback as an opportunity of coaching (hereafter SOC);
3) increasing challenging demands, or looking for new tasks at work, looking for more responsibilities (Petrou, Demerouti, Peeters, Schufeli & Hetland, 2012) (hereafter CHAL).
4) decreasing hindering demands, or minimizing the emotionally, mentally, or physically demanding job aspects (Petrou et al., 2012) (hereafter HIND).

RESULTS

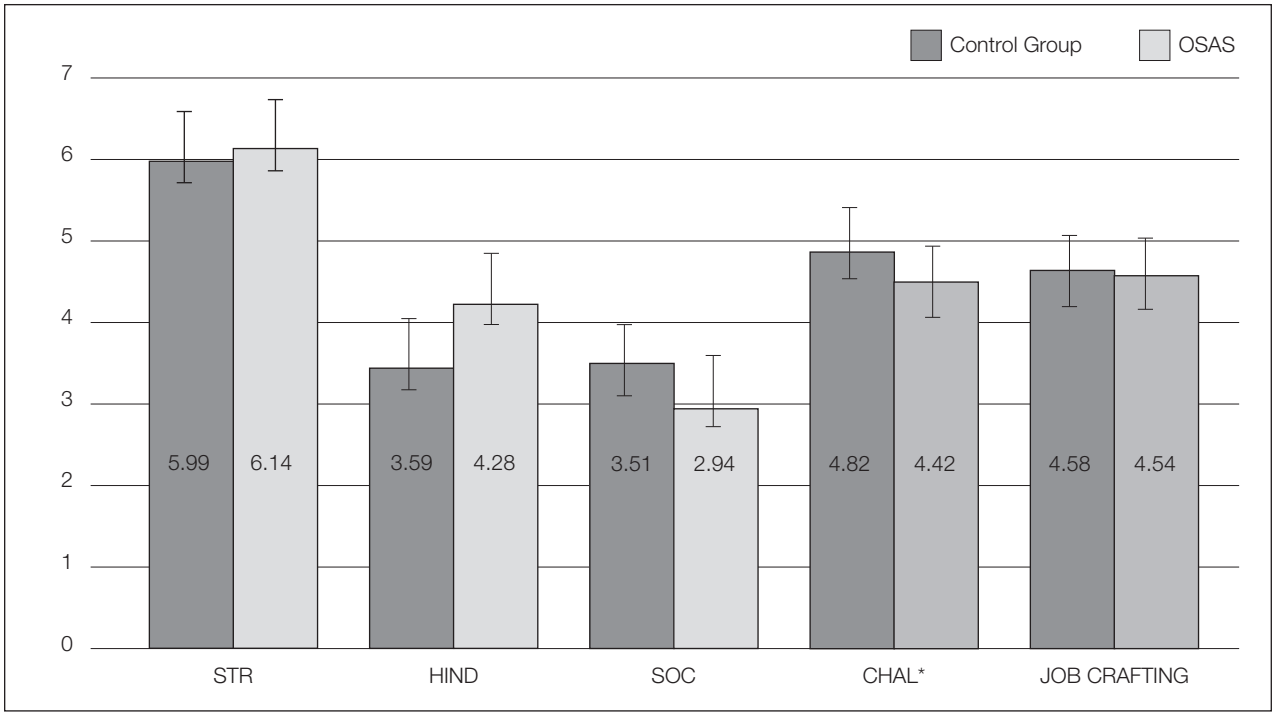
As reported in Table 3, OSA and control group showed significant differences for increasing challenging demands' dimension. At the same time, no significant difference was found between OSA and control group in others job crafting subdimensions.

Different studies (Ingusci et al., 2019; Van Wingerden, Derks & Bakker, 2017) indicated that job crafting could positively impact performance. Accordingly, estimated coefficients confirmed the existing literature about the relationship.

Interestingly, based on the regression model hypothesized, in both groups, job crafting strategies influenced positively and significantly performance, but in OSA patients this path was stronger than the control group ($\beta_{OSA} = .69$, $p<.001$ and $\beta_{CONTROL\ GROUP} = .50$, $p<.05$).

As represented in Table 4, moderation analysis indicates that the influence of sleepiness on the relation between job crafting and self-perceived performance in OSA group is not statistically significant. On the contrary, the apnea-hypopnea index (AHI), effectively moderated the relations

Figure 1 – Comparison between control group and OSA patients in using job crafting strategies



Legenda. STR = structural resources; HIND = hindering demands; SOC = social resources; CHAL = challenging demands.

Table 3 – *t*-test comparison on job crafting strategies and performance: all analysis were performed through Student's *t*-test

		STR	HIND	SOC	CHAL	Job crafting	Self-perceived performance
OSA	***Mean***	6.14	4.28	2.94	4.41	4.53	2.79
	SD	1.05	1.60	1.35	.77	.91	.68
Control group	***Mean***	5.99	3.59	3.51	4.82	4.58	2.89
	SD	.67	1.30	1.01	.52	.69	.53
	p	.559	.092	.092	.027	.809	.580

Legenda. STR = structural resources; HIND = hindering demands; SOC = social resources; CHAL = challenging demands.

Table 4 – Moderation output of the analysis

AHI as moderator in the relationship between job crafting and job performance						
	Estimate	**SE**	**Lower**	**Upper**	**Z**	***p***
Job crafting	.675	.132	.417	.934	5.13	<.001
AHI	−.005	.005	−.015	.005	−1.05	.295
Job x AHI	.016	.007	.002	.030	2.32	<.05
ESS index as moderator in the relationship between job crafting and job performance						
Job crafting	.559	.125	.314	.803	4.48	<.001
ESS index	−.042	.035	−.109	.026	−1.20	.229
Job x ESS index	−.053	.067	−.186	.079	−.79	.431

Legenda. ESS = *Epworth Sleepiness Scale*.

between job crafting (considered as the overall mean of the different subdimensions, or increasing structural resources, increasing social resources, increasing challenging demands and decreasing hindering demands) and self-perceived performance in OSA group. The consequently general consideration is that in OSA group the intensity of the relation between job crafting and performance is conditional to AHI. In order to assess which level of the apnea-hypopnea index allows to make the moderation statistically significant we represented the simple slope estimation graphically by using *medmod* package in R Studio.

Figure 2 and Table 5 show the levels of the variables through which the moderations resulted statistically significant. In the interaction term between job crafting and performance, results show that the moderation effect occurs when the level of apnea-hypopnea index is on the average, low (one *SD* less than average) or high (one *SD* more than the average). This outcome appears interesting since our sample of OSA patients suffered from mild to severe OSA following AHI evaluation ($OSA_{AHIMEAN}$ = 43.89, with 28% and 72% of patients suffering from mild and severe OSA, respectively).

Table 5 highlights that each value of AHI moderates the relation between job crafting and performance. The estimates of the relationship increase as the level of the moderator assume higher values. According to these results, job crafting has an important and significant impact on performance with a higher level of AHI in OSA ($\beta_{AHI\ LOW}$ = .386, $\beta_{AHI\ AVERAGE}$ = .695, $\beta_{AHI\ HIGH}$ = 1.004).

Finally, through Table 6 we can identify the cut-off values of apnea-hypopnea index through which moderation between job crafting and performance became significant. Low AHI values (–1 *SD* than the average) correspond to values near to 25, or a situation of moderate OSA. Average AHI (43.9) and high AHI (64.1) values represent severe OSA situations, as AHI index range considers as tighter cases the ones starting above AHI = 30. Thus, based on our data, we can conclude

Figure 2 – Graphical simple slope estimates of the statistically significant moderations

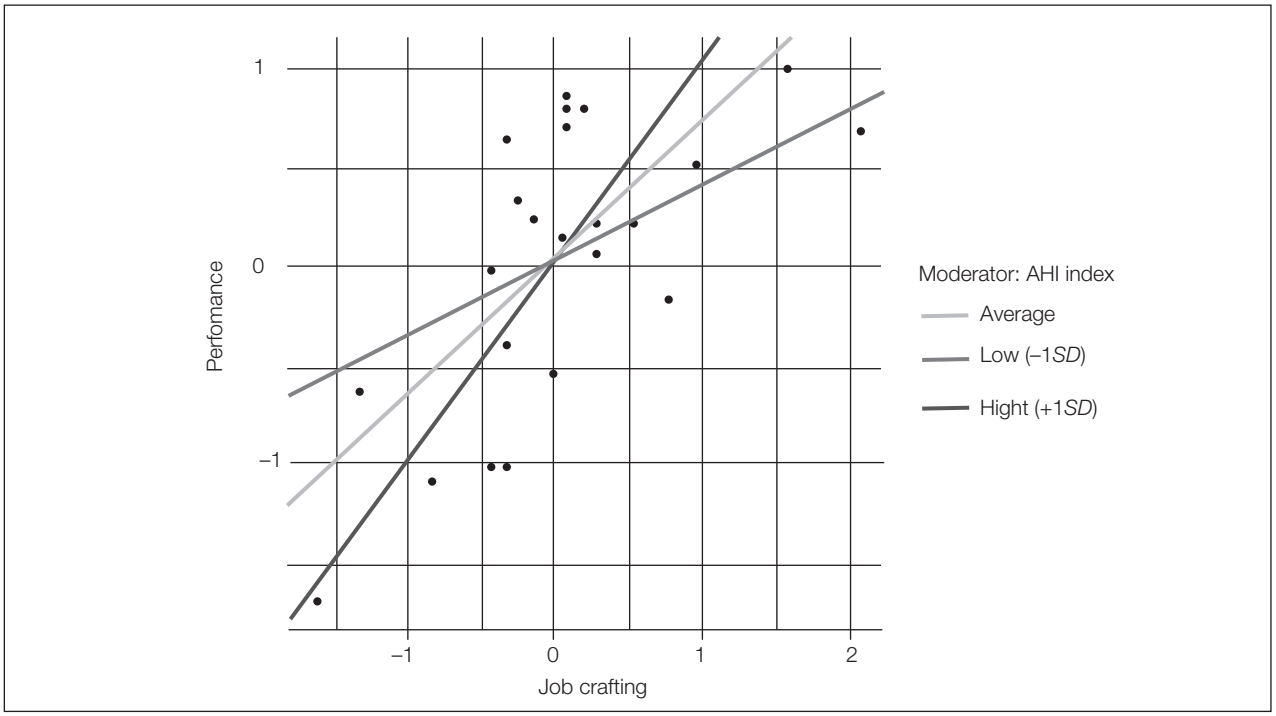


Table 5 – Simple slope estimates of the statistically significant moderations

	Estimate	SE	Lower	Upper	Z	*p*
Low (–1 *SD*)	.386	.173	.046	.726	2.23	<.05
Average	.695	.149	.403	.987	4.67	<.001
High (+ 1 *SD*)	1.004	.233	.548	1.460	4.32	<.001

Table 6 – AHI measure for significant moderation

AHI	Effect	SE	*t*	*p*	Lower	Upper
16.1	.2154	.2353	.9155	.3714	–.2771	.7079
19.01	.2636	.2173	1.213	.24	–.1913	.7184
21.92	.3117	.2004	1.5558	.1363	–.1077	.7311
24.83	.3599	.1848	1.9473	.0664	–.027	.7467
25.8314	.3765	.1799	2.0932	.05	0	.7529
27.74	.408	.171	2.3859	.0276	.0501	.766
30.65	.4562	.1594	2.8612	.01	.1225	.79
33.56	.5044	.1506	3.3493	.0034	.1892	.8196
36.47	.5525	.1449	3.8119	.0012	.2491	.8559
39.38	.6007	.1429	4.2032	.0005	.3015	.8998
42.29	.6488	.1446	4.4862	.0003	.3461	.9516
45.2	.697	.15	4.6474	.0002	.3831	1.0109
48.11	.7452	.1586	4.6989	.0002	.4132	1.0771
51.02	.7933	.17	4.6678	.0002	.4376	1.1491
53.93	.8415	.1836	4.5838	.0002	.4572	1.2257
56.84	.8896	.199	4.4707	.0003	.4731	1.3062
59.75	.9378	.2158	4.3455	.0003	.4861	1.3895
62.66	.986	.2337	4.2183	.0005	.4967	1.4752
65.57	1.0341	.2525	4.0951	.0006	.5055	1.5627
68.48	1.0823	.272	3.9788	.0008	.5129	1.6516
71.39	1.1304	.292	3.8708	.001	.5192	1.7417
74.3	1.1786	.3125	3.7713	.0013	.5244	1.8327

that in the case of more severe impairment, the relation between job crafting and performance is likely to be stronger. Job crafting behaviours could be considered, in this context, a conservative and a coping strategy aimed at facing difficulties due to OSA condition, particularly in severe conditions. In fact, moderation analysis was always significant but the regression relationship between job crafting and performance increased intensity with AHI values ≥25.8.

DISCUSSION AND CONCLUSIONS

Recently, the number of studies concerning work related behaviours in OSA patients is increased. It has been suggested that OSA is associated with job performance and presenteeism (e.g. being physically present at a job but unable to, for example, finish assigned tasks or concentrating or organization), as well as with poor occupational health (e.g. job burnout) (Guglielmi et al., 2015; Swanson et al., 2011). However, the relationship between OSA and impairment in work-related psycho-behaviour variables is not obvious. For example, Guglielmi et al. (2014) failed to find a significant difference between OSA and the control group in job stress, burnout and satisfaction. In the present study, we investigate the job crafting construct in OSA patients, a work-related behaviour that has not been investigated in this peculiar population of workers. The term job crafting refers to the ability to develop strategies to increase and improve job management, and thus job crafting could also improve job-performance. Considering that OSA is associated with low work performance, cognitive impairment, and sleepiness (e.g. Swanson et al., 2011), one might expect that OSA patients could manifest difficulties in developing strategies underlying job-crafting and thus could also be characterized by low levels of self-perceived job performance. Our data indicated no significant difference between OSA's and control's group in both job crafting (except for increasing challenging demands) and self-perceived job performance. However, it is possible to note that, based on a merely descriptive evaluation of the data (as represented in Figure 1), OSA patients, compared with control group participants, tend to use less frequently some job crafting strategies. We are aware that this outcome on the differences between OSA's patient and control group's participants in "social job crafting" is an overinterpretation of non-significant results. Nevertheless, we just want to stress that our result suggests the insight that OSA patients could have low propensity to adopt social strategies, as the subdimension of job crafting. This insight seems to be interesting and meaningful because it is very consistent with the evidence that OSA could suffer from socio-cognitive deficit (Macchitella et al., 2021) and tend to avoid interactions with co-workers (Swanson et al., 2011). Thus, this research is an exploratory one and other studies are necessary to confirm this impairment in social job crafting in OSA patients.

Moreover, we found an association between job crafting and self-perceived job performance in OSA patients. In other words, our data indicate that job crafting could positively impact performance in OSA patients. Crucially, we found also that the impact of job crafting on perceived performance increases whether AHI values become higher. This result indicates that the impact of job crafting on self-perceived job performance becomes higher as OSA severity increases. This evidence strongly suggests that OSA patients could use job crafting strategies as a self-determined way to cope with their OSA related difficulties (e.g. cognitive impairment or sleepiness) and to support their work performances. Notably, our data provided important insights about some work-related issues, as job stress, burnout and satisfaction in OSA (Guglielmi et al., 2014).

The impact of OSA on job performance has been conceptualized due mainly to sleepiness. Sleepiness is one of the main sleep-related factor that may influence cognitive performance and achievements across many contexts (e.g.from school to work contexts) (Accattoli et al., 2008; Macchitella, Marinelli, Signore, Ciavolino & Angelelli, 2020). Accordingly, for example, several studies showed a relationship between sleepiness and work-related behaviours (e.g. Guglielmi et al., 2014; Msaad et al., 2018; Mulgrew et al., 2007; Stepnowsky et al., 2019). However, sleepiness is only one of the psycho-physiological effect of OSA and at the same time, it is only one of the possible factors related to neurocognitive deficits in OSA patients (e.g. Angelelli et al., 2020; Olaithe et al., 2018). OSA could influence work-related behaviours independently by sleepiness. For example, OSA may induce dysfunction in a wide range of brain regions via intermittent hypoxia that, in turn, lead to multiple neuropsychological deficits beyond sleepiness (e.g. Olaithe et al., 2018), each of which could cause (independently or together with drowsiness) work-related problems. Interestingly, our results indicate that the moderation of sleepiness is not significant in the relation between job crafting and self-perceived job

performance. This preliminary evidence suggests that OSA patients adopt job crafting to balance cognitive failures, mainly related to hypoxia.

Our study has several limitations, and some precautions are needed before generalising our conclusions. The relatively small sample size did not lead to a strong conclusion: further studies could benefit from a replication of the results in a larger independent cohort of patients. Moreover, the work-related variables of the study descended from self-reported assessment scales. Further research needs to be corroborated by more objective data. Furthermore, subsequent investigations could adopt a more heterogeneous control group, in terms of age, gender and profession. Finally, the cross-sectional design of the study must be accompanied by in-depth longitudinal analysis to confirm the causal nature of the relationship suggested, considering other neurocognitive variables.

Despite these limitations, the study can provide interesting theoretical and practical implications for the future. From a theoretical view, job crafting seems to be an active coping strategy adopted by OSA patients to normalize their (self-perceived) job-performance. This suggestion is in line with the issue's literature, where job crafting is considered a powerful tool aimed at boosting a worker's performance, irrespective of the condition (Dubbelt, Demereuti & Rispens, 2019); moreover, in line with the Conservation of Resources Theory (COR), the loss and helplessness of the resources can predict anxiety and depression with crucial implications and consequences for working life (Dirik & Karanci, 2010).

Furthermore, recent research showed that job crafting could be considered a fruitful strategy during an emergency (Ingusci et al., 2021) and our outcome confirmed that OSA workers, characterized by some cognitive and psychological impairments, tend to adopt this autonomous approach to improve their performance. The relation between job crafting and performance is widely studied: by balancing job resources and job demands and aligning psychological needs to work requests, job satisfaction could be improved. Job crafting interventions, in fact, are widely studied in association with different positive outcomes linked to motivation and satisfaction processes, as work engagement, performance and job satisfaction (Devotto & Wechsler; 2019; Oprea, Barzin, Vîrgă, Iliescu & Rusu, 2019; Signore et al., 2020). This suggestion could be more useful in subjects with cognitive impairments, as the preliminary evidence from our study suggested that this strategy could be used by OSA, by increasing certain subdimensions, even in situation of cognitive fragility. Job crafting is a proactive bottom-up strategy adopted by workers to optimize person job fit and improve the performance. The empirical realization of it is based on the management of job demands and job resources existing in a job context. OSA workers probably face every day more job demands due to the difficulties of their physical condition. Job crafting interventions are characterised by the opportunity to offer to the workers a different point of view towards their working environment. As job demands-resources model suggests, each job can be considered as a constellation of demands and resources, where the first are all those conditions which cause obstacles to the workers and the latter are working aspects which could balance the difficulty caused by the demands.

In job crafting interventions, as above-mentioned, participants are taught how demands and resources can be related to motivational and well-being processes, emphasising how job crafting is the process by which they can shape and balance their demands and resources. Job crafting behaviours, therefore, can influence the management of demands by using the resources. Participants are facilitated in mapping their tasks, demands and job resources. Subsequent reflection helps to identify those situations at work which would be desirable to improve well-being (Devotto & Wechsler; 2019; Oprea et al., 2019; Signore et al., 2020; Van Wingerden et al., 2017). In view of the above, job crafting interventions could be adopted as coping strategies to reduce negative consequences of cognitive impairments in OSA workers and at the same time to encourage this specific target of population to consider their difficulty as a job demands which can be overcome with bottom-up and proactive individual strategy. Practical implications of the study can also be discussed. For organizations, various problems related to sleep disorders can arise, such as loss of productivity and motivation by the worker, an increase even in the number of days of leave required and in workplace injuries (Nezamodini, Hoseyni, Behzadi & Latifi, 2014). Future research could explore job crafting actions in specific companies, also considering typical target groups. These organizational interventions could provide for a longitudinal design to develop new strategies for risk management, to reduce stress and to help and support OSAS patients in their personal and working life (Van Wingerden et al., 2017), contributing to improving productivity as well as the well-being at work.

References

ACCATTOLI, M.P., MUZI, G., MAZZOLI, M., GENOVESE, V., PALUMBO, G. & ABBRITTI, G. (2008). Occupational accidents, work performance and obstructive sleep apnea syndrome (OSAS). *Giornale Italiano di Medicina del Lavoro ed Ergonomia*, *30* (3), 297-303.

ALGANIM, N., COMONDORE, V.R., FLEETHAM, J., MARRA, C.A. & AYAS, N.T. (2008). The economic impact of obstructive sleep apnea. *Lung*, *186* (1), 7-12.

ANGELELLI, P., MACCHITELLA, L., TORALDO, D.M., ABBATE, E., MARINELLI, C.V., ARIGLIANI, M. & DE BENEDETTO, M. (2020). The neuropsychological profile of attention deficits of patients with obstructive sleep apnea: An update on the daytime attentional impairment. *Brain Sciences*, *10* (6), 325.

BAKKER, A.B. & DEMEROUTI, E. (2017). Job demands-resources theory: Taking stock and looking forward. *Journal of Occupational Health Psychology*, *22* (3), 273.

BALBI, B., CARLI, S., CREVACORE, M., GODIO, M., DANIONI, A., SACCO, C. & BRAGHIROLI, A. (2014). Sleep apnea, CPAP therapy and work activity. *Giornale Italiano di Medicina del Lavoro ed Ergonomia, 36* 1), 17-21.

BECK, A.T., WARD, C.H., MENDELSON, M., MOCK, J. & ERBAUGH, J. (1961). An inventory for measuring depression. *Archives of General Psychiatry*, *4* (6), 561-571.

BERRY, R.B., BUDHIRAJA, R., GOTTLIED, D.J., GOZAL, D., IBER, C., KAPUR, V.K., CAROLE, L.M. et al. (2012). Rules for scoring respiratory events in sleep: Update of the 2007 AASM manual for the scoring of sleep and associated events: deliberations of the sleep apnea definitions task force of the American Academy of Sleep Medicine. *Journal of Clinical Sleep Medicine*, *8* (5), 597-619.

BUE, A.L., SALVAGGIO, A., ISIDORO, S.I., ROMANO, S. & INSALACO, G. (2019). OSA and CPAP therapy: Effect of gender, somnolence, and treatment adherence on health-related quality of life. *Sleep and Breathing*, 1-8.

CHUNG, F., ABDULLAH, H.R. & LIAO, P. (2016). STOP-Bang questionnaire: A practical approach to screen for obstructive sleep apnea. *Chest*, *149*, 631-638.

COOKSEY, J.A. & BALACHANDRAN, J.S. (2016). Portable monitoring for the diagnosis of OSA. *Chest*, *149*, 1074-1081.

CORRAL., J., SÁNCHEZ-QUIROGA, M.Á., CARAMONA-BERNAL, C., SÁNCHEZ S-ARMENGOL, Á., DEN LA TORRE, A.S., DURÁN-CANTOLLA, J., CARLOS, J.E. et al. (2017). Conventional polysomnography is not necessary for the management of most patients with suspected obstructive sleep apnea. Non inferiority, randomised controlled trial. *American Journal of Respiratory and Critical Care Medicine*, *196* (9), 1181-1190.

DEVOTTO, R.P.D. & WECHSLER, S.M. (2019). Job crafting interventions: Systematic review. *Trends in Psychology*, *27* (2), 371-383.

DIRIK, G. & KARANCI, A.N. (2010). Psychological distress in rheumatoid arthritis patients: An evaluation within the conservation of resources theory. *Psychology and Health*, *25* (5), 617-632.

DUBBELT, L., DEMEROUTI, E. & RISPENS, S. (2019). The value of job crafting for work engagement, task performance, and career satisfaction: Longitudinal and quasi-experimental evidence. *European Journal of Work and Organizational Psychology*, *28* (3), 300-314.

GARBARINO, S., GUGLIELMI, O., SANNA, A., MANCARDI, G.L. & MAGNAVITA, N. (2016). Risk of occupational accidents in workers with obstructive sleep apnea: Systematic review and meta-analysis. *Sleep*, *39* (6), 1211-1218.

GUGLIELMI, O., JURADO-GÀMEZ, B., GUDE, F. & BUELA-CASAL, G. (2014). Job stress, burnout, and job satisfaction in sleep apnea patients. *Sleep Medicine*, *15* (9), 1025-1030.

GUGLIELMI, O., JURADO-GÀMEZ, B., GUDE, F. & BUELA-CASAL, G. (2015). Occupational health of patients with obstructive sleep apnea syndrome: A systematic review. *Sleep and Breathing*, *19* (1), 35-44.

HAGHIGHI, K.S., MONTAZERI, A., MEHRIZI, A.K., AMINIAN, O., GOLKHANDAN, A.R., SARAEI, M. & SEDAGHAT, M. (2013). The Epworth Sleepiness Scale: Translation and validation study of the Iranian version. *Sleep and Breathing*, *17* (1), 419-426.

HAYES, A.F. (2017). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. Guilford.

HUANG, X., TANG, S., LYU, X., YANG, C. & CHEN, X. (2019). Structural and functional brain alterations in obstructive sleep apnea: A multimodal meta-analysis. *Sleep Medicine*, *54*, 195-204.

INGUSCI, E., CALLEA, A., CORTESE, C.G., ZITO, M., BORGOGNI, L., CENCIOTTI, R., COLOMBO, L. et al. (2019). Self-efficacy and work performance: The role of job crafting in middle-age workers. *International Journal of Business and Society*, *20* (2), 533-551.

INGUSCI, E., SIGNORE, F., GIANCASPRO, M.L., MANUTI, A., MOLINO, M., RUSSO, V., ZITO, M. & CORTESE, C.G. (2021). Workload, techno-overload and behavioral stress during COVID-19 emergency: The role of job crafting in remote

workers. *Frontiers in Psychology*, *12*, 1141.

KAPUR, V.K., AUCKLEY, D.H., CHOWDHURI, S., KIHLMANN, D.C., MEHRA, R., RAMAR, K. & HARROD, C.G. (2017). Clinical practice guideline for diagnostic testing for adult obstructive sleep apnea: An American Academy of Sleep Medicine clinical practice guideline. *Journal of Clinical Sleep Medicine*, *13* (3), 479-504.

KENDZERSKA, T., GERSHON, A.S., HAWKER, G., LEUNG, R.S. & TOMLINSON, G. (2014). Obstructive sleep apnea and risk of cardiovascular events and all-cause mortality: A decade-long historical cohort study. *PLOS Med*, *11*.

KOOPMANS, L., BERNAARDS, C., HILDEBRANDT, V., VAN BUUREN, S., VAN DER BEEK, A.J. & DE VET, H.C. (2013). Development of an individual work performance questionnaire. *International Journal of Productivity and Performance Management*.

JOHNS, M.W. (1991). A new method for measuring daytime sleepiness: The Epworth Sleepiness Scale. *Sleep*, 14, 540-545.

JOHNS, M.W. (2000). Sensitivity and specificity of the multiple sleep latency test (MSLT), the maintenance of wakefulness test and the Epworth Sleepiness Scale: failure of the MSLT as a gold standard. *Journal of Sleep Research*, *9*, 5-11.

JURADO-GÀMEZ, B., GUGLIELMI, O., GUDE, F. & BUELA-CASAL, G. (2015). Workplace accidents, absenteeism and productivity in patients with sleep apnea. *Archivos de Bronconeumología*, *51* (5), 213-218.

MACCHITELLA, L., MARINELLI, C.V., SIGNORE, F., CIAVOLINO, E. & ANGELELLI, P. (2020). Sleepiness, neuropsychological skills, and scholastic learning in children. *Brain Sciences*, 10(8), 529.

MACCHITELLA, L., ROMANO, D., MARINELLI, C.V., TORALDO, D.M., ARIGLIANI, M., DE BENEDETTO, M. & ANGELELLI, P. (2021). Neuropsychological and socio-cognitive deficits in patients with Obstructive Sleep Apnea. *Journal of Clinical and Experimental Neuropsychology*, *43* (5).

MEASSO, G., CAVARZERAN, F., ZAPPALA, G., LEBOWITZ, B.D., CROOK, T.H., PIROZZOLO, F.J., AMADUCCI, D.M. et al. (1993). The Mini mental state examination: Normative study of an Italian random sample. *Developmental Neuropsychology*, *9*, 77-85.

MORSY, N.E., FARRAG, N.S., ZAKI, N.F., BADAWY, A.Y., ABDELHAFEZ, S.A., El-EL-GILANY, A.H., SHAFEY, M.M. et al. (2019). Obstructive sleep apnea: Personal, societal, public health, and legal implications. *Reviews on Environmental Health*, *34* (2), 153-169.

MSAAD, S., KAMMOUN, N., HAJJAJI, M., KALLE, N. & BAHLOUL, N. (2018). The impact of obstructive sleep apnea and daytime sleepiness on work performance: An observational cross-sectional study in a North African population. *Occupational Medicine & Health Affairs*, *6* (270), 2.

MULGREW, A.T., RYAN, C.F., FLEETHAM, J.A., CHEEMA, R., FOX, N., KOEHOORN, M., FITZGERARD, J.M. et al. (2007). The impact of obstructive sleep apnea and daytime sleepiness on work limitation. *Sleep Medicine*, *9* (1), 42-53.

NEZAMODINI, Z., HOSEYNI, P., BEHZADI, E. & LATIFI, S.M. (2014). Relationship between shift works with sleep disorders and public health in a pipe company. *Safety Promotion and Injury Prevention (Tehran)*, *2* (3), 189-195.

OLAITHE, M., BUCKS, R.S., HILLMAN, D.R. & EASTWOOD, P.R. (2018). Cognitive deficits in obstructive sleep apnea: Insights from a meta-review and comparison with deficits observed in COPD, insomnia, and sleep deprivation. *Sleep Medicine Reviews*, *38*, 39-49.

OMACHI, T.A., CLAMAN, D.M., BLANC, P.D. & EISNER, M.D. (2009). Obstructive sleep apnea: A risk factor for work disability. *Sleep*, *32* (6), 791-798.

OPREA, B.T., BARZIN, L., VÎRGĂ, D., ILIESCU, D. & RUSU, A. (2019). Effectiveness of job crafting interventions: A meta-analysis and utility analysis. *European Journal of Work and Organizational Psychology*, *28* (6), 723-741.

PEPPARD, P.E., YOUNG, T., BARNET, J.H., PALTA, M., HAGEN, E.W. & MAEHLA, K. (2013). Increased prevalence of sleep disordered breathing in adults. *American Journal of Epidemiology*, *177*, 1006-1014.

PETROU, P., DEMEROUTI, E., PEETERS, M.C., SCHUFELI, W.B. & HETLAND, J. (2012). Crafting a job on a daily basis: Contextual correlates and the link to work engagement. *Journal of Organizational Behavior*, *33* (8), 1120-1141.

SIGNORE, F., CORTESE, C.G., PARISI, S., RUSSO, V., ZITO, M. & INGUSCI, E. (2020). Job crafting and well-being at work: An exploratory analysis during health emergency period. *La Medicina del Lavoro*, *111* (6), 478-492.

STEPNOWSKY, C., SARMIENTO, K.F., BUJANOVER, S., VILLA, K.F., LI, V.W. & FLORES, N.M. (2019). Comorbidities, health-related quality of life, and work productivity among people with obstructive sleep apnea with excessive sleepiness: Findings from the 2016 US National Health and Wellness Survey. *Journal of Clinical Sleep Medicine*, *15* (2), 235-243.

SWANSON, L.M., ARNEDT, J.T., ROSEKIND, M.R., BELENKY, G., BALKIN, J. & DRAKE, C. (2011). Sleep disorders and work performance: Findings from the 2008 National Sleep Foundation Sleep in America poll. *Journal of Sleep Research*, *20* (3), 487-494.

TIMS, M., BAKKER, A.B. & DERKS, D. (2012). Development and validation of the job crafting scale. *Journal of Vocational Behavior*, *80* (1), 173-186.

TIMS, M., BAKKER, A.B. & DERKS, D. (2015). Job crafting and job performance: A longitudinal study. *European Journal of Work and Organizational Psychology*, *24* (6), 914-928.

TREGEAR, S., RESTON, J., SCHOELLES, K. & PHILLIPS, B. (2010). Continuous positive airway pressure reduces risk of motor vehicle crash among drivers with obstructive sleep apnea: Systematic review and meta-analysis. *Sleep*, *33* (10), 1373-1380.

VANEK, J., PRASKO, J., GENZOR, S., OCISKOVA, M., KANTOR, K., HOLUBOVA, M., SLEPECKY, M. et al. (2020). Obstructive sleep apnea, depression and cognitive impairment. *Sleep Medicine*, *72*, 50-58.

VAN WINGERDEN, J., DERKS, D. & BAKKER, A. (2017). The impact of personal resources and job crafting interventions on work engagement and performance. *Human Resource Management*, *56* (1), 51-67.