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Neurocognitive and psychosocial outcomes of obstructive sleep apnoea in Hong Kong Chinese

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KEY MESSAGES

1. Patients with obstructive sleep apnoea (OSA) had a number of neurocognitive deficits including attention lapses, working memory, verbal learning and recall, semantic fluency, and processing speed.

2. Psychological impairments including sleepiness and poor sleep quality, depressive, anxiety, and stress symptoms, poor functional outcomes and quality of life were noted in patients with OSA, compared with healthy controls.

3. This study serves as a potential first step in enhancing health care for patients with OSA in Hong Kong by establishing a neurocognitive and psychosocial profile and by identifying relevant daytime outcomes for treatment efficacy evaluation.

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Introduction

Obstructive sleep apnoea (OSA) is the most common sleep disorder causing excessive daytime sleepiness, affecting 2% of females and 4% of males in the middle-aged workforce in Hong Kong.[1,2] This study aimed to investigate the functioning of individuals with OSA using a systematic paradigm of working memory, thereby establishing a cognitive and psychosocial profile of Hong Kong Chinese with OSA in comparison to western populations.

Methods

Individuals aged 30 to 70 years who presented at the Sleep Disorders Centre of the Queen Mary Hospital with (1) a diagnosis of moderate to severe OSA (Apnea-Hypopnea Index [AHI] of ≥15 per hour) using standardised overnight polysomnography,[3] and (2) subjective symptoms of non-restorative sleep as indicated by excessive daytime sleepiness, fatigue, or functional impairment were recruited. Those who were excluded had (1) concurrent diagnoses of other sleep pathologies or significant medical condition or procedure (eg chronic obstructive pulmonary disease, active phase of cancers) or neurological disorder, past head injury with loss of consciousness, any other neurological conditions associated with cognitive impairment; (2) current alcohol or drug abuse (self-report); (3) a history of or current severe psychiatric illness that began >10 years before the diagnosis of OSA; and (4) current use of medication that could affect cognitive function (eg psychotropics, benzodiazepines).

Age- and education-matched controls were recruited from the community. Those with the above exclusion criteria and (1) evidence of sleep pathology or disorder based on a clinical interview, and (2) evidence of having high risk for OSA as indicated by responses on the Berlin Questionnaire using the recommended cut-off score[4] were excluded.

All participants filled out questionnaires of subjective sleep quality, sleepiness, and psychosocial measures, and were tested on the neurocognitive tests. All tests were conducted in Cantonese, and all translated tests had been validated in Chinese populations.

Daytime sleepiness was assessed using the self-administered, 8-item Epworth Sleepiness Scale.[5-7] Sleep quality and disturbances over a 1-month interval was assessed using the self-rated Pittsburgh Sleep Quality Inventory.[8] Neuropsychological tests[9] and working memory tasks[10] including the two storage systems: the phonological loop and visuospatial sketchpad, and the attentional controller (the central executive) were assessed; the verbal and spatial storage capacity of working memory was assessed using the Digit Span and Spatial Span of the Wechsler Memory Scale-Third Edition,[11] whereas the maintenance and online processing functioning of the central executive of working memory were assessed using a spatial n-back task.[12,13] Mood symptoms were assessed using the 21-item Depression Anxiety Stress Scales.[14,15] The Profile of Mood States[16] was used to separate somatic

symptoms (sleepiness, fatigue) from affective symptoms. The effects of sleep disturbances were assessed using the Functional Outcomes of Sleep Questionnaire.[17] The sleep apnoea-specific health-related quality of life was assessed using a validated Chinese version of the Calgary Sleep Apnea Quality of Life Index.[18]

The OSA and control groups were compared using t-tests. A significance level of 0.01 was set to reduce type I error owing to multiple comparisons. Hierarchical regressions were used to explore predictors for neuropsychological outcomes.

Results

The OSA and control groups were comparable on age ($t(53)=0.61$, P=0.546), education level ($t(53)=0.226$, P=0.822), and gender ratio ($\chi^2 (1)=4.771$, P=0.041), but the OSA group had higher body mass index ($t(32)=3.505$, P=0.001), Epworth Sleepiness Scale score ($t(53)=10.59$, P<0.001), and Pittsburgh Sleep Quality Index global score ($t(53)=2.632$, P=0.011) [Table 1].

Neurocognitive functioning

Compared with healthy controls, patients with OSA had more (attention) lapses on the Psychomotor Vigilance Test, performed worse on the learning trials, immediate recall, and total recall of the Rey Auditory Verbal Learning Test, on the speed of naming colours and reading colour names of the Stroop Test, and on both semantic trials of the Fuld Verbal Fluency Test. For the working memory tasks, patients with OSA scored lower on the Backward Spatial Span, and had longer reaction times on the 0-back condition of the spatial n-back task. The effect sizes (Cohen's d) for all significant differences were large (>0.8) [Table 2].

Psychosocial functioning

Compared with healthy controls, patients with OSA had higher scores in all three subscales of the Depression Anxiety Stress Scales, higher fatigue-inertia and more confusion-bewilderment on the Profile of Mood States, lower total score and all subscales on the Functional Outcomes of Sleep Questionnaire, and lower quality of life on the Calgary Sleep Apnea Quality of Life Index. The effect sizes (Cohen's d) for all significant differences were very large (>1) [Table 3].

Predictors of neuropsychological functioning

Hierarchical regression analyses were conducted to explore the predictors of neurocognitive and psychosocial functioning in the OSA group. None of the regression coefficients, including those of the demographic variables were significant (P>0.05).

Discussion

Compared with healthy controls, patients with OSA performed significantly worse (with large effect sizes) on tasks of vigilance, working memory, verbal learning and recall, semantic fluency, and processing speed, but had comparable general intellectual functioning. These findings were consistent with those on western samples, except that the western samples had more pervasive deficits on working memory (2-back accuracies) and executive measures (eg Trail Making Test, Mazes) and less problems with verbal immediate recall.[19-21] Nonetheless, our patients with OSA showed difficulties on the Backward Spatial Span, learning trials and semantic fluency on the Rey Auditory Verbal Learning Test, all of which require intact executive functioning. The lack of significant differences on other tests could be due to less exposure to psychological testing in general and computer tasks in the middle-aged population in Hong Kong, hence weaker performance in our healthy controls than western populations.

Patients with OSA showed higher level of depressive, anxiety, and stress symptoms, more fatigue and confusion, poorer functional outcomes, and lower quality of life. These findings concur

TABLE 1. Demographics and sleep variables of the obstructive sleep apnoea (OSA) and healthy control groups

Variable	Mean±SD	
	OSA (n=25)	Controls (n=30)
Age (years)	50.05±8.44	48.49±10.27
Education (years)	11.36±3.79	11.62±4.50
No. of females:males	4:21	13:17
Body mass index (kg/m²)	28.72±5.82*	23.43±5.26
Sleepiness (Epworth Sleepiness Scale)	16.88±4.11	5.77±3.67
Sleep Quality (Pittsburgh Sleep Quality Index)		
Global score	7.12±3.63*	4.97±2.40
Subjective sleep quality	1.56±1.04	1.10±0.31
Sleep latency	0.80±0.91	0.97±0.72
Sleep duration	0.92±0.76	0.70±0.75
Sleep efficiency	0.92±1.29	0.53±0.86
Sleep disturbance	1.48±0.71	1.07±0.52
Daytime dysfunction	1.36±1.04*	0.60±0.56
Total sleep time (minutes)	406.08±42.76	-
Sleep efficiency (%)	82.27±8.71	-
% of stage 1 sleep	13.34±5.48	-
% of stage 2 sleep	59.66±11.89	-
% of stages 3 and 4 sleep	9.23±9.71	-
Apnea-Hypopnea Index	50.45±21.70	-
Minimum oxygen saturation	70.28±12.05	-

* P<0.01

TABLE 2. Neuropsychological outcomes of the obstructive sleep apnoea (OSA) and healthy control groups

Variable	Mean±SD		t(df=53)	P value	Effect size (d)
	OSA group (n=25)	Controls (n=30)			
General intelligence					
Raven's Standard Progressive Matrices	43.87±9.23	45.53±12.43	0.538	0.593	-0.13
Attention & working memory					
Psychomotor Vigilance Test (PVT) mean response time (RT) [ms]	338.09±55.09	323.05±63.00	0.111	0.912	0.24
PVT lapses (RT>3 sec)	3.84±4.91	0.13±0.34	3.989	<0.001	10.91
Digit Vigilance Test (DVT) mean RT	355.38±121.4	321.50±51.85	1.376	0.175	0.65
DVT errors	8.17±8.79	5.17±6.50	1.433	0.158	0.46
Digit symbol	77.64±16.00	83.97±18.52	1.341	0.186	0.34
Digit span forward	13.36±3.26	14.43±1.36	1.641	0.107	0.79
Digit span backward	7.72±3.53	9.17±2.73	1.713	0.092	0.53
Spatial span forward	8.28±2.39	9.70±2.18	2.301	0.025	0.65
Spatial span backward	7.60±2.35	9.27±1.93	2.893	0.006	0.87
Spatial 0-back RT (ms)	722.51±178.19	604.54±145.02	4.183	<0.001	0.81
Spatial 0-back accuracy (%)	87.76±15.62	87.02±16.24	0.265	0.792	0.05
Spatial 2-back RT (ms)	1057.49±260.09	953.43±279.48	1.634	0.109	0.37
Spatial 2-back accuracy (%)	76.92±13.22	74.10±18.02	0.369	0.712	0.16
Learning & memory					
Rey Auditory Verbal Learning Test (RAVLT) learning trials	45.32±9.41	55.10±6.92	4.435	<0.001	1.41
RAVLT immediate recall	9.60±2.63	12.17±2.98	3.350	0.001	0.86
RAVLT delayed recall	8.68±3.02	11.67±2.81	3.793	<0.001	1.06
Brief Visual Memory Test (BVMT)-R learning trials	21.65±6.33	24.33±6.41	1.518	0.135	0.42
BVMT-R delayed recall	9.09±2.64	10.47±1.93	2.199	0.032	0.72
Psychomotor dexterity					
Grooved Pegboard Test: dominant	67.44±11.27	64.80±11.60	0.851	0.398	0.23
Grooved Pegboard Test: non-dominant	72.40±12.37	71.93±14.60	0.126	0.900	0.03
Executive functions					
Color Trail Test 1 RT (sec)	41.83±24.43	36.52±16.13	1.355	0.181	0.33
Color Trail Test 2 RT (sec)	78.07±23.80	76.52±31.90	0.201	0.841	0.05
Fuld Verbal Fluency Test (FVFT) fruits and vegetables	19.35±5.67	23.4±4.46	2.909	0.005	0.91
FVFT animals	17.74±3.80	21.87±5.88	2.925	0.005	0.70
Stroop Color RT (sec)	14.24±3.36	11.91±2.26	3.065	0.003	1.03
Stroop Word RT (sec)	18.44±5.93	14.69±3.21	2.980	0.004	1.17
Stroop Color-word RT (sec)	29.85±10.11	25.43±7.83	1.826	0.074	0.56
Wisconsin Card Sorting Test (WCST) categories	5.16±1.83	5.50±1.23	0.919	0.362	0.28
WCST perseverative errors	13.92±12.54	11.93±11.29	0.618	0.539	0.18
Mazes (Wechsler Intelligence Scale for Children III)	24.60±3.24	26.23±5.12	1.381	0.173	0.32

with those in western samples,[22] and highlight the widespread psychological impact of OSA on patients without treatment.

It is important to understand both the night-time and daytime function of patients with OSA in order to make treatment decisions, optimise outcomes, and provide more precise information to health care providers, patients, and families regarding long-term prognosis of OSA.

Acknowledgement

TABLE 3. Psychosocial outcomes of the obstructive sleep apnoea (OSA) and healthy control groups

Variable	Mean±SD		t(df=53)	P value	Effect size (d)
	OSA group (n=25)	Controls (n=30)			
Depression Anxiety Stress Scale					
Depression	7.76±8.73	2.4±3.27	3.115	0.003	1.64
Anxiety	8.2±7.31	3.13±3.39	3.389	0.001	1.50
Stress	11.76±9.09	5.97±5.53	2.907	0.005	1.05
Profile of Mood States					
Total score	1.49±1.19	0.94±0.57	2.235	0.030	0.96
Tension-anxiety	1.14±0.84	0.67±0.72	2.230	0.030	0.65
Depression-dejection	1.02±1.11	0.55±0.62	1.983	0.053	0.76
Anger-hostility	1.26±1.02	0.67±0.77	2.452	0.018	0.77
Vigor-activity	2.19±2.95	2.15±0.93	0.068	0.946	0.04
Fatigue-inertia	1.96±1.25	0.96±0.80	3.594	0.001	1.25
Confusion-bewilderment	1.36±1.05	0.65±0.64	3.086	0.003	1.11
Functional Outcomes of Sleep Questionnaire					
Total score	15.07±2.50	18.60±1.64	6.118	<0.001	2.15
General productivity	3.15±0.57	3.83±0.24	5.444	<0.001	2.83
Social outcome	3.14±0.83	3.86±0.32	3.867	0.001	2.25
Activity level	2.96±0.47	3.70±0.32	6.968	<0.001	2.31
Vigilance	2.86±0.59	3.68±0.45	5.770	<0.001	1.82
Intimate relationships	3.02±0.85	3.69±0.43	3.282	0.003	1.56
Calgary Sleep Apnea Quality of Life Index					
Total score	4.63±1.18	6.10±0.61	5.644	<0.001	2.41
Daily functioning	4.94±1.27	6.05±0.78	3.796	0.001	1.42
Social interaction	5.03±1.47	6.11±0.77	3.303	0.002	1.40
Emotional functioning	5.19±1.17	6.12±0.64	3.581	0.001	1.45
Health-related symptoms	3.35±1.74	6.14±0.92	7.210	<0.001	3.03

References

1. Ip MS, Lam B, Lauder IJ, et al. A community study of sleep-disordered breathing in middle-aged Chinese men in Hong Kong. Chest 2001;119:62-9.
2. Ip MS, Lam B, Tang LC, Lauder IJ, Ip TY, Lam WK. A community study of sleep-disordered breathing in middle-aged Chinese women in Hong Kong: prevalence and gender differences. Chest 2004;125:127-34.
3. Iber C. The AASM manual for the scoring of sleep and associated events: rules, terminology and technical specifications. Westchester: American Academy of Sleep Medicine; 2007.
4. Netzer NC, Stoohs RA, Netzer CM, Clark K, Strohl KP. Using the Berlin Questionnaire to identify patients at risk for the sleep apnea syndrome. Ann Intern Med 1999;131:485-91.
5. Johns MW. Reliability and factor analysis of the Epworth Sleepiness Scale. Sleep 1992;15:376-81.
6. Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. Sleep 1991;14:540-5.
7. Chung KF. Use of the Epworth Sleepiness Scale in Chinese patients with obstructive sleep apnea and normal hospital employees. J Psychosom Res 2000;49:367-72.
8. Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res 1989;28:193-213.
9. Décary A, Rouleau I, Montplaisir J. Cognitive deficits associated with sleep apnea syndrome: a proposed neuropsychological test battery. Sleep 2000;23:369-81.
10. Baddeley AD. Exploring the Central Executive. Q J Exp Psychol A 1996;49:5-28.
11. Wechsler D. WMS-III administration and scoring manual. San Antonio: The Psychological Corporation; 1997.
12. Smith EE, Jonides J, Koeppe RA. Dissociating verbal and spatial working memory using PET. Cereb Cortex 1996;6:11-20.
13. Gevins A, Cutillo B. Spatiotemporal dynamics of component processes in human working memory. Electroencephalogr Clin Neurophysiol 1993;87:128-43.
14. Taouk M, Lovibond PF, Laube R. Psychometric properties of a Chinese version of the short Depression Anxiety Stress Scales (DASS21). Report for New South Wales

Transcultural Mental Health Centre, Cumberland Hospital, Sydney; 2001.
15. Lovibond SH, Lovibond PF. Manual for the depression anxiety stress scales. 2nd ed. Sydney: Psychology Foundation; 1995.
16. McNair DM, Lorr M, Druppleman LF. EITS Manual for the Profile of Mood States. San Diego: Education and Industrial Test Services; 1971.
17. Weaver TE, Laizner AM, Evans LK, et al. An instrument to measure functional status outcomes for disorders of excessive sleepiness. Sleep 1997;20:835-43.
18. Flemons WW, Reimer MA. Development of a disease-specific health-related quality of life questionnaire for sleep apnea. Am J Respir Crit Care Med 1998;158:494-

503.
19. Aloia MS, Arnedt JT, Davis JD, Riggs RL, Byrd D. Neuropsychological sequelae of obstructive sleep apnea-hypopnea syndrome: a critical review. J Int Neuropsychol Soc 2004;10:772-85.
20. Engleman HM, Kingshott RN, Martin SE, Douglas NJ. Cognitive function in the sleep apnea/hypopnea syndrome (SAHS). Sleep 2000;23(Suppl 4):S102-8.
21. Saunamäki T, Jehkonen M. A review of executive functions in obstructive sleep apnea syndrome. Acta Neurol Scand 2007;115:1-11.
22. Sateia MJ. Neuropsychological impairment and quality of life in obstructive sleep apnea. Clin Chest Med 2003;24:249-59.