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Original Article

Determining the prevalence of symptoms and risk of obstructive sleep apnoea among old Saudis

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الملخص

أهداف البحث: تحديد مدى انتشار أعراض وخطر انقطاع النفس الانسدادي النومي، وتحديد العوامل المرتبطة بانقطاع النفس الانسدادي النومي بين كبار السن السعوديين.

طرق البحث: استخدمت الدراسة المسح الوطني السعودي لصحة المسنين، وهو مسح يشمل عينة وطنية لكبار السن بين عامي ٢٠٠٦ و٢٠٠٧ في المملكة العربية السعودية. وتم تحديد أعراض انقطاع النفس الانسدادي النومي والمخاطر من خلال استبانة برلين. كما تم استخدام تحليل الانحدار اللوجستي متعدد المتغيرات لتحديد العوامل الرئيسة المرتبطة بخطر انقطاع النفس الانسدادي النومي.

النتائج: من بين ٢٩٤٦ من كبار السن، كان ١٥٤٤ (٥٢.٤٪) معرضين لخطر الإصابة بانقطاع النفس الانسدادي النومي مع تعرض النساء لخطر أعلى من الرجال (٦٠.٨٪ مقابل ٤٤.٢٪ على التوالي، القيمة الاحتمالية <٠.٠٠١). وكانت السمنة أعلى بين النساء مقارنة بالرجال (٤٠.٥٪ مقابل ٢٤.٨٪، القيمة الاحتمالية <٠.٠٠١). وأبلغ ٥٦٪ تقريبا عن الشخير، لكن لم يكن هناك فرق إحصائي بين النساء والرجال (٥٧.٣٪، ٥٣.٥٪، القيمة الاحتمالية = ٠.٣١٧، على التوالي). تم تحديد العوامل التالية على أنها عامل مستقل لخطر الإصابة بانقطاع النفس الانسدادي النومي: كون المريض امرأة تعيش في المناطق الريفية، والضعف الإدراكي الشديد، والاكتئاب، واستخدام مضادات الاكتئاب أكثر احتمالا للإصابة بانقطاع النفس الانسدادي النومي.

الاستنتاجات: في هذه الدراسة، كان معدل انتشار المخاطر لتوقف التنفس أثناء النوم عاليا ٥٢.٤٪. وكانت النساء أكثر عرضة للإصابة بانقطاع النفس الانسدادي النومي من الرجال. بالإضافة إلى كونها امرأة، كان الاكتئاب، واستخدام مضادات الاكتئاب، والضعف الإدراكي الشديد، والعيش في المناطق الريفية من العوامل الرئيسة التي تنبئ بانقطاع النفس الانسدادي النومي.

الكلمات المفتاحية: استبانة برلين؛ الشخير؛ الاكتئاب؛ الجنس؛ صحة المرأة

Abstract

Objectives: This study aimed to determine the prevalence of symptoms and risk of obstructive sleep apnoea (OSA) and to identify the risk factors associated with OSA among old Saudis.

Methods: In this population-based survey, we administered the Saudi National Survey for Elderly Health to old Saudis between 2006 and 2007. Symptoms of OSA and its associated risk factors were determined using the Berlin questionnaire. A multivariable logistic regression analysis was used to determine key factors associated with the risk of OSA.

Results: Out of 2946 participants, 1544 (52.4%) were at high risk of OSA, with women having a higher risk than men (60.8% vs. 44.2%, respectively; *p*-value <0.001).

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Obesity was higher among women than men (40.5% vs. 24.8%, respectively; p-value <0.001). Almost 56% of the participants reported snoring as a risk factor, but there was no statistical difference between women and men (57.3% vs. 53.5%, respectively; p-value = 0.317). The factors identified as independent predictors of a high risk of OSA were the female gender (OR 1.732, 95% CI [1.375−2.182]), living in rural areas (OR 1.384, 95% CI [1.094−1.750]), severe cognitive impairment (OR 2.709, 95% CI [1.350−5.436]), depression (OR: 1.432 95%CI [1.147−1.789]), and antidepressants usage (OR 2.959, 95% CI [1.402−6.244]).

Conclusion: This study reported a 52.4% prevalence of a high risk of OSA. Women were more likely to be at high risk of OSA than men. In addition to the female gender, depression, antidepressant usage, severe cognitive impairment, and living in rural areas were main predictors of OSA.

Keywords: Berlin questionnaire; Depression; Gender; Snoring; Women's health

Introduction

Obstructive sleep apnoea (OSA) is defined as a recurrent complete or partial upper airway closure during sleep.[1] It is one of the most under-recognised and commonly misdiagnosed respiratory disorders.[2] It contributes to dangerous diseases, fatal sequelae, and increased morbidity and mortality.[3]

The modifiable risk factors of OSA include obesity, drugs, smoking, supine body position during sleep, and nasal congestion or obstruction.[4] At the same time, gender, genetics, age, race, menopause, and craniofacial anatomy are non-modifiable risk factors.[4] Several serious consequences have been linked to OSA, such as depression, neurocognitive dysfunction, and motor vehicle accidents caused by hypersomnolence. Certain medical conditions have also been found to be associated with OSA. These include type 2 diabetes, uncontrolled hypertension, congestive heart failure, coronary artery disease, and stroke.[5–7] In addition, OSA has been shown to affect family relationships negatively. In a recent review, OSA was shown to decrease partners' sleep quality and sexual desire while increasing their sleep fragmentation and daytime sleepiness.[8]

Furthermore, OSA has been associated with a substantial economic burden resulting from higher utilisation of health services, related vehicle crashes, absenteeism, and productivity loss.[9,10] Moreover, the Busselton Health study suggested that moderate to severe OSA has an independent association with an increased risk of all-cause mortality.[3] Such consequences make OSA a public health issue that needs more attention from the medical community and public health experts.

In KSA, 33% and 39% of middle-aged men and women were reported to be at high risk of OSA, respectively.[11,2] However, information is scarce regarding the prevalence of OSA among older adults. Studies have demonstrated that OSA increases in prevalence as we age, which is likely related to physiological and physical changes that occur with aging.[12] Despite that, no studies focused solely on older adults. Therefore, there is a literature gap regarding OSA among Saudi older adults and Arabs in general. Consequently, this study had two main objectives: first, to determine the prevalence of OSA symptoms among Saudi older adults. Second, to determine the factors associated with the risk of OSA in Saudi older adults.

Materials and Methods

This study was approved by the institutional review board of Imam Mohammad Bin Saud Islamic University (HAPO-01-R-011), and informed written consent was obtained from all participants.

The data used came from the Saudi National Survey for Elderly Health, a cross-sectional, nationwide, population-based survey of Saudi older adults. The dataset is the largest source of health-associated information related to the aging population in KSA. The sample was calculated using a complex sampling design to be a representative sample of Saudi older adults. Since the retirement age in KSA is 60, older adults were defined as 60 years old or above. In brief, the survey consisted of demographic information of the participating subjects, including age, gender, education level, income, marital status, residence region, and location of residence (urban vs. rural). The survey also asked the subjects about their history of stroke, ischemic heart disease (IHD), and diabetes; their smoking status; their perceptions of their health during the last 30 days before the interview (good or poor); and their benzodiazepine and antidepressant use.

Furthermore, depression was measured using the Geriatric Depression Scale (GDS), a 15-item questionnaire developed to assess depression symptoms among older adults.[13] A score greater than 5 points suggests depression, while a score greater than or equal to 10 is almost always indicative of depression. Cognitive impairment was assessed with the Short Portable Mental Status Questionnaire,[14] a widely used 10-item questionnaire by which cognitive function can be classified into normal, mild, moderate, or severe. Lastly, a question regarding the quality of sleep was presented to participating subjects to characterise their sleep disturbances. All of the variables listed above were included as factors that may have been associated with OSA. Our team published a more detailed description of the sampling method and other survey components in a previous study.[15]

OSA risk was estimated using a validated Arabic version of the Berlin Questionnaire (BQ), which was developed in 1996 and validated in different settings.[11,16] The BQ has three sets of questions: the first set is related to whether the individual experiences apnoea and snoring. Those who snore rate their snoring's loudness, whether it bothers

others, and its frequency. Individuals are marked positive if they frequently experience apnoea and snoring symptoms (i.e. more than three times/week). The second set addresses fatigability during daytime and sleepiness and the frequency of falling asleep in the car while driving or being driven. Having two frequent symptoms out of the three makes an individual positive for the second set. The third set asks about their history of hypertension and their body mass index (BMI). The subject is considered positive for the third set if he/she has a BMI >30 kg/m^2 or self-reports hypertension. Finally, to classify a subject as at high risk of developing OSA, the subject must have two positive categories out of the three. Otherwise, the individual is classified as having a low risk of OSA. The BQ was reported to predict a respiratory disturbance index of >5 with a specificity of 0.77, a sensitivity of 0.86, and a positive predictive value of 0.89.[17]

The cohort was portrayed using frequencies and percentages as well as means and standard deviations based on the variable type. All frequencies and percentages throughout were adjusted by the survey weights (survey design, non-response, and post-stratifications). To assess high risk for OSA predictors, a bivariable logistic regression model was applied in a preliminary analysis where one explanatory variable was tested in the model at a time. The tested variables included demographics, cognitive function, depression, medications used, medical comorbidities, and smoking. Multivariable logistic regression was used to identify the independent predictors of a high risk of OSA. Odds ratios were calculated with 95% confidence intervals (95% CI). The Hosmer–Lemeshow test and C-statistic test were used to assess the model's goodness of fit. STATA 14 was used for the data analysis.

Results

Men represented 50.4% (n = 1485) of the subjects. Most participants were illiterate (69.7%). Around 80% were living in urban regions. The mean age was 70.2 ± 8.3 years. Most participants were non-smokers (82.9%). Regarding BMI, 37.0% were overweight (above 25 but under 30), 32.6% were obese (BMI ≥30), and the rest had a BMI below 25 (30.3%) (Table 1).

Out of 2946 subjects, 1544 (52.4%) were classified as at high risk of OSA. Women were at higher risk than men (60.8% vs. 44.2%, respectively; p < 0.001) (Figure 1).

Table 1: Prevalence of sleep apnoea-related symptoms among Saudi older adults (N = 2946).

Characteristics	Women		Men		Total		Total Male
	Frequency (Col%)		Frequency (Col%)		Frequency (Col.%)[a]		
	1461	(49.6)	1485	(50.4)	2946	100%	
Age (Years)**							<0.001
60–65	640	(43.8)	461	(31)	1101	(37.4)	
66–70	309	(21.1)	372	(25)	681	(23.1)	
71–75	207	(14.1)	283	(19)	489	(16.6)	
76–80	151	(10.3)	178	(12)	329	(11.2)	
81–85	76	(5.2)	102	(6.8)	178	(6)	
86–90	41	(2.8)	58	(3.9)	99	(3.4)	
>90	37	(2.5)	32	(2.2)	69	(2.3)	
Region**							0.857
Central	325	(22.3)	358	(24.1)	684	(23.2)	
Western	447	(30.6)	470	(31.6)	917	(31.1)	
Eastern	214	(14.7)	189	(12.7)	403	(13.7)	
Southern	374	(25.6)	366	(24.6)	739	(25.1)	
Northern	101	(6.9)	103	(6.9)	203	(6.9)	
BMI WHO categories**							<0.001
< 18.5	34	(2.3)	20	(1.4)	54	(1.8)	
≥ 18.5 - < 25	347	(23.7)	494	(33.3)	841	(28.5)	
≥ 25- < 30	488	(33.4)	603	(40.6)	1091	(37)	
≥30	592	(40.5)	368	(24.8)	960	(32.6)	
Smoking Status**							<0.001
No	1398	(95.7)	1043	(70.2)	2441	(82.9)	
Yes	62	(4.3)	443	(29.8)	505	(17.1)	
Has your weight changed?							0.002
Increased	388	(26.6)	323	(21.7)	711	(24.1)	
Decreased	391	(26.7)	338	(22.8)	729	(24.7)	
No Change	682	(46.7)	825	(55.5)	1507	(51.1)	
Do you snore?							0.317
No	587	(40.2)	657	(44.2)	1243	(42.2)	
Yes	836	(57.3)	795	(53.5)	1631	(55.4)	
Do not know	37	(2.6)	35	(2.3)	72	(2.4)	

Table 1 (*continued*)

Characteristics	Women		Men		Total		Total Male
	Frequency (Col%)		Frequency (Col%)		Frequency (Col.%)[a]		
	1461	(49.6)	1485	(50.4)	2946	100%	
If you snore, your snoring is:							0.068
Slightly louder than breathing	601	(41.1)	525	(35.4)	1126	(38.2)	
As loud as talking	172	(11.8)	213	(14.3)	385	(13.1)	
Louder than talking	32	(2.2)	33	(2.2)	65	(2.2)	
Very loud; can be heard in adjacent rooms	31	(2.1)	24	(1.6)	55	(1.9)	
Don't know/no snoring/refused	624	(42.7)	691	(46.5)	1315	(44.6)	
How often do you snore?							0.006
Never or nearly never	669	(45.8)	725	(48.8)	1394	(47.3)	
1 to 2 times per month	40	(2.7)	40	(2.7)	79	(2.7)	
1 to 2 times per week	48	(3.3)	95	(6.4)	143	(4.9)	
3 to 4 times per week	111	(7.6)	116	(7.8)	227	(7.7)	
Almost every day	593	(40.6)	509	(34.3)	1103	(37.4)	
Has your snoring ever bothered other people?							<0.001
No	700	(47.9)	890	(59.9)	1589	(54)	
Yes	761	(52.1)	596	(40.1)	1357	(46)	
Has anyone noticed that you stop breathing during your sleep?							0.044
Never or nearly never	808	(55.3)	920	(61.9)	1728	(58.7)	
1 to 2 times per month	137	(9.4)	132	(8.9)	269	(9.1)	
1 to 2 times per week	228	(15.6)	226	(15.2)	453	(15.4)	
3 to 4 times per week	179	(12.3)	136	(9.2)	315	(10.7)	
Nearly every day	109	(7.4)	72	(4.8)	180	(6.1)	
How often do you feel tired or fatigued after your sleep?							<0.001
Never or nearly never	406	(27.8)	509	(34.3)	915	(31.1)	
1 to 2 times per month	220	(15.1)	269	(18.1)	489	(16.6)	
1 to 2 times per week	192	(13.1)	187	(12.6)	379	(12.9)	
3 to 4 times per week	283	(19.4)	288	(19.4)	571	(19.4)	
Nearly every day	360	(24.6)	232	(15.6)	592	(20.1)	
During your waking time, do you feel tired, fatigued, or not up to par?							<0.001
Never or nearly never	368	(25.2)	447	(30.1)	814	(27.6)	
1 to 2 times per month	216	(14.8)	301	(20.3)	517	(17.6)	
1 to 2 times per week	194	(13.3)	271	(18.3)	466	(15.8)	
3 to 4 times per week	375	(25.7)	306	(20.6)	681	(23.1)	
Nearly every day	308	(21.1)	160	(10.8)	468	(15.9)	
Have you ever nodded off or fallen asleep while driving a vehicle?							0.885
No	1303	(89.2)	1321	(89)	2625	(89.1)	
Yes	157	(10.8)	164	(11)	321	(10.9)	
Do you have high blood pressure?							<0.001
No	750	(51.4)	909	(61.2)	1659	(56.3)	
Yes	710	(48.6)	576	(38.8)	1287	(43.7)	
Do you have sleep difficulties?*							<0.001
No	612	(41.9)	813	(54.7)	1425	(48.4)	
Difficulty in getting to sleep	159	(10.9)	91	(6.1)	250	(8.5)	
Disturbed sleep	315	(21.6)	270	(18.2)	585	(19.8)	
Early morning awakening	92	(6.3)	105	(7.1)	197	(6.7)	
Difficulty in getting sleep and disturbed sleep	124	(8.5)	60	(4)	184	(6.2)	
Difficulty in getting sleep and early morning awakening	17	(1.2)	9	(0.6)	26	(0.9)	
Disturbed sleep and early morning awakening	22	(1.5)	25	(1.7)	47	(1.6)	
Difficulty in getting to sleep, disturbed sleep, and early morning awakening	21	(1.4)	9	(0.6)	29	(1)	
No response	98	(6.7)	105	(7)	203	(6.9)	
Describe the quality of your sleep*							0.001
Adequate	872	(59.7)	1014	(68.2)	1886	(64)	
Not adequate	510	(34.9)	394	(26.5)	904	(30.7)	
Cannot state	79	(5.4)	78	(5.2)	157	(5.3)	
Do you have a day sleep?*							<0.001
No	396	(27.1)	244	(16.4)	640	(21.7)	
Yes	1065	(72.9)	1241	(83.6)	2306	(78.3)	

BMI: Body mass index based on the World Health Organization (WHO).

* Not part of the Berlin Questionnaire (BQ).

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[a] The frequencies and percentages throughout the table are adjusted for survey weights (survey design, non-response, and post-stratifications).

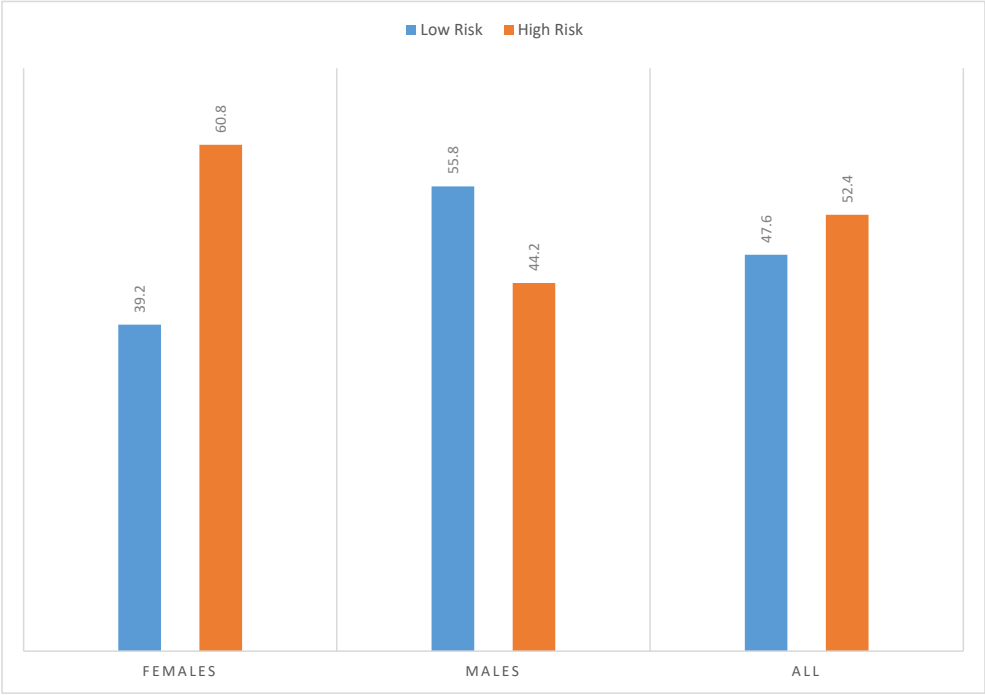

Figure 1: Risk of sleep apnoea among Saudi older adults (N = 2946).

Snoring was reported among 55.4% of participants. There was no statistical difference between women and men (57.3% vs. 53.5%, respectively; p = 0.317) (Table 1). Alarmingly, 11% of men reported nodding off or falling asleep during driving. Among the participants, 43.7% stated that they have hypertension. Almost 78.3% reported daytime sleepiness, with it being less common among women than men (70.4% vs. 83.3%, respectively; p > 0.001).

A directly proportional relationship was found between BMI and snoring status (Figure 2). Around 42.2% of subjects with a BMI of <18.5 kg/m^2 reported snoring, while 60.7% of subjects with a BMI of ≤30 kg/m^2 reported snoring (p = 0.014).

In the bivariable analysis, individuals who reported benzodiazepine use (n = 119) had a higher risk of OSA than those who did not (73.3% vs. 51.5%, respectively; p = 0.022).

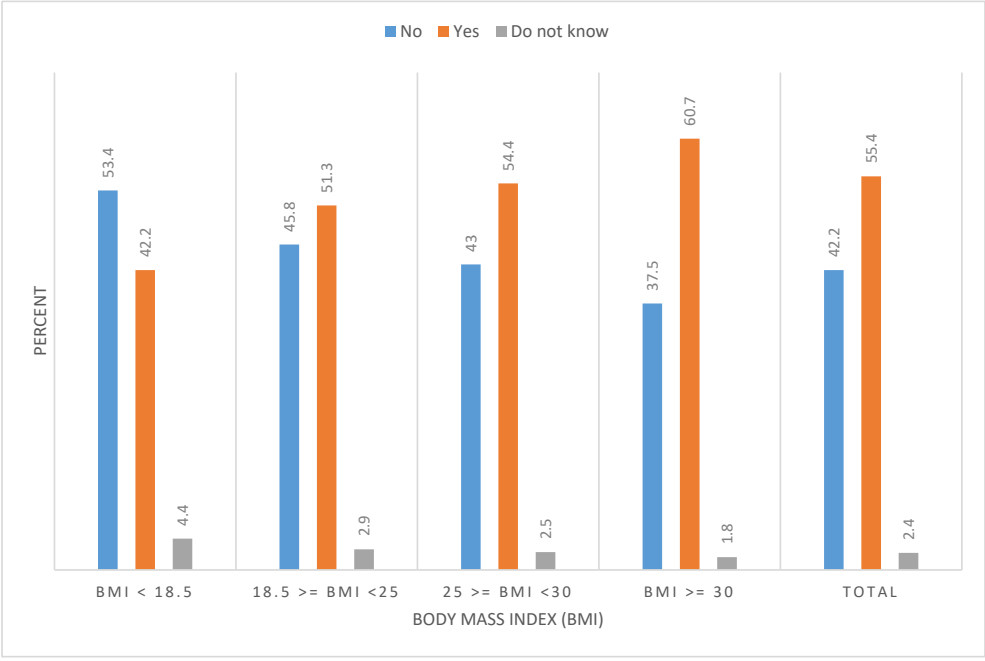

Figure 2: Distribution of snoring by body mass index among Saudi older adults (N = 2946).

Table 2: Uni-variable and bivariable analyses of factors associated with sleep apnoea defined by the Berlin Questionnaire (N = 2946).

Characteristic			Risk of obstructive sleep apnoea				P-value
	Total(N = 2946)		Low (N = 1402)		High (N = 1544)		
	n	(Col%)	n	(Row%)	n	(Row%)	
Age (Years)							**0.383**
60–65	1101	(37.4)	499	(45.4)	601	(54.6)	
66–70	681	(23.1)	351	(51.6)	330	(48.4)	
71–75	489	(16.6)	236	(48.2)	254	(51.8)	
76–80	329	(11.2)	158	(48)	171	(52)	
81–85	178	(6)	76	(43)	102	(57)	
86–90	99	(3.4)	45	(45.6)	54	(54.4)	
>90	69	(2.3)	36	(52.7)	33	(47.3)	
Gender							**<0.001**
Woman	1461	(49.6)	573	(39.2)	887	(60.8)	
Man	1485	(50.4)	829	(55.8)	656	(44.2)	
Level of education							**0.165**
Illiterate	2052	(69.7)	945	(46.1)	1107	(53.9)	
Less than 8 years	641	(21.7)	335	(52.2)	306	(47.8)	
Intermediate to high school	191	(6.5)	94	(49.1)	97	(50.9)	
University or higher	63	(2.1)	29	(46.3)	34	(53.7)	
Income (SR, 2007)							**0.708**
>10,000	165	(5.6)	74	(45)	91	(55)	
9999–7500	121	(4.1)	55	(45.7)	65	(54.3)	
7499–5000	283	(9.6)	135	(47.8)	148	(52.2)	
4999–2500	702	(23.8)	354	(50.4)	348	(49.6)	
<2500	1675	(56.9)	784	(46.8)	892	(53.2)	
Marital Status							**<0.001**
Monogamy	1686	(57.2)	876	(52)	810	(48)	
Polygamy	390	(13.2)	196	(50.3)	194	(49.7)	
Widowed	678	(23)	245	(36.1)	433	(63.9)	
Single	107	(3.6)	44	(41.6)	62	(58.4)	
Separated	86	(2.9)	41	(48)	45	(52)	
Location							**0.568**
Urban	2359	(80.1)	1141	(48.4)	1218	(51.6)	
Rural	587	(19.9)	261	(44.5)	325	(55.5)	
Five regions of KSA							**0.43**
Central	684	(23.2)	371	(54.3)	313	(45.7)	
Western	917	(31.1)	338	(36.9)	578	(63.1)	
Eastern	403	(13.7)	227	(56.2)	177	(43.8)	
Southern	739	(25.1)	351	(47.5)	388	(52.5)	
Northern	203	(6.9)	115	(56.8)	88	(43.2)	
BMI WHO categories							**<0.001**
Less than 18.5	54	(1.8)	23	(43.6)	30	(56.4)	
From 18.5 to 25	841	(28.5)	483	(57.4)	358	(42.6)	
From 25 to 30	1091	(37)	617	(56.5)	474	(43.5)	
More than 30	960	(32.6)	279	(29.1)	681	(70.9)	
Stroke							**0.126**
No	2907	(98.7)	1379	(47.4)	1528	(52.6)	
Yes	39	(1.3)	24	(60.8)	15	(39.2)	
IHD							**0.818**
No	2842	(96.5)	1354	(47.7)	1488	(52.3)	
Yes	104	(3.5)	48	(46.1)	56	(53.9)	
Diabetes							**0.633**
No	1461	(49.6)	704	(48.2)	758	(51.8)	
Yes	1485	(50.4)	698	(47)	786	(53)	
Smoking							**0.872**
No	2441	(82.9)	1165	(47.7)	1277	(52.3)	
Yes	505	(17.1)	238	(47.1)	267	(52.9)	
Use of benzodiazepines							
No	2825	(95.9)	1370	(48.5)	1455	(51.5)	**0.022**
Yes	121	(4.1)	32	(26.7)	89	(73.3)	
Use of antidepressants							**<0.001**
No	2806	(95.3)	1371	(48.9)	1435	(51.1)	
Yes	140	(4.7)	31	(22.3)	109	(77.7)	

(*continued on next page*)

Table 2 (*continued*)

Characteristic	Total(N = 2946)		Risk of obstructive sleep apnoea				P-value
			Low (N = 1402)		High (N = 1544)		
	n	(Col%)	n	(Row%)	n	(Row%)	
Perception of health in the last 30 days							**<0.001**
Good health	1981	(67.3)	1050	(53)	931	(47)	
Poor health	822	(27.9)	288	(35.1)	534	(64.9)	
Can't say	143	(4.8)	64	(44.6)	79	(55.4)	
Depression (GDS)*							**<0.001**
Normal	2157	(73.2)	1153	(53.5)	1003	(46.5)	
Suggestive	713	(24.2)	230	(32.3)	483	(67.7)	
Depression	76	(2.6)	19	(24.6)	57	(75.4)	
Cognitive impairment†							**0.010**
Normal cognition	2415	(82)	1140	(47.2)	1275	(52.8)	
Mild	348	(11.8)	196	(56.3)	152	(43.7)	
Moderate	118	(4)	50	(42.4)	68	(57.6)	
Severe	64	(2.2)	16	(24.8)	48	(75.2)	
Sleep disturbances							**<0.001**
No sleep difficulties	1425	(48.4)	988	(69.3)	437	(30.7)	
Difficulty in getting sleep	250	(8.5)	102	(40.8)	148	(59.2)	
Disturbed sleep	585	(19.8)	176	(30.2)	408	(69.8)	
Early morning awakening	197	(6.7)	73	(37.3)	124	(62.7)	
Difficulty in getting to sleep and disturbed sleep	184	(6.2)	23	(12.5)	161	(87.5)	
Difficulty in getting to sleep and early morning awakening	26	(0.9)	4	(13.9)	22	(86.1)	
Disturbed sleep and early morning awakening	47	(1.6)	15	(32.7)	31	(67.3)	
Difficulty in getting to sleep, disturbed sleep, and early morning awakening	29	(1)	2	(8.3)	27	(91.7)	
No response	203	(6.9)	18	(8.9)	185	(91.1)	

SR: Saudi Riyals in 2007.
Significant if P-value < 0.05.
* Based on Geriatric Depression Scale (GDS).
† Based on Short Portable Mental Status Questionnaire.

The same trend was observed among individuals on antidepressants (77.7% vs. 51.5%, respectively; p = 0.001). Furthermore, subjects with symptoms suggestive of depression and those with diagnosed depression reported a higher risk of OSA than patients who did not (67.7% and 75.4% vs. 46.5%, respectively; p < 0.001). A similar trend was observed among individuals with cognitive impairments and subjects who reported difficulty in getting to sleep, disturbed sleep, early morning awakening, or any combination of these (Table 2).

The multivariable logistic multivariate analysis showed a good fit for the model using both the Hosmer–Lemeshow test (p = 0.1519; Supplement A) and C-statistic (78.7%). The risk of OSA was significantly lower in men than women (odds ratio [OR] 0.577, 95% CI [0.458–0.727]). In addition, OSA risk was the lowest among subjects 90 years old or older (OR 0.468 95%, CI [0.254–0.860]), then subjects between 76 and 80 years old (OR 0.646 95%, CI [0.478–0.873]), and finally those between 66 and 70 years (OR 0.752 95%, CI [0.601–0.943]). OSA risk increased significantly in rural inhabitants compared to those living in urban areas (OR 1.384, 95% CI [1.094–1.750]). Certain comorbidities were associated with OSA. For instance, participants with mild cognitive impairments had a lower OSA risk than those who had normal cognition (OR 0.644, 95% CI [0.481–0.862]). In contrast, severe cognitive

Table 3: Multivariable logistic regression of factors associated with sleep apnoea among Saudi older adults (N = 2946).

Variable (Risk factor)	Odds ratio	95% CI
Age (Ref: 60–65 years)		
66–70	0.752*	[0.601,0.943]
71–75	0.793	[0.615,1.022]
76–80	0.646**	[0.478,0.873]
81–85	0.822	[0.552,1.222]
86–90	0.744	[0.451,1.226]
>90	0.468*	[0.254,0.860]
Man (Ref: Woman)	1.732***	[1.375, 2.182]
Rural (Ref: Urban)	1.384**	[1.094,1.750]
Smoking (Ref: Never Smoke)	1.115	[0.881,1.412]

Table 3 (*continued*)

Variable (Risk factor)	Odds ratio	95% CI
Region (Ref: Central)	1	
Southern	1.299*	[1.017,1.659]
Western	0.835	[0.612,1.140]
Eastern	1.192	[0.931,1.525]
Northern	1.117	[0.770,1.618]
Education Level, (Ref: Illiterate)	1	
Less than 6 years	1.033	[0.821,1.300]
Intermediate or high school	1.002	[0.679,1.479]
University or higher	0.922	[0.493,1.723]
Average monthly Income (SR), (Ref: <2500)	1	
≥10,000	1.321	[0.861,2.027]
7500−9999	1.399	[0.893,2.191]
5000−7499	1.181	[0.868,1.607]
2500−4999	1.082	[0.873,1.340]
Marital Status, (Ref: Monogamy)	1	
Polygamy	1.302*	[1.016,1.667]
Widow	1.305*	[1.009,1.688]
Single	0.939	[0.597,1.476]
Separated	0.867	[0.508,1.480]
Cognitive Impairment (Ref: Normal Cognition)	1	
Mild	0.644**	[0.481,0.862]
Moderate	0.901	[0.554,1.468]
Severe	2.709**	[1.350,5.436]
Diabetes Mellitus	0.973	[0.818,1.158]
Depression (Ref: Normal)	1	
Suggestive	1.432**	[1.147,1.789]
Depression	1.773	[0.917,3.430]
Stroke, reported	0.489	[0.220,1.084]
IHD, reported	1.379	[0.883,2.151]
Benzodiazepine use	1.088	[0.511,2.317]
Antidepressant use	2.959**	[1.402,6.244]
Perception of health in the last 30 days (Ref: Good Health)	1	
Poor Health	1.736***	[1.410,2.137]
Cannot Say	1.219	[0.830,1.792]
Sleep Quality (Ref: No)	1	
Difficulty in getting to sleep	2.705***	[2.003,3.653]
Disturbed sleep	4.362***	[3.476,5.474]
Early morning awakening	3.306***	[2.372,4.610]
Difficulty in getting to sleep and disturbed sleep	10.07***	[6.196,16.37]
Difficulty in getting to sleep and early morning awakening	7.859***	[2.805,22.02]
Disturbed sleep and early morning awakening	3.836***	[1.955,7.526]
Difficulty in getting sleep, disturbed sleep, and early morning awakening	19.35***	[4.439,84.35]
No response	16.56***	[10.45,26.23]
Observations	**2946**	

Exponentiated coefficients; 95% confidence intervals in brackets.
*p < 0.05, **p < 0.01, ***p < 0.001.
IHD: Ischemic Heart Disease.
OR: Odds Ratio.
Significant if P-value < 0.05.

impairments increased OSA's odds by 2.7 times (OR 2.709, 95% CI [1.350−5.436]). Similarly, subjects with a GDS score suggestive of depression were associated with an increased risk of OSA (OR 1.432, 95% CI [1.147−1.789]). Individuals on antidepressants were 2.96 times more likely to have OSA than those who were not using antidepressants (OR 2.959, 95% CI [1.402−6.244]).

Regarding the impact on quality of life, participants in poor health during the last 30 days were more likely to have OSA (OR 1.736, 95% CI [1.410−2.137]). Difficulty in getting to sleep, disturbed sleep, early morning awakening, and any combination of these were significant risk factors for OSA ($p < 0.001$). Smoking; education level; monthly income; benzodiazepine use; and the presence of comorbidities such as diabetes mellitus, stroke, or IHD were not significant risk factors of OSA ($p > 0.05$; Table 2).

Discussion

In this study, around 52% of the subjects were classified as being at high risk of OSA. Therefore, OSA prevalence is considered higher than in older adults in other countries. In a population-based study conducted in the U.S., Hiestand et al. found that 33% of subjects between the age of 50−64

years were at high risk of OSA.[1] In addition, the same study reported that 48.6% of subjects aged ≤65 years were at high risk of OSA, with higher OSA risk among men (27%) than women (16%) ($p < 0.001$).[1]

In the current study, the severity and frequency of sleep-related symptoms were always higher among women than men, including daily snoring, bothering other people by snoring, breathing stoppage during sleep, tiredness after sleep, and fatigue during the day (Table 1). All of these factors contributed to the higher OSA prevalence among women than men (60.7% vs. 42.6%, respectively; $p < 0.001$).

In a previous Saudi study that included 2095 healthy volunteers with a mean age of 42.3 ± 15.5 years recruited from King Abdulaziz Medical City, Riyadh employees, visitors to the medical city, blood donors, and individuals coming to the pre-employment clinic, 33.4% of women and 31.1% of men were at high risk of developing OSA.[18] Similarly, in two separate studies, 33.3% and 39% of middle-aged men and women were at risk from OSA, respectively.[11,2] Obesity is a major risk for OSA in general and particularly in women.[19] In KSA, women are significantly more obese than men, with an overall prevalence of 44% and 26.4%, respectively.[20] Therefore, the observed difference between women and men in the current study and previous Saudi studies is probably related to higher obesity among women compared to men (40.5% vs. 24.8%, respectively; $p < 0.001$), and the higher prevalence of hypertension among women compared to men (48.6% vs. 38.8%, respectively; $p < 0.001$).

Moreover, all women included in this study were post-menopausal. A previous study assessed the association between menopausal status and OSA in women.[21] The investigators reported that the calculated OR (95% CI) for an apnoea-hypopnea index of >5 events/hour of sleep was 1.2 (0.7−2.2) in pre-menopausal and 2.6 (1.4−4.8) in post-menopausal women.[21] After menopause, OSA prevalence in women approaches men and peaks in the fifth and sixth decades.[22]

Regarding gender, OSA remains under-diagnosed in women, which is probably related to differences in clinical presentation, different tolerance of symptoms, and under-recognition by treating physicians.[23,24] This clinical under-diagnosis may have serious consequences, as the Wisconsin Sleep Cohort Study suggested that the five-year mortality for women with OSA might be significantly higher than for women without it.[25]

In the current study, around 20% of subjects felt fatigued after waking up every day, while 16% felt fatigued during the daytime (Table 1). In a U.S. study, Hiestand et al. found that 26% of subjects were feeling fatigued after waking from sleep ≤3 days/week.[1] Feeling fatigued during the daytime can lead to more snoozing during the day. Daytime sleeping has been linked to increased cardiovascular mortality risk among older adults.[26] Furthermore, subjects may end up sleeping while driving. In this study, around 14% of the subjects reported falling asleep while driving. It is worth mentioning that during this era, older women did not drive in the country. Therefore, stringent rules for preventing individuals who may be at risk of falling asleep while driving from driving should be implemented to reduce the already very high death toll due to car crashes. The National Sleep Foundation has concluded that sleep-deprived drivers can be as dangerous as drunk drivers.[27]

In contrast to some previous studies,[12,2] the present study showed that people who live in rural areas had a 38% higher risk of OSA compared to those living in urban areas (OR 1.384, 95% CI [1.094−1.750]). Lower health literacy, type of healthcare setting, and longer distances to healthcare facilities limit rural people's ability to receive healthcare and process health-related information, which may exacerbate their health problems,[28] leading to a higher OSA prevalence.

Mild cognitive impairment was associated with a lower risk of OSA (OR 0.644, 95% CI [0.481−0.862]). Cognitive impairment is a debilitating condition that may worsen over time. When a patient is diagnosed with such a condition, a more comprehensive approach may be taken to identify the cause and determine whether the causative condition is reversible. Consequently, the patient, their family, and their health care providers focus on changing all modifiable risk factors that may affect the patient's cognition. Such care may reduce the OSA risk in those with mild cognitive impairment by modifying factors such as obesity or hypertension. However, as the impairment worsens, it becomes inevitable for the patient's overall health to be affected. For instance, impaired cognition may be accompanied by psychotic disorders, which are usually treated with atypical antipsychotics that have been implicated in obesity and, consequently, OSA.[29] Thus, severe cognitive impairment was associated with OSA (OR 2.709, 95% CI [1.350−5.436]) among Saudi older adults. In line with this study's results, several studies confirmed the association between cognitive impairment and OSA.[30,31] Several pathological changes accompany OSA and increase the risk of cognitive dysfunctions such as intermittent hypoxia, disturbed sleep, systemic inflammation, increased oxidative stress, comorbidities, and daytime sleepiness.[32]

Participants with a GDS score suggestive of depression or those on antidepressant medications had a higher risk of OSA (Table 3). Studies have showed that depression is bi-directionally associated with OSA.[33] As many as 24−58% of people with OSA have depression, and around 18% of patients diagnosed with major depressive disorder have sleep disturbances.[34]

Contrary to the findings of many studies,[5−7] the association between OSA and comorbidities such as stroke, IHD, and diabetes was not significant in this study. This finding could be justified by the low number of participants who had a stroke or IHD (1.3% and 3.6% of the total participants, respectively) in this study. Therefore, one cannot ignore the possibility of a type 2 error. Therefore, more powerful studies are needed to find such comorbidities' impact on OSA among the subjects.

Smoking has different effects on OSA. Inhaled nicotine impairs the neuromuscular protective reflexes of the upper respiratory tract. In addition, inhaled smoke particles cause airway inflammation, narrowing the airways and exacerbating airway obstruction in OSA patients.[35] Despite these findings, the association between smoking and OSA is still controversial. This study showed no significant association between cigarette smoking and OSA risk after adjusting for demographics and other risk factors. This finding is similar to a meta-analysis of 14 studies that focused on the

association between smoking and OSA.[36] Nonetheless, other studies have suggested the existence of an association between smoking and OSA.[35] Therefore, a well-designed prospective study is recommended to examine this association.

This is the first nationwide study that determined the relation between OSA risk and sleep-related symptoms among the subjects. This study creates the baseline for any future national study to determine a change in OSA's prevalence. It sheds light on the fact that women are at higher risk of OSA in Saudi society than men, contrary to what is seen in Western societies.[1] This is very important in informing clinicians of the differences observed between Saudi society and other societies. The study will increase OSA awareness among patients, caregivers, general practitioners, family physicians, and geriatricians. Consequently, corrective actions can be implemented to reduce OSA's impact on patients' health.

Nonetheless, our study has its limitations; first, polysomnography, the gold standard confirmatory test for OSA diagnosis, was not used. However, the high sensitivity and specificity of the BQ make it an excellent first screening tool for OSA. Second, the survey did not contain questions regarding treatment options to objectively determine the percentage of participants who had been treated for OSA and who had not. Third, the cross-sectional design prevented the assessment of OSA's relationship with specific variables such as cognitive impairment and depression in more detail. Consequently, the possibility of reverse causality cannot be precluded. Lastly, type 2 errors may exist in the assessment of OSA's relationship with specific comorbidities such as IHD, stroke, and diabetes.

Conclusion

Among Saudi older adults, 52.4% of the subjects were at high risk of OSA. Women were more likely to be at high risk of OSA than men. In addition, women had a higher risk of snoring, breathing stoppage during sleep, and tiredness after sleep and during the day. In addition to being a woman, depression, antidepressant use, severe cognitive impairment, living in a rural area, and poor health status in the last 30 days were the main factors associated with OSA.

Recommendations

Clinicians should be aware of the factors associated with OSA among Saudi older adults, including the female gender, depression, antidepressant use, severe cognitive impairment, living in a rural area, and poor health status in the last 30 days; these were the main factors associated with OSA. Future studies should focus on the impact of being at high risk of OSA on mortality.

Lastly, from a public health perspective, the high prevalence of OSA among Saudi older adults necessitates some initiatives. First, a national screening program for OSA should be put in place to help with the early detection of OSA and prevent further consequences among older adults. Second, certain policies regarding driving and operating heavy machinery should be laid out since daytime somnolence can be dangerous in these situations. Third, introducing a national awareness program about OSA and its consequences could help older adults and their families be cognizant of the disease.[37,8]

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Conflict of interest

The authors have no conflicts of interest to declare.

Ethical approval

This study was approved by the institutional review board of Imam Mohammad Bin Saud Islamic University (HAPO-01-R-011) on 15/10/2017 and informed written consent was obtained from all participants.

Authors contributions

Both MHA and ATK worked on the conceptualisation, methodology, software, and original draft preparation. NMA, MKA, and OA contributed to the methodology and original draft preparation. ASB participated in the writing, reviewing, and editing. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jtumed.2020.10.024.

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