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Original Article

Comparison of Sleep Apnea Questionnaires and Reported Diagnosis in Neurological Disorders of Aging

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ABSTRACT: ***Background:*** Obstructive sleep apnea (OSA) is associated with worse outcomes in stroke, Alzheimer's disease (AD) and Parkinson's disease (PD), but diagnosis is challenging in these groups. We aimed to compare the prevalence of high risk of OSA based on commonly used questionnaires and self-reported OSA diagnosis: 1. within groups with stroke, AD, PD and the general population (GP); 2. Between neurological groups and GP. ***Methods:*** Individuals with stroke, PD and AD were identified in the Canadian Longitudinal Study of Aging (CLSA) by survey. STOP, STOP-BAG, STOP-B28 and GOAL screening tools and OSA self-report were compared by the Chi-squared test. Logistic regression was used to compare high risk/self-report of OSA, in neurological conditions vs. GP, adjusted for confounders. ***Results:*** We studied 30,097 participants with mean age of 62.3 years (SD 10.3) (stroke $n = 1791$; PD $n = 175$; AD $n = 125$). In all groups, a positive GOAL was the most prevalent, while positive STOP was least prevalent among questionnaires. Significant variations in high-risk OSA were observed between different questionnaires across all groups. Under 1.5% of individuals self-reported OSA. While all questionnaires suggested a higher prevalence of OSA in stroke than the GP, for PD and AD, there was heterogeneity depending on questionnaire. ***Conclusions:*** The wide range of prevalences of high risk of OSA resulting from commonly used screening tools underscores the importance of validating them in older adults with neurological disorders. OSA was self-reported in disproportionately small numbers across groups, suggesting that OSA is underdiagnosed in older adults or underreported by patients, which is concerning given its increasingly recognized impact on brain health.

RÉSUMÉ : Comparaison entre des questionnaires portant sur l'apnée du sommeil et les diagnostics rapportés dans le cas de troubles neurologiques du vieillissement ***Contexte :*** L'apnée obstructive du sommeil (AOS) est associée à une évolution défavorable de l'état de santé d'individus victimes d'AVC, mais aussi atteints de la maladie d'Alzheimer (MA) et de la maladie de Parkinson (MP). Un diagnostic demeure toutefois difficile à établir dans leur cas. Nous avons ainsi cherché à comparer la prévalence du risque élevé d'AOS sur la base de questionnaires couramment utilisés et de diagnostics auto-déclarés d'AOS au sein : 1) de cohortes de patients victimes d'un AVC ou atteints de la MA, de la MP en comparaison avec la population générale (PG) ; de groupes neurologiques en comparaison avec la PG. ***Méthodes :*** C'est au moyen d'enquêtes que des individus victimes d'un AVC ou atteints de MP et de MA ont été identifiés dans le cadre de l'*Étude longitudinale canadienne sur le vieillissement* (ELCV). Les outils de dépistage STOP, STOP-BAG, STOP-B28 et GOAL, de même que l'auto-évaluation de l'AOS, ont été comparés à l'aide d'un test du khi carré. Un modèle de régression logistique a par ailleurs permis de comparer le risque élevé ou l'auto-déclaration de l'AOS selon l'état neurologique des patients par rapport à la PG, et ce, en procédant à un ajustement tenant compte de facteurs de confusion (*confounders*). ***Résultats :*** Au total, nous avons étudié 30 097 participants dont l'âge moyen était de 62,3 ans (σ 10,3 ; AVC : $n = 1791$, MP : $n = 175$, MA : $n = 125$). Dans tous les groupes, des résultat positifs à l'outil d'évaluation GOA se sont avérés les plus répandus, tandis que des résultats positifs à l'outil STOP étaient les moins répandus. Des variations significatives du risque élevé d'AOS ont été observées entre les différents questionnaires, et ce, dans tous les groupes. Mentionnons aussi que moins de 1,5 % des individus ont déclaré être atteints d'AOS. Alors que tous les questionnaires suggèrent une prévalence plus élevée d'AOS dans le cas des AVC qu'au sein de la PG, on a observé, dans le cas de la MP et de la MA, une hétérogénéité en fonction des questionnaires. ***Conclusions :*** Un large éventail de prévalences de risque élevé d'AOS résultant d'outils de dépistage couramment utilisés souligne en bref l'importance de bien les valider chez les individus âgés qui sont atteints de troubles neurologiques. L'AOS a été auto-déclarée dans une proportion disproportionnellement plus faible dans tous les groupes, ce qui suggère qu'elle demeure sous-diagnostiquée chez les personnes âgées ou sous-déclarée par les patients. Cela est préoccupant compte tenu de l'impact de plus en plus reconnu de ce trouble sur la santé cérébrale.

Keywords: comparison; elderly; neurological disorder; obstructive sleep apnea; questionnaire; screening

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Introduction

Obstructive sleep apnea (OSA) is characterized by repetitive upper airway obstruction during sleep. OSA, defined by an apnea-hypopnea index ≥ 15 events per hour on polysomnography (PSG), is prevalent in 49.7% of men and 23.4% of women aged 40–85 years, and increases with age.[1] OSA remains largely underdiagnosed and undertreated in the general population (GP).[2–4] OSA contributes to poor outcomes like excessive daytime sleepiness, motor vehicle accidents, neurocognitive impairment and cardiometabolic diseases.[5]

Sleep disturbances are frequent in neurodegenerative diseases.[6] OSA is prevalent in 20-66% of individuals with Parkinson's disease (PD),[7] 38%–53% in Alzheimer's disease (AD)[8] and 30%–80% in stroke.[9] OSA appears to have a bidirectional association with several neurological disorders.[10] It is an independent risk factor for worse neurocognitive outcomes.[11–13] and treatment can improve neurocognitive.[14–16] and functional[17–19] outcomes. Hence OSA may be a modifiable risk factor in neurodegenerative conditions[11] but a large burden of untreated OSA remains.

PSG, the gold standard for diagnosis of OSA, is often difficult to obtain, costly and burdensome to individuals with neurodegenerative disease. Several screening instruments exist that might help identify patients at high risk for OSA (HROSA) for more targeted testing[20] However, few tools have been validated specifically in neurological populations.

The primary aim for this study was to compare, in the Canadian Longitudinal Study on Aging (CLSA), the prevalence of HROSA using commonly used questionnaires and of self-reported OSA, in individuals with PD, AD, and stroke. Secondary aims were to compare the prevalence of HROSA and of self-reported OSA diagnosis between neurological conditions versus the general population (GP).

Methods

We conducted a cross-sectional study using the CLSA, a population-based, prospective research cohort of older Canadians that recruited 51,338 participants, aged 45–85 years, with no major cognitive impairment.[21] The CLSA comprehensive cohort collected data through face-to-face and telephone interviews on demographic, social, medical, functional and other aspects relevant to aging at baseline with a plan for follow-up at three-year intervals. We used baseline (collected 2011–2015) and three-year follow-up data (collected 2015–2018). This study was approved by the Research Ethics Board of the McGill University Health Centre.

Stroke or TIA were ascertained with a positive answer to: "Has a doctor ever told you that you: have experienced a stroke or cerebrovascular accident (CVA); have experienced a mini-stroke or TIA; or suffer from the effects of a stroke, CVA, ministroke or TIA?".[21] PD (Parkinsonism) was identified based on an affirmative response to "Has a doctor ever told you that you had Parkinsonism or Parkinson's Disease?" combined with either taking PD medications or a score ≥ 3 on the Tanner Questionnaire.[21,22] AD was identified with a positive answer to: "Has a doctor ever told you that you have dementia or Alzheimer's disease?". It should be noted that patients with major neurocognitive disorder are excluded from CLSA enrollment so AD patients would have mild impairment and not be representative of the whole AD population. Individuals were identified at baseline or at 3-year follow-up and were excluded from the general population.

Hypertension was defined as systolic blood pressure ≥ 140 mmHg or diastolic ≥ 90 mmHg (mean of 4 measures), history of hypertension or taking antihypertensive medications. Diabetes, depression, thyroid dysfunction, chronic obstructive pulmonary disease (COPD), chronic kidney disease (CKD) and heart disease were identified from the questionnaire item: 'Has a doctor ever told you that you have . . . '. Head trauma was ascertained with the question: Have you suffered a head injury from any of the following . . . ? Participants who answered "yes" for being a current smoker or using any type of tobacco products were categorized as smokers. Participants were categorized as regular alcohol drinkers if they drank ≥ 1 time per week in the past 12 months.

The STOP questionnaire (snoring, tiredness, observed apneas, hypertension)[23] was included in the CLSA assessment. A score ≥ 2 is considered HROSA. The STOP-BAG[24] is based on the STOP-BANG[25] and consists of the STOP with body mass index (BMI) > 35 kg/m^2, age (>50 years) and gender (male). A score ≥ 3 indicates HROSA. The STOP-B28 is based on the STOP with BMI > 28 kg/m^2.[26] The GOAL questionnaire consists of gender (males), obesity (≥30 kg/m^2), age (≥50 years), and loud snoring[27] items, with a score ≥ 2 indicating HROSA.[27] Because sex and age are risk factors for the neurological conditions, and because hypersomnolence can be a feature of the disease process, screening scores in these conditions can be driven upwards by factors unrelated to apnea. Therefore, we analyzed specific symptoms (questionnaire items) individually. Participants who self-reported OSA under "Do you have any other long-term physical or mental condition that has been diagnosed by a health professional?" were categorized as having self-reported OSA.

Analyses

Patients with missing data were excluded. Descriptives statistics (mean, standard deviation, count, percentage) were used to report baseline characteristics of the study groups. We calculated the prevalence with 95% confidence intervals (CIs) of HROSA from each questionnaire and of individual OSA symptoms, for each of the groups (PD, AD, Stroke, GP). We compared the prevalence of HROSA and reported OSA within each group using Pearson chi-square test with False Discovery Rate corrections. Logistic regression was used to estimate odds ratios (ORs) for HROSA in neurological conditions versus the GP, unadjusted and adjusted for age, sex and BMI. We used analytic weights for better representation of the population in the regression analyses as provided by the CLSA.[28] Data were analyzed using SPSS 24.0 and R version 3.6. $P < 0.05$ was considered statistically significant.

Results

Baseline characteristics of participants included in our analyses are presented in Table 1. Among 30,097 participants included, 175 (0.58%) had PD, 125 (0.41%) had AD and 1791 (6.0%) had Stroke/TIA.

Prevalence of symptoms and HROSA

The prevalence of snoring, sleepiness and observed apnea are shown in Table 2. Snoring was highly prevalent across all groups. Observed apnea was the second most prevalent variable in all groups. The combination of snoring and sleepiness presented a prevalence ranging from 3.5% to 6.5% across groups.

We found a positive GOAL to have the highest prevalence in all groups (Table 3) and most notably in Stroke/TIA (81.1%) and PD (79.3%). Positive STOP-BAG and STOP-B28 occurred in similar

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Table 1. Demographic characteristics of participants with and without neurological conditions in the Canadian longitudinal study on aging

Parameters	PD ($n = 175$)	AD ($n = 125$)	Stroke/TIA ($n = 1791$)	General population ($n = 28\,006$)
Age (years), mean(sd)	70.6 (9.1)	74.1 (9.2)	70.9 (9.7)	62.4 (10.1)
Gender (Male), *n* (%)	109 (62.3)	67 (53.6)	961 (53.7)	13 640 (48.7)
BMI (kg/m^2), mean(sd)	27.15 (4.6)	26.79 (4.7)	28.8 (5.8)	28.0 (5.4)
Smoking, *N* (%)	10 (5.7)	14 (11.2)	198 (11.1)	2836 (10.1)
Alcohol consumption, *N* (%)	88 (50.3)	50 (40.0)	887 (49.5)	16 231 (58.0)
Hypertension, *N* (%)	92 (52.6)	67 (53.6)	1329 (74.2)	13 024 (46.5)
Diabetes, *N* (%)	44 (25.3)	35 (28.0)	540 (30.2)	4723 (16.9)
Thyroid dysfunction, *N* (%)	31 (17.7)	21 (16.8)	325 (18.1)	4033 (14.4)
Depression, *N* (%)	24 (13.7)	22 (17.6)	348 (19.4)	4540 (16.2)
COPD, *N* (%)	16 (9.1)	8 (6.4)	214 (11.9)	1498 (5.4)
CKD, *N* (%)	9 (5.1)	6 (4.8)	134 (7.5)	741 (2.7)
Heart disease, *N* (%)	44 (25.1)	37 (29.6)	616 (34.4)	3026 (10.8)
Head trauma, *N* (%)	33 (18.9)	17 (13.6)	340 (19.0)	3879(13.9)

PD = Parkinson's Disease; AD = Alzheimer's Disease; TIA = Transient Ischemic Attack; COPD = Chronic obstructive pulmonary disease; CKD = Chronic kidney disease; BMI = Body Mass Index.

Table 2. Prevalence of OSA symptoms in neurological conditions and general population in the Canadian longitudinal study on aging

Parameters *N* (%) (95% CI)	PD ($n = 175$)	AD ($n = 125$)	Stroke/TIA ($n = 1791$)	General population ($n = 28\,006$)
Snoring	62 (36.3) (29.4,43.7)	38 (33.0) (25.1,42.1)	667 (39.6) (37.3,42.0)	9185 (34.2) (33.7,34.8)
Snoring and sleepiness	11 (6.4) (3.6,11.2)	5 (4.4) (1.9,9.8)	110 (6.5) (5.4,7.8)	971 (3.6) (3.4,3.9)
Sleepiness,	31 (17.7) (12.8,24.1)	17 (13.6) (8.7,20.7)	259 (14.5) (13.0,16.2)	2415 (8.6) (8.3,9.0)
Observed apnea	32 (18.7) (13.6,25.2)	28 (24.1) (17.3,32.7)	404 (23.9) (22.0,26.0)	4388 (16.4) (16.0,16.8)

PD = Parkinson's Disease; AD = Alzheimer's Disease; TIA = Transient Ischemic Attack; *N* = total number of individuals in the population; CI = Confidence Interval.

Table 3. The prevalence of high risk of OSA using different definitions in neurological conditions and general population

Outcomes *N* (%; 95% CI)	PD ($n = 175$)	AD ($n = 125$)	Stroke/TIA ($n = 1791$)	General population ($n = 28\,006$)
STOP ≥ 2,	63 (36.8; 30.0, 44.3)	36 (31.3;23.6,40.3)	797 (47.3;45.0,50.0)	7769 (29.0;28.4,29.5)
STOP-B28 ≥ 2	86 (51.2;43.7,58.7)	53 (46.1;37.3,55.2)	1101 (67.2;64.9,69.5)	12 472 (47.2;46.7,47.9)
STOP-BAG ≥ 3	98 (59.8; 50.8,65.5)	58 (55.2;45.7,64.4)	1152 (69.9;67.6,72.1)	13 757 (52.1;51.5,52.7)
GOAL ≥ 2,	130 (79.3;72.4,84.8)	80 (76.2;67.2,83.3)	1332 (81.1;79.2,83.0)	16 147 (61.2;60.6,61.8)
OSA diagnosis	1 (0.6;0.1,3.2)	1 (0.8;0.1,4.4)	16 (0.9;0.6,1.4)	341 (1.2;1.1,1.4)

PD = Parkinson's Disease; AD = Alzheimer's Disease; TIA = Transient Ischemic Attack; BMI = Body Mass Index; *N* = total number of individuals in the population; CI = Confidence Interval.

proportions across all diagnostic groups. A positive STOP had the lowest prevalence of all questionnaires. OSA was self-reported in a much lower proportion than prevalence of HROSA by any questionnaire (Fig. 1).

Neurological conditions vs. general population

To compare prevalence of symptoms, HROSA and OSA diagnosis between neurological disorders versus the GP, we performed logistic regression. In adjusted analyses, all OSA symptoms were more likely in individuals with stroke than the GP, including snoring with sleepiness. Participants with PD had higher odds of sleepiness than the GP. Those with AD had higher odds of observed apnea compared with the GP (Table 2). Table 4 shows ORs for HROSA in neurological disorders versus the GP. Individuals with stroke had higher adjusted odds of HROSA for each questionnaire. Individuals with PD showed higher odds for positive STOP-BAG and GOAL only. Those with AD had lower odds for positive STOP-B28 but higher for positive GOAL, compared with the GP. There were no significant differences between any neurological disorder and the GP with respect to self-reported OSA diagnosis.

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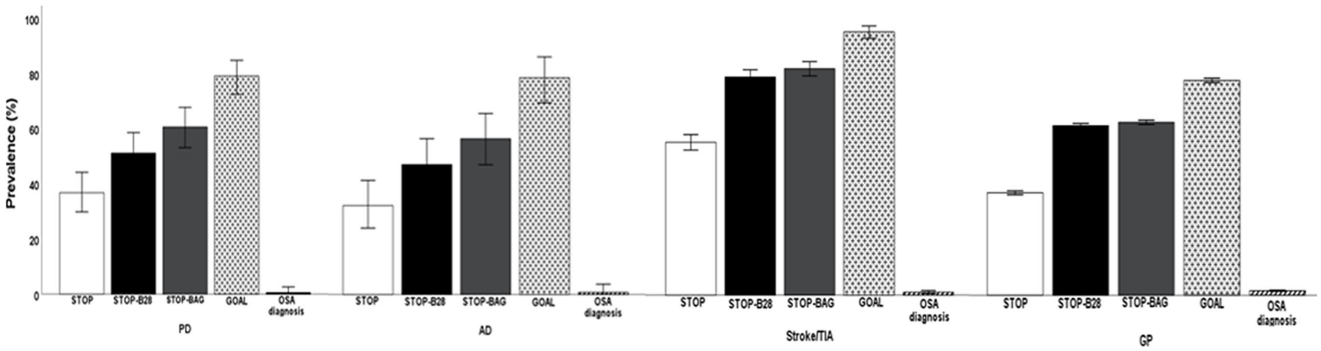

Figure 1. Bar graph comparing the prevalence of high risk of OSA using different definitions in neurological conditions and the general population. The prevalence was statistically significantly different between all OSA measures (questionnaires or OSA diagnosis) within each study group, except for STOP-BAG vs. STOP-B28 in PD, AD and stroke. Differences within-group tested with Pearson chi-squared and post hoc false discovery rate correction.

Table 4. Logistic regression analysis comparing prevalence of high risk of OSA using different definitions in neurological conditions versus the general population

Outcomes OR (95% CI)	PD ($n = 175$)		AD ($n = 125$)		Stroke/TIA ($n = 1791$)	
	Unadjusted	Adjusted[1]	Unadjusted	Adjusted[1]	Unadjusted	Adjusted[1]
STOP ≥ 2	1.5* (1.1,2.0)	1.2 (0.8,1.6)	1.1 (0.8,1.7)	0.7 (0.4, 1.1)	2.2* (2.1,2.5)	1.8* (1.6,2.0)
STOP-BAG ≥ 3	1.7* (1.2,2.3)	1.5 * (1.1,2.1)	1.3 (0.9,1.9)	1.2 (0.8,1.8)	2.5* (2.2,2.8)	2.4* (2.1,2.6)
STOP-B28 ≥ 2	1.2 (0.9,1.6)	1.0 (0.7,1.5)	0.9 (0.6,1.4)	0.6* (0.4,1.0)	2.3* (2.1,2.5)	1.9* (1.7,2.1)
GOAL ≥ 2	2.6* (1.8,3.8)	1.7 * (1.0,2.7)	2.1* (1.4,3.4)	1.9* (1.1,3.4)	2.9* (2.5,3.3)	2.7* (2.3,3.1)
OSA diagnosis	0.5 (0.03,2.1)	0.07 (2.2^{-6},1.4)	0.65 (0.04,2.9)	0.1 (2.1^{-6},1.7)	0.7 (0.4,1.2)	0.7 (0.4, 1.1)

PD = Parkinson's Disease; AD = Alzheimer's Disease; TIA = Transient Ischemic Attack; OR = Odds ratio; OSA = Obstructive sleep apnea; CI = Confidence Interval.
[1]OR values adjusted for age, sex and BMI
*Significant *p*-value at < 0.05.

Discussion

In this study, we found that different screening questionnaires result in a wide range of estimated prevalence of HROSA in older adults with and without neurological disorders, while OSA may be heavily underreported. Our findings indicate prevalence of questionnaire-based HROSA of 47%–81% in stroke, 37%–79% in PD and 31%–76% for AD (Table 3). Questionnaires in the somewhat younger GP were positive in 21%–61% of participants. Individuals with stroke were consistently more likely to have positive questionnaires than the GP. This corresponds to the high previously documented prevalence of OSA in stroke patients.[9,29] Compared with the GP, individuals with PD were more likely to have a positive STOP-BAG and GOAL. Individuals with AD were more likely to have a positive GOAL, but less likely to have a positive STOP-B28.

The prevalence of OSA increases with age, estimated at more than 60% of people aged 65–99.[30–32] This is associated with age-related physiological changes such as decreased endurance and strength of head and neck muscles, hormonal, sleep, respiratory chemosensitivity alterations and comorbidities.[32] Several screening questionnaires have been developed to identify HROSA, which might be used to prioritize patients for sleep testing, or in epidemiological studies. Using the STOP with percentage of body fat, the estimated prevalence of OSA was 17.5% in the CLSA baseline cohort.[33] However, only few studies have validated OSA screening tools in older populations or in neurodegenerative disorders.[26,34,35] In the elderly, a lower BMI cutoff than used in middle-aged individuals has been found to be predictive of OSA, yielding an adapted tool, the STOP-B28.[26] In stroke patients, the STOP has been shown to have good characteristics with sensitivity 91% and specificity 93%.[36] The STOP-BAG had a sensitivity of 91% but lower specificity of 48%.[37] This suggests that the prevalence of HROSA ascertained by STOP, in individuals with stroke in our CLSA population, closely reflects the true prevalence of OSA in that group. OSA is known to be highly prevalent in stroke and an independent risk factor for stroke.[38] It may predate stroke, worsen during acute stages, and persist subsequently.[39] OSA is associated with recurrent stroke, cognitive decline and increased physical disability.[9] Given the high prevalence of OSA and related adverse outcomes, it has been argued all stroke patients should be screened for OSA, irrespective of symptoms or other risk factors, and treated if OSA is found.[11] Conversely, prescreening with a questionnaire like STOP may help reduce testing burden and help efficient resources utilization.

In a previous study,[35] our group examined the diagnostic characteristics of OSA questionnaires in a PD clinical cohort. We found that GOAL ≥ 2 had the highest sensitivity (83%) but low specificity (35%), STOP-BAG ≥ 3 had sensitivity 74%, specificity 40%, STOP-B28 ≥ 2 sensitivity 76%, specificity 65% and STOP ≥ 2 sensitivity 65%, specificity 70%. These results are congruent with the current study, with the highest rate of HROSA identified by GOAL in each group, and the lowest with STOP. It is probable that GOAL and STOP-BAG are identifying more false positive cases given their lower specificity, especially given demographics of the

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Table 5. Logistic regression analysis comparing OSA symptoms in neurological conditions versus the general population

Outcomes OR (95% CI)	PD ($n = 175$)		AD ($n = 125$)		Stroke/TIA ($n = 1791$)	
	Unadjusted	Adjusted[1]	Unadjusted	Adjusted[1]	Unadjusted	Adjusted[1]
Snoring	1.1 (0.8,1.5)	1.1 (0.8,1.5)	0.9 (0.6,1.4)	0.7 (0.5,1.1)	1.3* (1.1,1.4)	1.2* (1.1,1.3)
Snoring and sleepiness	1.9* (1.0,3.4)	1.2 (0.6,2.4)	1.3 (0.4,2.8)	0.6 (0.1,1.8)	1.9* (1.6,2.4)	1.7* (1.3,2.1)
Sleepiness	2.3* (1.5,3.3)	2.1* (1.3,3.0)	1.7 (1.0,2.7)	1.6 (0.9,2.6)	1.8* (1.6,2.1)	1.5* (1.3,1.8)
Observed apnea	1.2 (0.8,1.7)	1.2 (0.8,1.8)	1.6* (1.0,2.5)	1.9* (1.2,3.1)	1.6* (1.4,1.8)	1.5* (1.4,1.7)

PD = Parkinson's Disease; AD = Alzheimer's Disease; TIA = Transient Ischemic Attack; OR = odds ratio; OSA = Obstructive sleep apnea; CI = Confidence Interval.
[1]OR values adjusted for age, sex and BMI
*Significant p-value at < 0.05.

population in question. Studies in PD have yielded inconsistent results with some studies finding that OSA is more common in PD and associated with its severity[40] and others finding no association,[41] possibly due to different OSA definitions, study populations or confounders such as medications. A recent meta-analysis found OSA to be present in close to 50% of PD patients,[42] and PD and non-PD risk factors were identified. The mechanisms contributing to the association between OSA and PD are not fully understood but there appears to be a causal bidirectional link.[43] Treatment of OSA in PD has been found to be beneficial.[16,44] More research is needed to confirm OSA relationships and benefits of treatment but data to date suggest benefit to identify and treat OSA in PD when possible.

OSA is found with increased prevalence in patients with AD.[45] Preexisting OSA is associated with increased risk of AD.[46] OSA treatment may improve outcomes.[47,14] OSA is also a risk factor for hypertension, diabetes, depression and heart failure, all of which are common risk factors for AD.[48] The STOP-BANG has been evaluated in AD[49] and found to have sensitivity 77% for at least moderate OSA but specificity of only 35%; modification of cutoffs for certain questions, e.g. age, BMI improved the characteristics of the questionnaire. This latter study and the one by Martins *et al.*[26] demonstrate that questionnaires developed for OSA screening of middle-aged individuals may not be well-suited for older individuals with or without neurodegenerative disorders. Moreover, cognitive decline may affect reliability of self-reported questionnaires. Currently, none of the commonly used questionnaires have been shown to have adequate diagnostic characteristics in AD, particularly in more advanced stages.

Participants with neurodegenerative conditions are more likely to be male and > 50 years old, which are both risk factors for OSA. Therefore, the GOAL and STOP-BAG, which include these two components, may not adequately distinguish those with OSA among individuals with neurodegenerative conditions (e.g. > 50% of PD patients would have a positive score based solely on sex and age). Snoring and BMI are best discriminatory factors for OSA in the GP.[50,51] However, the threshold of 30 kg/m^2 in GOAL and 35 kg/m^2 in STOP-BAG may not be suitable for older individuals or those with neurological conditions.[26] We found all OSA symptoms to be more common in individuals with stroke compared with the GP (Table 5). Sleepiness was more common in individuals with PD. This is consistent with known high prevalence of sleepiness in PD, with OSA being one of multiple contributing causes.[52] Individuals with AD were more likely to have observed apneas compared with the GP. Though the confidence intervals are wide, the potential differences in symptoms further support the need for development and validation of specific tools for distinct patient populations.

Given the significant impact of OSA on health and quality of life in aging individuals with neurological diseases, screening, diagnosis and treatment can have a meaningful impact on these patients, caregivers and the healthcare system. Previous studies estimated that over 80% of individuals of all ages with moderate-to-severe OSA remain undiagnosed and untreated.[4] Only 3% of Canadians aged 18 years or older received a formal OSA diagnosis despite high rates of symptoms.[53] Our findings show that only a small proportion of older individuals in the CLSA cohort self-reported an OSA diagnosis despite having OSA symptoms (Fig. 1). Low diagnosis may have several causes such as poor symptom reporting to physicians, lack of access to medical care including specialist evaluation[54] and testing, lack of recognition of OSA as a possible diagnosis by physicians or perception that it is not worth pursuing in this population. Alternatively, a diagnosis may have been made but not reported by patients due to poor recall or understanding While not statistically significant, reported diagnosis of OSA in those with neurological disorders was lower than in the GP. We suspect that Canadians with neurological diagnoses might not be as frequently assessed for OSA while they might benefit most from treatment, this warrants further investigation.

Strengths and limitations

To date, our study is the first comparing different screening instruments for HROSA in neurological diseases, using a large population cohort that included the STOP assessment. Several limitations are noted. First, neurological conditions were self-reported. Second, there were no objective measures of OSA Reporting OSA symptoms and diagnosis depends on participant recall and could be underreported due to low perceived importance. However, this emphasizes the point that older individuals do not perceive OSA as a significant medical condition, despite the associated adverse outcomes There is also no information on the use of Continuous Positive Airway Pressure or other OSA therapy. Moreover, self-selection bias may have resulted in a study population not be fully representative of the Canadian population. Patients with moderate-severe dementia were excluded from the CLSA baseline evaluation, hence we cannot extrapolate results to advanced stages of the diseases. Participants in the CLSA were more educated, had higher household incomes, and were mostly White and Canadian-born, which may negatively influence the generalizability and external validity of results.[55]

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Conclusion

In conclusion, we report, in a population-based cohort, that prevalence of HROSA in individuals with stroke, PD, AD and the GP, varies widely depending on screening tool. While all questionnaires suggest a higher prevalence of OSA in stroke/TIA than the GP, for PD and AD, there was wide variation of estimated prevalence depending on questionnaire. A self-reported diagnosis of OSA was found in a much smaller proportion of patients, suggesting that OSA is underdiagnosed or underreported in older adults. Strategies should be implemented to improve awareness of OSA in older Canadians and their healthcare providers with shared decision-making on testing and treatment.

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