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# Assessment of Neck Grasp as a Screening Tool for Identifying Obstructive Sleep Apnea in Community-Dwelling Older Adults

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## Abstract

**Background:** Inability to encircle the neck by hands (neck grasp) has been proposed as an indicator of obstructive sleep apnea (OSA) that would be useful for recognition of candidates for polysomnography (PSG). We assessed the value of neck grasp for predicting OSA in community-dwelling older adults of Amerindian ancestry. **Methods:** Neck grasp was evaluated in individuals aged ≥60 years undergoing PSG. The association between neck grasp and OSA was assessed by logistic regression models adjusted for relevant covariates. Mediation analysis was used to establish the proportion of the effect of the association between neck grasp and OSA, which is mediated by the neck circumference (a well-known OSA biomarker). Receiver operator characteristics curve analysis was used to estimate diagnostic accuracy of neck grasp for predicting OSA. **Results:** Of 201 individuals undergoing PSG, 167 (83%) had the neck grasp test. The remaining 34 could not perform the test because of different factors. Neck grasp was positive in 127 (76%) cases, and 114 (68%) individuals had OSA (apnea-hypopnea index ≥5). Multivariate logistic regression models disclosed a significant association between neck grasp and OSA. The neck circumference was the single covariate remaining independently significant in these models. Neck grasp was not efficient at predicting OSA (sensitivity: 83.3%, specificity: 39.6%, positive predictive value: 0.75 and negative predictive value: 0.53). The area under the curve disclosed only a moderate predictive capability (61.5%) of neck grasp. **Conclusion:** Results do not support the use of neck grasp as an independent predictor of OSA in the study population.

## Keywords

neck grasp, polysomnography, obstructive sleep apnea, neck circumference, Atahualpa, Amerindians

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## Introduction

Obstructive sleep apnea (OSA) increases the risk of stroke and all-cause mortality.[1] According to conservative estimates, about 1 billion of adults worldwide have OSA.[2] However, the burden of this condition remains unknown in remote communities, mostly because technology needed for OSA diagnosis—polysomnography (PSG) is not readily available. Moreover, mass screening with field instruments designed to identify candidates for PSG, such as the Epworth Sleepiness Scale or the Berlin questionnaire, have shown a disappointing diagnostic accuracy due to cross-cultural factors and illiteracy.[3-5] In addition, several studies have evaluated the diagnostic accuracy of anthropometric indices in this setting. With the exception of the neck circumference, which has been almost consistently associated with OSA, the debate on the value of other anthropometric indices is never-ending and probably depends on several factors, including race/ethnicity and the environment.[6-14]

There is a need for a screening tool that may be able to identify persons at risk for OSA in rural populations. In this

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**Figure 1.** The neck grasp is performed by instructing the subject to place the thumbs together in the ventral aspect of the neck and to wrap fingers around the neck until they met in the posterior aspect (without severe choking). The inability to touch fingertips is a positive test (left panel) and the ability to encircle the neck with fingers is a negative test (right panel).

view, 2 small series have shown 100% specificity of neck grasp for identifying subjects with OSA.[15,16] However, these results have not been replicated in other populations/ethnic groups. Taking the opportunity of a well-established cohort of community-dwellers living in rural Ecuador, this study aimed to assess the independent association between neck grasp and OSA as well as the diagnostic accuracy of neck grasp for predicting OSA in older adults of Amerindian ancestry.

## Methods and Materials

This study was conducted in Atahualpa, a rural village located in coastal Ecuador, and approved by the Institutional Review Board of our Institution. All individuals signed a comprehensive informed consent before enrollment. As detailed elsewhere, homogeneity of the population regarding race/ethnicity (Amerindian ancestry) and lifestyles, as well as the low migration rate, provide an optimal setting for the conduction of epidemiological studies by reducing the occurrence of hidden or unexpected confounders.[17]

Neck grasp was evaluated in community-dwelling older adults aged ≥60 years undergoing PSG for research purposes.[18,19] Individuals undergoing PSG had been selected by the use of the Random Integer Generator (https://www.random.org/integers/), as previously described.[18] The neck grasp consisted on instructing the subject to place the thumbs together in the ventral aspect of the neck and to wrap fingers around the neck until they met in the posterior aspect. Inability to touch fingertips is a positive test and the opposite is a negative test (Figure 1). Individuals unable to perform the neck grasp were excluded.

As detailed elsewhere, single-night diagnostic PSGs were performed at the sleep unit of our Center. Exams were done with the use of an Embletta® X100™ Comprehensive Portable PSG System (Embla Systems, Inc; Thornton, CO, USA).[18] A certified sleep medicine neurologist reviewed raw data and interpreted all exams blinded to clinical data.[20] Attention was given to the apnea-hypopnea index (AHI), which calculated the number of apnea/hypopnea events divided by the number of sleep hours. OSA was defined if the AHI was ≥5.[2]

Demographics (age and sex), relevant cardiovascular risk factors (body mass index, blood pressure, fasting glucose and total cholesterol blood levels), and the neck circumference were selected as clinical covariates. Demographics and cardiovascular risk factors were assessed through interviews and procedures previously described in the Atahualpa Project.[21] The neck circumference was measured using a stretch-resistant tape with individuals on the seated position, immediately above the cricoid cartilage and perpendicular to the long axis of the neck. These covariates were selected as they have been shown to be related to the main variables investigated in the study population.[18]

**Table 1.** Characteristics of Atahualpa Residents Included in This Study Across Categories of Neck Grasp and Obstructive Sleep Apnea (Univariate Analyses).

| | | Neck grasp | | | Obstructive sleep apnea | | |
|---|---|---|---|---|---|---|---|
| Variable | Total series ($n=167$) | Negative neck grasp ($n=40$) | Positive neck grasp ($n=127$) | *P* value | Apnea-hypopnea index <5 per hour ($n=53$) | Apnea-hypopnea index ≥5 per hour ($n=114$) | *P* value |
| Age, years (mean ± SD) | 71.7 ± 6.9 | 70.9 ± 5.7 | 71.2 ± 7.3 | .812 | 70.5 ± 7.2 | 71.4 ± 6.8 | .436 |
| Women, *n* (%) | 107 (64) | 25 (63) | 82 (65) | .813 | 39 (74) | 68 (60) | .081 |
| Body mass index ≥30 kg/m$^2$, *n* (%) | 39 (23) | 1 (2.5) | 38 (30) | <.001* | 8 (15) | 31 (27) | .085 |
| Blood pressure ≥140/90 mmHg, *n* (%) | 78 (47) | 10 (25) | 68 (53) | <.001* | 22 (42) | 56 (49) | .359 |
| Fasting glucose ≥126 mg/dL, *n* (%) | 47 (28) | 8 (20) | 39 (31) | .189 | 17 (32) | 30 (26) | .441 |
| Total cholesterol levels ≥240 mg/dL, *n* (%) | 27 (16) | 5 (13) | 22 (17) | .469 | 9 (17) | 18 (16) | .846 |
| Neck circumference, cm (mean ± SD) | 35.2 ± 3 | 33.8 ± 2.6 | 35.7 ± 2.9 | <.001* | 33.8 ± 2.9 | 35.9 ± 2.9 | <.001* |

*Statistically significant result.

Data analyses were carried out by using STATA version 16 (College Station, TX, USA). In univariate analyses, continuous variables (expressed as means ± SD) were compared by linear models (ANOVA) and categorical variables (expressed as percentages with 95% confidence intervals when needed) by the $x^2$ or Fisher exact test as appropriate. Multivariate models were fitted to assess the association between a positive neck grasp and OSA (as the dependent variable), after adjusting for the above-mentioned covariates. Mediation analysis was used to establish the proportion of the effect between neck grasp and OSA, which is mediated by the neck circumference.[22] Sensitivity analysis assessed the diagnostic accuracy of a positive neck grasp to predict OSA. Using receiver operator characteristics curve analysis, we calculated the area under the curve (AUC) for the predictive value of a positive neck grasp and the neck circumference for classifying subjects with OSA as positive or negative.

## Results

A total of 167 out of 201 (83%) community-dwellers aged ≥60 years undergoing PSG were included in this study. The remaining 34 individuals could not perform the test because of inability to understand the instructions (mostly related to dementia), history of a stroke causing arm weakness, recent fractures of the fingers or arms, or partial or complete shoulder ankylosis. The mean age of participants was 71.7 ± 6.9 years (median age: 70 years), 107 (64%) were women, 39 (23%) had a body mass index ≥30 kg/m$^2$, 78 (47%) had blood pressure ≥140/90 mmHg, 47 (28%) had fasting glucose ≥126 mg/dL, and 27 (16%) had total cholesterol blood levels ≥240 mg/dL. The mean (±SD) value of the neck circumference was 35.2 ± 2.9 cm (median value: 35 cm).

A total of 127 (76%) individuals had a positive neck grasp, and 114 68%) had OSA. Of 127 subjects with a positive neck grasp, 95 (75%) had OSA. On the other hand, of the 40 individuals with a negative neck grasp, only 19 (48%) had OSA (OR: 3.28; 95% C.I.: 1.57-6.07; $P=.002$). Also in univariate analyses, covariates associated with a positive neck grasp were a body mass index ≥30 kg/m$^2$, blood pressure levels ≥140/90 mmHg, and increasing neck circumference. In contrast, the only significant difference in the covariates investigated across individuals with and without OSA was a higher neck circumference in the former (Table 1).

A multivariate regression model, including the above-mentioned covariates but the neck circumference, showed a significant association between a positive neck grasp and OSA (OR: 3.03; 95% C.I.: 1.33-6.88; $P=.008$). When the neck circumference was added as a covariate to the above-mentioned model, a fully-adjusted model disclosed that the significance of the association between a positive neck grasp and OSA vanished (OR: 2.29; 95% C.I.: 0.97-5.39; $P=.059$). However, the fully-adjusted model contained several covariates that were not related to the outcome ($P>.6$) and contributed little to the model. Then, we fitted a most parsimonious model that included relevant covariates, and found an independent significance between a positive neck grasp and OSA (OR: 2.36; 95% C.I.:1.06-5.28; $P=.036$). The neck circumference remained as the single covariate achieving independent significance in both the fully-adjusted and the most parsimonious models (Table 2). Mediation analysis demonstrated that 35% (95% C.I.: 21.3%-90.2%) of the effect of the association between neck grasp and OSA was mediated by the neck circumference.

**Table 2.** Uni- and Multivariate Logistic Regression Models, Adjusted for Different Covariates, Using a Positive Neck Grasp as the Independent Variable and Obstructive Sleep Apnea (OSA) as the Outcome (Dependent Variable).

| Model | Covariates included | Significance of covariates | Significance between neck grasp and OSA |
|---|---|---|---|
| Univariate | None | . . . | OR: 3.28; 95% C.I.: 1.57 to 6.07; $P=.002$* |
| Multivariate logistic regression model (without neck circumference) | Age | OR: 1.04; 95% C.I.: 0.98 to 1.09; $P=.192$ | OR: 3.03; 95% C.I.: 1.33 to 6.88; $P=.008$* |
| | Female gender | OR: 0.37; 95% C.I.: 0.17 to 0.82; $P=.015$* | |
| | Body mass index $\geq$30 kg/m$^2$ | OR: 2.33; 95% C.I.: 0.88 to 6.14; $P=.088$ | |
| | Blood pressure $\geq$140/90 mmHg | OR: 0.98; 95% C.I.: 0.47 to 2.07; $P=.963$ | |
| | Fasting glucose $\geq$126 mg/dL | OR: 0.57; 95% C.I.: 0.26 to 1.25; $P=.160$ | |
| | Total cholesterol $\geq$240 mg/dL | OR: 1.04; 95% C.I.: 0.40 to 2.69; $P=.934$ | |
| Fully-adjusted logistic regression model | Age | OR: 1.04; 95% C.I.: 0.98 to 1.10; $P=.133$ | OR: 2.29; 95% C.I.: 0.97 to 5.39; $P=.059$ |
| | Female gender | OR: 1.01; 95% C.I.: 0.36 to 2.88; $P=.981$ | |
| | Body mass index $\geq$30 kg/m$^2$ | OR: 1.15; 95% C.I.: 0.38 to 3.45; $P=.806$ | |
| | Blood pressure $\geq$140/90 mmHg | OR: 0.99; 95% C.I.: 0.46 to 2.13; $P=.975$ | |
| | Fasting glucose $\geq$126 mg/dL | OR: 0.51; 95% C.I.: 0.23 to 1.15; $P=.104$ | |
| | Total cholesterol $\geq$240 mg/dL | OR: 1.08; 95% C.I.: 0.41 to 2.84; $P=.883$ | |
| | Neck circumference | OR: 1.32; 95% C.I.: 1.09 to 1.59; $P=.003$* | |
| Most parsimonious logistic regression model | Age | OR: 1.04; 95% C.I.: 0.99 to 1.09; $P=.126$ | OR: 2.36; 95% C.I.: 1.06 to 5.28; $P=.036$* |
| | Fasting glucose $\geq$126 mg/dL | OR: 0.52; 95% C.I.: 0.23 to 1.14; $P=.102$ | |
| | Neck circumference | OR: 1.32; 95% C.I.: 1.14 to 1.53; $P<.001$* | |

*Statistically significant result.

The proportion correctly classified for a positive neck grasp in predicting OSA was moderate (69.5%), while the sensitivity was high 83.3% [74.9-89.4%], and specificity low 39.6% [26.7-53.9%]. The AUC for a positive neck grasp in identifying subjects with OSA was 0.615 (0.539-0.689) and that of the neck circumference was 0.683 (0.597-0.769).

## Discussion

This study shows a significant association between a positive neck grasp and OSA in community-dwelling older adults of Amerindian ancestry. However, mediation analysis disclosed that roughly one-third of this association is mediated by the neck circumference, probably explaining the poor diagnostic accuracy found in the sensitivity analysis and the mild predictive value (61.5%) of the AUC.

As previously noticed, only 2 studies have addressed the value of neck grasp for predicting OSA.[15,16] Both studies were conducted by the same group of investigators. The age of participants in 1 of them ranged from 29 to 81 years, and the other only mentioned that participants were aged 18 years or older. Race/ethnicity was not specified. Studies are limited by the small number of cases included (47 and 43 patients, respectively) and by the fact that 1 of them was confined to patients with diabetes mellitus. There was no information on the percentage of eligible candidates unable to perform the maneuver. Using an AHI cutoff $\geq$5 to diagnose OSA, both studies found a specificity of 100% of a positive neck grasp for predicting OSA, and a sensitivity ranging from 55% to 68.3%. According to the authors, neck grasp is easy to perform and will serve as an unequivocal identifier of subjects with OSA. However, it was recognized the sizable percentage of false negative cases, and the fact that they enrolled a selected population attending a sleep clinic, which may not necessarily be extrapolated to the population at large.

Subjects participating in the current study were identified by means of door-to-door surveys and randomly selected to undergo PSG for research purposes.[18,19] This reduces the possibility of selection bias. In such population, neck grasp did not perform well for predicting OSA despite the significant association found between the main variables investigated, although the AUC statistic may not reflect the discreteness of the data.[23]

Likely, the effect of the neck circumference was responsible for this poor diagnostic accuracy, as shown in the above-described models. In addition, 17% of individuals could not preform the test because of several reason already described. This is a major limitation of the test if it is planned to be used for mass screening of OSA.

Major strengths of our study include the unbiased selection of participants taken from the community and the models used to assess diagnostic accuracy of neck grasp for predicting OSA. Limitations of the study are those of the neck grasp maneuver itself, that is, correct performance of neck grasp, which depends on proper understanding of the maneuver, integrity of shoulder girdle articulations, and other factors. It is also possible that some hidden confounders may have influenced the results of this study. In addition, the study population is limited to individuals of Amerindian

ancestry, and our results may not be generalized to other races/ethnic groups.

Study results do not support the use of neck grasp as an independent predictor of OSA. Neck circumference is easier to measure and provide a more accurate information on the OSA status, as previously shown.[14] More information is needed before widespread acceptance of neck grasp as a mass screening tool for predicting OSA in different populations/ethnic groups.

## Authors' Contributions

OHD: study design, manuscript drafting; RMM: statistical analyses; BYR: data collection and analysis; PRC: reading and interpretation of polysomnograms, significant intellectual contribution to manuscript content.

## Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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## Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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