

## Original Article

# Validity of obstructive sleep apnoea diagnoses

Emilia Colding Ofverlind<sup>1</sup>, Jesper Bille<sup>1, 2</sup>, Thure Filskov Overvad<sup>3</sup>, Peter Brønnum Nielsen<sup>4, 5</sup> & Ida Ehlers Albertsen<sup>1</sup>

1) Department of Otolaryngology, Head and Neck Surgery and Audiology, Aalborg University Hospital, 2) Department of Otolaryngology, Head and Neck Surgery and Audiology, Aarhus University Hospital, 3) Department of Clinical Pharmacology, Aalborg University Hospital, 4) Department of Cardiology, Aalborg University Hospital, 5) Danish Center for Health Services Research, Department of Clinical Medicine, Aalborg University, Denmark

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## ABSTRACT

**INTRODUCTION.** Healthcare databases are a valuable source for epidemiological research in obstructive sleep apnoea, but accurately registered diagnoses are pivotal in contributing quality evidence. We examined positive predictive values (PPV) of the International Classification of Diseases, tenth version (ICD-10) diagnosis for “obstructive sleep apnoea” and “sleep apnoea” in the Danish National Patient Register.

**METHODS.** Using the Danish National Patient Registry, we randomly sampled 100 patients from the North Denmark Region diagnosed with “obstructive sleep apnoea” (ICD-10 code DG4732) and 100 patients diagnosed with “sleep apnoea” (DG473\*) during the year 2020. We calculated the PPV using a documented Apnea-Hypopnea Index (AHI)  $\geq 5$  to confirm the recorded diagnosis. A total of 70 patients were referred to the private sector for assessment of the AHI and excluded due to limited access to their data.

**RESULTS.** The study population included 130 patients, among whom 64 were diagnosed with “obstructive sleep apnoea”, and 66 patients were registered with “sleep apnoea”. The PPV for “obstructive sleep apnoea” was 93.8% (95% confidence interval (CI): 85.0-97.5%), and the PPV for “sleep apnoea” was 80.3% (95% CI: 69.2-88.1%).

**CONCLUSIONS.** Our findings indicated a high validity of the ICD-10 code DG4732 with a PPV of 93.8% and a lower PPV (80.3%) for the ICD-10 code DG473\* for identifying patients with obstructive sleep. The “obstructive sleep apnoea” diagnosis is a suitable source of data for epidemiological research to identify patients with the disease.

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Obstructive sleep apnoea is characterised by obstructive apnoea, hypopnoea and/or respiratory effort-related arousals caused by repetitive collapse of the upper airway during sleep [1]. Obstructive sleep apnoea is a common disorder, affecting up to 20% of adults [2]. Given the current trend towards increasing obesity and overweight, it is recognised that the clinical and public health burdens of obstructive sleep apnoea are increasing [2].

The severity of sleep apnoea is measured by the Apnea-Hypopnea Index (AHI), which counts the number of hypopneas and apnoeas per hour of sleep. Despite increasing awareness of the condition and improved diagnostic procedures, most patients in the community remain undiagnosed and untreated [3].

Valid data on obstructive sleep apnoea are important in epidemiological studies investigating the risk and

prognosis for patients diagnosed with obstructive sleep apnoea. Hospital discharge registries may be a valuable and cost-effective source of epidemiological research in obstructive sleep apnoea provided records of diagnoses are valid. Despite its potential importance, the International Classification of Diseases, tenth version (ICD-10), hospital diagnosis of obstructive sleep apnoea has not been validated in a population-based healthcare system. Previous register-based studies have used both DG4732 (“obstructive sleep apnoea”) and DG473\* (“sleep apnoea”) to identify patients with obstructive sleep apnoea [4, 5].

Therefore, to optimise future epidemiological research in obstructive sleep apnoea, we examined the positive predictive value (PPV) of the obstructive sleep apnoea diagnosis (ICD-10 code DG4732) and a broader sleep apnoea diagnosis (ICD-10 code DG473\*).

## METHODS

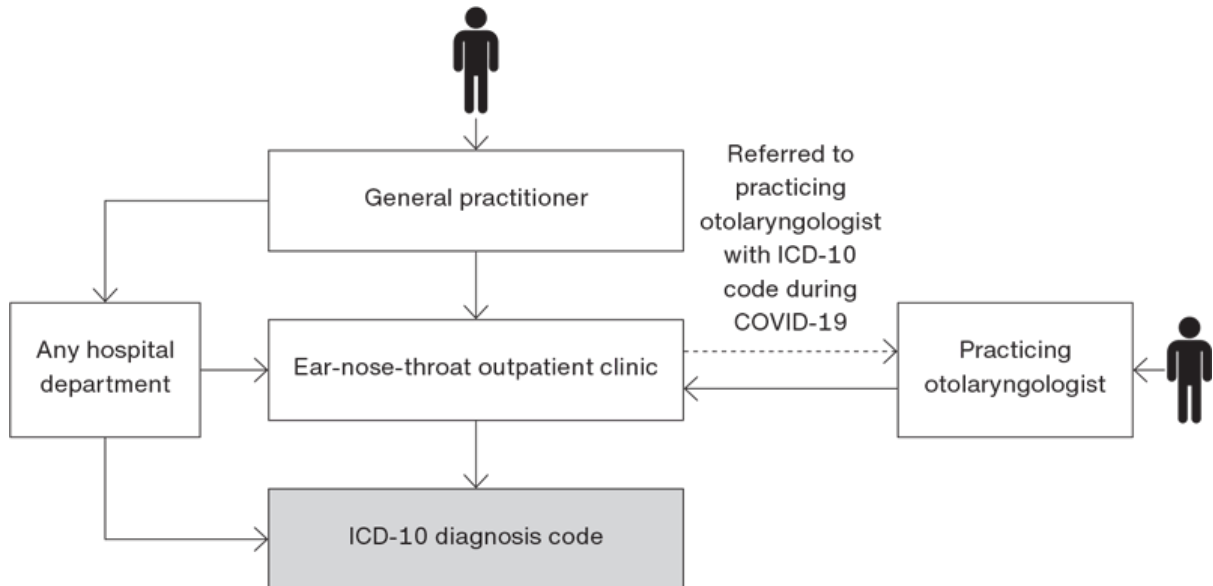
### Setting and data sources

Denmark is divided into five regions, each of which is representative of the Danish population with respect to demographic and socioeconomic characteristics, healthcare usage and medication use [6]. For this study, we used data from the North Denmark Region, which has a source population of 0.6 million inhabitants.

Using the Danish Civil Registration System (CPR) number [7] and the Danish National Patient Registry [8], we sought to validate the obstructive sleep apnoea diagnoses available in the Danish National Patient Registry.

Patients suffering from obstructive sleep apnoea may contact their general practitioner who may then refer them to an ear-nose-throat (ENT) outpatient clinic, or they may contact a practicing otolaryngologist directly without referral, see **Figure 1**. Formal diagnosing with sleep monitoring equipment is performed solely via ENT outpatient clinics and at specialised private otolaryngologists. Some practicing otolaryngologists refer sleep apnoea patients to hospital ENT outpatient clinics for further treatment/diagnosing. An ICD-10 diagnosis, with or without formal diagnosing with sleep monitoring equipment, may be given during hospitalisation at any given department, including an ENT outpatient clinic. Additionally, patients referred from the hospital to a practicing otolaryngologist receive a diagnosis code, which is then registered by the hospital department prior to the actual performance of the diagnostic test in the private clinic. This type of referral was especially relevant during the COVID-19 pandemic in 2020 because some of the hospitals' ENT functions were shut down.

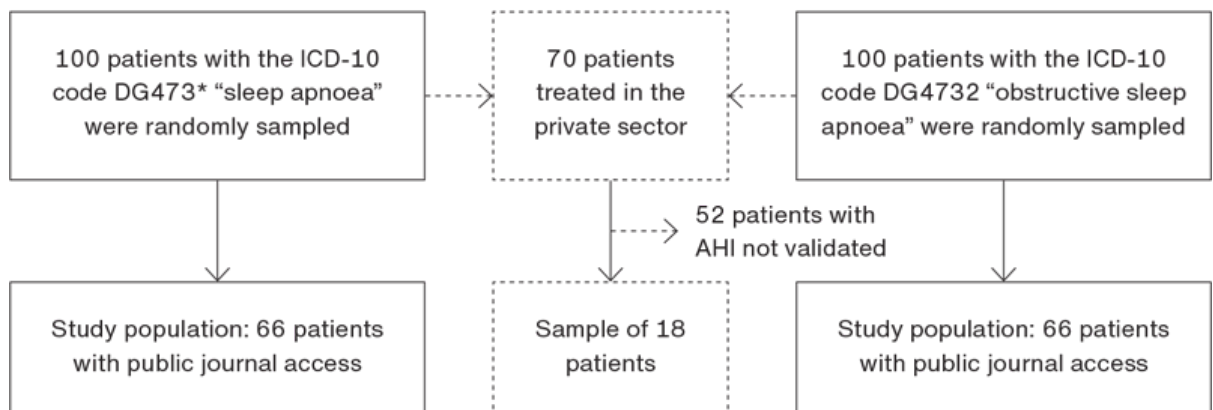
**FIGURE 1** Patient pathway to diagnosis and healthcare registration of the ICD-10 diagnosis code.



## Study population

The Danish National Patient Registry was used to randomly sample 100 patients with an ICD-10 code of DG4732 as a primary or secondary diagnosis code, and another 100 patients with DG473\*, registered during 2020, using data from the North Denmark Region as seen in previous validation studies [9], see **Figure 2**. Diagnoses needed to be incident-occurring diagnoses. As medical records were unavailable for patients referred from the hospital to the private sector, these patients were excluded from the primary study population. See **eTable 1** for an overview of the diagnose codes for “sleep apnoea”.

**FIGURE 2** Flow chart of the study population.



AHI = Apnea-Hypopnea Index.

## Validation using electronic healthcare records

The validation was conducted during July and August 2022. The medical records were reviewed for all patients included in the study. For each patient, information listed in **Table 1** was registered in the RedCap program,

version 11.1.29 [10, 11]. The records were examined for the AHI score related to the examination of the patient when testing for “obstructive sleep apnoea”. If the diagnosis was given without measuring the AHI, the AHI was registered as missing. The gold standard for the diagnosis “obstructive sleep apnoea” is an AHI of  $\geq 5$ . As such, a missing AHI record meant that the diagnosis criterium was not met.

**TABLE 1** Descriptive characteristics of 130 patients in the North Denmark Region during the year 2020, by “sleep apnoea” and “obstructive sleep apnoea” diagnoses. The values are n (%).

	ICD-10 code DG473*: “sleep apnoea” (N <sub>SA</sub> = 66 (50.8%))	ICD-10 code DG4732: “obstructive sleep apnoea” (N <sub>OSA</sub> = 64 (49.2%))
<i>AHI</i>		
No AHI recorded	13 (19.7)	4 (6.3)
AHI recorded	53 (80.3)	60 (93.8)
<i>Sex</i>		
Male	41 (62.1)	43 (67.2)
Female	25 (37.9)	21 (32.8)
<i>Age</i>		
< 40 yrs	15 (22.7)	17 (26.6)
40-59 yrs	25 (37.9)	24 (37.5)
60-74 yrs	18 (27.3)	17 (26.6)
$\geq 75$ yrs	8 (12.1)	6 (9.4)
<i>OSA severity: AHI recorded</i>		
Not confirmed OSA: AHI < 5	13 (19.7)	4 (6.3)
Mild: AHI 5-15	9 (13.6)	12 (18.8)
Moderate: AHI 15-30	18 (27.3)	20 (31.3)
Severe: AHI > 30	26 (39.4)	28 (43.8)
<i>Admission type</i>		
Acute inpatient	11 (16.7)	8 (12.5)
Elective inpatient	55 (83.3)	56 (87.5)
<i>Diagnosis type</i>		
Primary	29 (43.9)	46 (71.9)
Secondary	37 (56.1)	18 (28.1)
<i>Department</i>		
Otolaryngology	50 (75.8)	57 (89.1)
Other surgical	2 (3.1)	0
Medical	10 (15.2)	5 (7.8)
Emergency	0	0
Other	4 (6.1)	2 (3.1)
<i>Treatment with CPAP</i>		
Yes	53 (80.3)	51 (79.7)
No	12 (18.2)	12 (18.7)
Unknown	1 (1.5)	1 (1.6)

AHI = Apnea-Hypopnea Index; CPAP = continuous positive airway pressure; OSA = obstructive sleep apnoea; SA = sleep apnoea.

## Statistical analyses

The PPV was defined as the proportion of patients registered with an “obstructive sleep apnoea” or “sleep apnoea” diagnosis in the Danish National Patient Registry, which was confirmed by a record of measured AHI  $\geq 5$  (gold standard). In our analysis, both persons with missing AHI and persons with an AHI < 5 were included in

the “obstructive sleep apnoea, not confirmed” category. We estimated the 95% confidence interval (CI) for each PPV by means of the Wilson Score Method [12].

The PPV was estimated in sex and age strata. Additionally, to investigate PPV variation, and thereby potentially guide the identification of obstructive sleep apnoea patients for future research, the following stratified analysis was performed: admission type, treatment with continuous positive airway pressure (CPAP), primary versus secondary diagnosis code and department type.

### Supplementary analyses

Patients referred to private practice were excluded from the primary study population. However, to investigate the validity of diagnoses given to patients referred to the private sector, a random sample of 18 patients was validated post-hoc, using information from a single private otolaryngology practice.

Analyses were conducted using STATA/MP (ver. 17).

### Study approval

The study was registered as a quality improvement project at Aalborg University Hospital, Denmark. According to Danish legislation, no approval from the Danish Scientific Ethics Committee is necessary for quality improvement studies using data from the Region. A written consent statement was obtained from the private otolaryngology practice allowing us to use and publish their data.

*Trial registration:* not relevant.

## RESULTS

After exclusions, the study population comprised 130 patients of whom 64 (49.2%) were diagnosed with “obstructive sleep apnoea” and 66 (50.8%) with “sleep apnoea” (Figure 2). Descriptive characteristics of the study population are presented in Table 1. For both “sleep apnoea” and “obstructive sleep apnoea”, most patients had “severe” (AHI > 30) (“sleep apnoea”: 39.4%, “obstructive sleep apnoea”: 43.8%).

The overall PPV for “sleep apnoea” code DG473\* was 80.3% (95% CI: 69.2-88.1%); and for the “obstructive sleep apnoea” code DG4732, the PPV was 93.8% (95% CI: 85.0-97.5%). **Table 2** presents the overall PPV and results from the stratified analyses.

**TABLE 2** Positive predictive value of ICD-10 codes for the presence of obstructive sleep apnoea stratified by “sleep apnoea” and “obstructive sleep apnoea”.

	Positive predictive value, % (95% CI)	
	ICD-10 code DG473*: “sleep apnoea” (N <sub>SA</sub> = 66 (50.8%))	ICD-10 code DG4732: “obstructive sleep apnoea” (N <sub>OSA</sub> = 64 (49.2%))
Overall	80.3 (69.2-88.1)	93.8 (85.0-97.5)
<i>Sex</i>		
Male	82.9 (68.7-91.5)	95.4 (84.5-98.7)
Female	76.0 (56.6-88.5)	90.5 (71.1-97.4)
<i>Age</i>		
< 40 yrs	86.7 (62.1-96.3)	94.1 (73.0-99.0)
40-59 yrs	80.0 (60.9-91.1)	95.8 (79.8-99.3)
60-74 yrs	88.9 (67.2-96.9)	88.2 (65.7-96.7)
≥ 75 yrs	50.0 (21.5-78.5)	100 (61.0-100)
<i>Admission type</i>		
Acute inpatient	63.6 (35.4-84.8)	100 (67.6-100)
Elective inpatient	83.6 (71.7-91.2)	92.9 (83.0-97.2)
<i>Diagnosis type</i>		
Primary	100 (88.3-100)	93.5 (82.5-97.8)
Secondary	64.9 (48.8-78.2)	94.4 (74.2-99.0)
<i>Department</i>		
Otolaryngology	86.0 (73.8-93.1)	96.5 (88.1-99.0)
Other surgical	100 (34.2-100)	0
Medical	70.0 (39.7-89.2)	80.0 (37.6-96.4)
Emergency	0	0
Other	25.0 (4.6-69.9)	50.0 (9.5-90.6)
<i>Treatment with CPAP</i>		
Yes	88.7 (77.4-94.7)	96.1 (86.8-98.9)
No	41.7 (19.3-68.1)	83.3 (55.2-95.3)

CI = confidence interval; CPAP = continuous positive airway pressure; OSA = obstructive sleep apnoea; SA = sleep apnoea.

Restricting to primary diagnosis types resulted in a PPV of 100% (95% CI: 88.3-100%) for “sleep apnoea” and 93.5% (95% CI: 82.5-97.8%) for “obstructive sleep apnoea”. The department type with the highest PPV was “other surgical” with a PPV of 100% (95% CI: 34.2-100%) for “sleep apnoea” and otolaryngology departments for “obstructive sleep apnoea” with a PPV of 96.5% (95% CI: 88.1-99.0%). Treatment with CPAP affected the PPV for both diagnoses. For patients not treated with CPAP, “sleep apnoea” had a PPV of 41.7% (95% CI: 19.3-68.1%) and “obstructive sleep apnoea” had a PPV of 83.3% (95% CI: 55.2-95.3%). For patients receiving the treatment, the PPVs were 88.7% (95% CI: 77.4-94.7%) and 96.1% (95% CI: 86.8-98.9%), respectively.

In the post hoc supplementary analysis using the sample of 18 patients referred to the private sector, the PPV was 100% for both “sleep apnoea” and “obstructive sleep apnoea”, see [eTable 2](#).

## DISCUSSION

To our knowledge, this is the first study to validate the ICD-10 diagnosis codes for “obstructive sleep apnoea” and “sleep apnoea” in the Danish Patient Register. The results from this study showed that the PPV is highest for the more specific diagnosis code “obstructive sleep apnoea” than for a broader “sleep apnoea” definition. For both diagnoses, a high PPV was ensured when limiting the study to primary diagnosis or if combined with “treatment with continuous positive airway pressure”.

Our findings suggest that the use of sleep apnoea diagnosis codes in hospital diagnosis registries has great potential for future epidemiological studies. Depending on the purpose of the study, using a broad definition of “sleep apnoea” may be useful, but this broad definition should be used with caution or restricted to primary diagnoses.

During year 2020, some of the patients usually treated in the ENT outpatient clinic were referred to the private sector due to COVID-19 shut down of some of the hospital’s ENT functions. In our study, 70 patients (35% of the initial sample) were referred to the private sector. We obtained information on the AHI from a random sample of 18 of these patients from a single practicing otolaryngologist. In the sample, a PPV of 100% was found for both diagnosis codes. Accordingly, the codes stemming from patients referred from a hospital to a private otolaryngologist included in future studies will most likely add to an overall higher validity of the diagnosis than what was found in this study.

We validated two diagnoses as previous register-based studies have used both DG4732 (“obstructive sleep apnoea”) and DG473\* (“sleep apnoea”) to identify patients with obstructive sleep apnoea [13]. Clinicians may not differentiate much when using either of the two codes. However, if epidemiological studies on “obstructive sleep apnoea” also include “sleep apnoea” codes, sufficient accuracy of ICD-10 coding is required if obstructive sleep apnoea is indeed the underlying disease for both groups. Optimally, both diagnoses should be included in future studies, ensuring a larger cohort. However, as found in our study, 20% of the patients with a “sleep apnoea” code did not suffer from obstructive sleep apnoea. Including these patients with no further restrictions, e.g., CPAP usage, restricting to primary diagnosis, may potentially cause an unacceptable misclassification, depending on the study purpose.

The documentation of the AHI score varied among the different departments, where the ENT and “other surgical departments” had an overall high PPV for both diagnoses. Medical departments had a PPV of 70.0% for “sleep apnoea” but 80.0% for “obstructive sleep apnoea”. At medical departments, a risk may exist that when patients are snoring during hospitalisation, they are diagnosed with “sleep apnoea” without further formal testing. Similarly, the low PPV of 63.6% for “sleep apnoea” for acute inpatient admission types may potentially be due to diagnoses given without further testing or referral. Among all patients with an available AHI, all were verified with obstructive sleep apnoea. No diagnoses were given in the emergency department where patients usually do not stay overnight. We are unaware of other studies validating these diagnoses and hence cannot compare with others.

Some limitations must be considered when interpreting our study results. The AHI for patients referred to the private sector was unknown, and these patients were therefore excluded from the primary analysis. However, in a post-hoc validation sample from the private sector of 18 patients, we observed a PPV of 100%. Consequently, we anticipate the overall PPV for both diagnoses to be higher when patients treated in the private sector are included in future register-based studies. Systematic differences between patients seen at a practising otolaryngologist and an ENT outpatient clinic have not been investigated. Although Danish healthcare is rather consistent in structure, it cannot necessarily be assumed that the results from our study apply to all regions in Denmark. Finally, we do not know to which extent our study findings are representative of other hospital

systems internationally, where the prevalence of “obstructive sleep apnoea” and “sleep apnoea” and also diagnostic and coding strategies may be different.

## CONCLUSIONS

This hospital-based study provided evidence of a high PPV of the ICD-10 code DG4732 for “obstructive sleep apnoea” when verified with actual AHI measurements in computerised medical records in Denmark. If the code DG473\* for “sleep apnoea” is used, specific restrictions should be considered to increase the validity and make it a suitable register-based sleep apnoea definition, which may serve for epidemiological research.

**Correspondence** *Ida Ehlers Albertsen*. E-mail: [i.albertsen@rn.dk](mailto:i.albertsen@rn.dk)

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**Supplementary** <https://content.ugeskriftet.dk/sites/default/files/2024-01/a11230701-supplementary.pdf>

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