

# Recognising obstructive sleep apnoea as a sign of developing diabetes

*Maria Pallayova, Shahrads Taheri*

**Citation:** Pallayova M, Taheri, S (2013) Recognising obstructive sleep apnoea as a sign of developing diabetes. *Journal of Diabetes Nursing* 17: 288–93

## Article points

1. An increasing body of evidence suggests that obstructive sleep apnoea (OSA) is independently associated with glucose intolerance and worsened glycaemic control. Also, OSA is a common comorbidity in people with type 2 diabetes (T2D), with a higher prevalence than in the general population.
2. The two primary disturbances in OSA, acute periods of hypoxic stress and sleep fragmentation, have been shown to potentially impair glucose homeostasis. OSA, obesity and impaired glucose metabolism create a vicious triangle leading to further weight gain, progression of OSA and deteriorating glucose homeostasis, which can result in T2D.
3. Given the complex bidirectional relationship between OSA and T2D, people with one condition should be considered for the other.

## Key words

- Diabetes risk
- Obstructive sleep apnoea,
- Type 2 diabetes

## Authors

For authors' details, see bottom of page 292

**The number of people with type 2 diabetes (T2D) is increasing rapidly worldwide and it is known that this is a consequence of the rising prevalence of obesity, driven by unhealthy diet and reduced physical activity. Diagnosis of obstructive sleep apnoea (OSA) is often missed and yet it is increasingly recognised as an independent risk factor for the development of T2D. Since both OSA and T2D share common increased susceptibility to oxidative stress, the coexistence of OSA and T2D potentially places individuals at an increased morbidity and mortality risk. This article aims to increase clinical awareness of and draw therapeutic attention to OSA as a potential sign of developing T2D in high-risk individuals.**

**D**espite major advances in sleep medicine and greater awareness of the role of sleep in health and wellbeing, one of the most common sleep disorders, obstructive sleep apnoea (OSA), remains underdiagnosed. If left untreated, depending on severity, OSA can lead to a variety of cardiovascular (Mannarino et al, 2012), metabolic (Punjabi et al, 2004), neuroendocrine (Gianotti et al, 2002) and inflammatory (Selmi et al, 2007) consequences.

An increasing body of evidence suggests that OSA is independently associated with glucose intolerance (Punjabi et al, 2004; Punjabi and Polotsky, 2005; Punjabi and Beamer, 2009) and worsened glycaemic control (Papanas et al, 2009; Aronsohn et al, 2010; Pillai et al, 2011; Priou et al, 2012). Also, OSA is a common comorbidity in people with type 2 diabetes (T2D), with a higher prevalence (23–86%; Einhorn et al, 2007; Foster et al, 2009) than in the general population (2–7%; Lurie, 2011).

Since both OSA and T2D increase susceptibility to oxidative stress, the coexistence of OSA and T2D potentially places individuals

with these conditions at an increased morbidity and mortality risk.

The number of people with T2D is rising rapidly worldwide, along with the prevalence of obesity, which is driven by unhealthy diets and reduced physical activity. Besides obesity, OSA is increasingly recognised as a potential independent risk factor for the development of T2D (Botros et al, 2009; Marshall et al, 2009; Muraki et al, 2010; Pallayova et al, 2011). The present article aims to increase clinical awareness of and draw therapeutic attention to OSA as a potential sign of developing T2D in high-risk individuals.

## OSA as a breathing disorder

OSA is characterised by frequent intermittent complete cessation of breathing (apnoea) or reduced breathing (hypopnoea), which in turn results in hypoxaemia and intermittent arousal. The frequent interruptions in sleep, which are generally not noticed by the individual, result in daytime sleepiness.

The most commonly employed measure of

**Table 1. Signs and symptoms of obstructive sleep apnoea (adapted from Epstein et al, 2009).**

Major signs and symptoms	Other common signs and symptoms
Loud heavy chronic snoring	Morning headaches, a dry mouth or sore throat
Witnessed apnoea	Unrefreshing sleep
Gasping/choking episodes during sleep	Decreased concentration/memory
Nocturia	Irritability, changes in mood/behaviour
Unexplained excessive daytime sleepiness	Anxiety or depression
Increased neck circumference	Decreased interest in sex, sexual dysfunction
Central obesity	Gastroesophageal reflux

OSA is the apnoea–hypopnoea index (AHI). This measures the number of apnoeas plus hypopnoeas per hour of sleep, or per hour of respiratory recording. OSA is diagnosed when the AHI is  $\geq 5$  events per hour, but becomes a significant health issue with AHIs  $\geq 15$  events per hour (Lurie, 2011). The severity

of OSA in adults is defined as: mild for AHI  $\geq 5$  and  $< 15$  events per hour; moderate for AHI  $\geq 15$  and  $\leq 30$  events per hour, and severe for AHI  $> 30$  events per hour (Epstein et al, 2009). The clinical signs and symptoms of OSA are shown in *Table 1*.

Diagnosis of OSA (*Table 2*) is based on a comprehensive sleep evaluation and findings identified by objective sleep testing that includes either in-laboratory polysomnography or home testing with portable monitors (Epstein et al, 2009). Portable monitoring comes with different degrees of complexity, with the simplest being oximetry alone.

Several validated sleep questionnaires, such as the Epworth Sleepiness Scale (Johns, 1991) or the Berlin questionnaire (Netzer et al, 1999), which are freely available on the internet, can be administered to obtain a relevant sleep history and assess the degree of sleepiness. Neither is, however, diagnostic of OSA. The Berlin questionnaire identifies individuals as high or low risk for OSA, while the Epworth scale measures symptoms of sleepiness.

Generally, lifestyle change and weight loss is recommended for treatment of OSA but this may be insufficient to completely

**Table 2. Diagnostic criteria for obstructive sleep apnoea (adapted from the ICSD-2; AASM, 2005).\***

**A. At least one of the following applies:**

1. The patient complains of unintentional sleep episodes during wakefulness, daytime sleepiness, unrefreshing sleep, fatigue or insomnia.
2. The patient wakes with breath holding, gasping or choking.
3. The bed partner reports loud snoring, breathing interruptions or both during the patient’s sleep.

**B. Polysomnographic recording shows the following:**

1. Five or more respiratory events (apnoea, hypopnoea or RERA) per hour of sleep.
2. Evidence of respiratory effort during all or a portion of each respiratory event.

**C. Polysomnographic recording shows the following:**

1. Fifteen or more respiratory events (apnoea, hypopnoea or RERA) per hour of sleep.
2. Evidence of respiratory effort during all or a portion of each respiratory event.

**D. The disorder is not better explained by another sleep disorder, medical or neurological disorder, medication use or substance use disorder.**

\*Minimal criteria: A plus B plus D, or C plus D.

AASM=American Academy of Sleep Medicine; ICDS-2= International Classification of Sleep Disorders, revised; RERA=respiratory event related arousal.

---

normalise breathing during sleep. The primary recommended therapy for moderate to severe OSA is positive airway pressure (PAP) delivered in continuous, bi-level or auto-titrating modes. This provides a pneumatic splint for the airway, preventing collapse during sleep. The alternative therapies for OSA include behavioural treatments, oral appliances, upper airway surgery and/or adjunctive therapies (bariatric surgery, pharmacologic agents and oxygen therapy). A regular sleep specialist follow-up to monitor tolerance and adherence to OSA treatments, side effects, development and progression of OSA complications, and symptom resolution is required.

### **OSA as a sign of developing diabetes**

The two primary disturbances in OSA, acute periods of hypoxic stress and sleep fragmentation, have been shown to potentially impair glucose homeostasis (Oltmanns et al, 2004; Aronsohn et al, 2010; Stamatakis and Punjabi, 2010; Priou et al, 2012). Moreover, OSA, obesity and impaired glucose metabolism create a vicious triangle, leading to further weight gain, progression of OSA, deteriorating glucose homeostasis and, ultimately, to overt T2D in predisposed individuals (Pallayova and Taheri, 2013). While behavioural therapy alone might be satisfactory for mild OSA, the treatment with PAP is the current best treatment for moderate to severe OSA and, although still controversial, may also improve glycaemic control (Babu et al, 2005; Dawson et al, 2008; Pallayova et al, 2008).

The identification of the development T2D in people with OSA may be a difficult task for the clinician, especially since people usually present to a respiratory/sleep department. People may be asymptomatic or present with symptoms and signs that are common to both OSA and T2D (for example, nocturia, dry mouth, difficulty in concentration, sexual dysfunction). Therefore, the diagnosis of T2D needs to be considered in all people with OSA, even in those without the typical signs and symptoms of the diabetes. Ideally, screening for diabetes and metabolic syndrome should be included as part of the sleep assessment.

### **The role of nurses**

Nurses play a critical role in delivering health promotion, advice and disease prevention. In collaboration with other healthcare professionals, nurses facilitate complex clinical care and undertake a variety of healthcare activities, including care coordination, supporting self-management of people with diabetes, and monitoring patient recall and reminder systems. Of importance, practice nurses can undertake health assessments and administration of sleep questionnaires and thus facilitate the screening for metabolic syndrome, diabetes and OSA within the primary care setting.

### Page points

1. Obstructive sleep apnoea (OSA), obesity and impaired glucose metabolism can all contribute to further weight gain, progression of OSA and deteriorating glucose homeostasis. All of these factors can lead to type 2 diabetes (T2D) in predisposed individuals.
2. Diagnosis of T2D needs to be considered in all people with OSA, even in those without the typical signs and symptoms of the disease.
3. The process of diagnosing T2D in people with OSA should ideally be started as early as possible in the primary care setting and specialist services, and followed by annual routine diabetes screening with HbA<sub>1c</sub> in asymptomatic adults at moderate, high and very high risk of diabetes.

### Authors

Maria Pallayova is research fellow, Heart of England NHS Foundation Trust and University of Birmingham, Birmingham; Shahrad Taheri is senior lecturer in Endocrinology, University of Birmingham, Birmingham

### Clinical aspects and future perspectives

Current clinical practice guidelines highlight the need for prevention, early diagnosis and treatment of diseases. Despite increasing evidence that OSA is potentially an independent risk factor for the development of T2D, none of the currently available diabetes risk calculators considers the presence of OSA as a risk factor for T2D. Therefore, the risk of T2D developing within 10 years can be determined with the use of a modified risk calculator. Factors considered in this calculator could include: age; sex; race/ethnicity; waist circumference; obesity; history of elevated glucose levels; history of gestational diabetes; history of hypertension; history and severity of sleep apnoea; family history of diabetes; limited activity levels and poor diet.

Given the high risk of impaired glucose metabolism in OSA, health professionals managing people with OSA should consider adopting their clinical practice to ensure that a person with OSA is considered for T2D. Fasting glucose measurement and glycated haemoglobin (HbA<sub>1c</sub>) testing can be used for screening of adults with OSA with moderate to high risk of diabetes, followed by the oral glucose tolerance test in those at very high risk. The process of diagnosing T2D in people with OSA should ideally be started as early as possible in the primary care setting and specialist services, and followed by annual routine diabetes screening with HbA<sub>1c</sub> in asymptomatic adults with moderate to very high risk of diabetes. People with moderate to severe OSA and pre-diabetes should be monitored closely because of the risk of progression to overt T2D. Successful implementation of these recommendations requires close liaison between primary care and specialist services, specifically, diabetes, endocrinology and sleep specialists.

### Summary and key learning points

OSA is a chronic disease requiring ongoing, long-term management that should ideally be approached on a case management basis utilising a multidisciplinary care team, including primary and secondary care

healthcare professionals. Given the complex bidirectional relationship between OSA and T2D, people with one condition should be considered for the other.

The multidisciplinary approach and timely specialist referral are essential for prevention, early diagnosis and treatment of the disorders of glucose metabolism that may present in people with OSA, or develop over time. The currently available T2D risk calculators need to be updated and validated to also include OSA as a risk factor for the development of T2D.

People with an inadequate T2D control should be evaluated for sleep apnoea that may contribute to worse glucose control and may also be associated with the presence of diabetes complications (Bottini et al, 2008).

Appropriate and comprehensive ongoing education, healthy diet and lifestyle, regular physical activity, as well as satisfactory treatment of OSA and other comorbidities are all needed for the successful management of people with concurrent prediabetes or overt T2D. ■

American Academy of Sleep Medicine (2005) *International classification of sleep disorders: Diagnostic and coding manual* (second edition). AASM, Westchester, USA

Aronsohn RS, Whitmore H, Van Cauter E, Tasali E (2010) Impact of untreated obstructive sleep apnea on glucose control in type 2 diabetes. *Am J Respir Crit Care Med* **181**: 507–13

Babu AR, Herdegen J, Fogelfeld L et al (2005) Type 2 diabetes, glycemic control, and continuous positive airway pressure in obstructive sleep apnea. *Arch Intern Med* **165**: 447–52

Botros N, Concato J, Mohsenin V et al (2009) Obstructive sleep apnea as a risk factor for type 2 diabetes. *Am J Med* **122**: 1122–7

Bottini P, Redolfi S, Dottorini ML, Tantucci C (2008) Autonomic neuropathy increases the risk of obstructive sleep apnea in obese diabetics. *Respiration* **75**: 265–71

Dawson A, Abel SL, Loving RT et al (2008) CPAP therapy of obstructive sleep apnea in type 2 diabetics improves glycemic control during sleep. *J Clin Sleep Med* **4**: 538–42

Einhorn D, Stewart DA, Erman MK et al (2007) Prevalence of sleep apnea in a population of adults with type 2 diabetes mellitus. *Endocr Pract* **13**: 355–62

Epstein LJ, Kristo D, Strollo PJ Jr et al (2009) Clinical guideline for the evaluation, management and long-term care of obstructive sleep apnea in adults. *J Clin Sleep Med* **5**: 263–76

- 
- Foster GD, Sanders MH, Millman R et al (2009) Obstructive sleep apnea among obese patients with type 2 diabetes. *Diabetes Care* **6**: 1017–19
- Gianotti L, Pivetti S, Lanfranco F et al (2002) Concomitant impairment of growth hormone secretion and peripheral sensitivity in obese patients with obstructive sleep apnea syndrome. *J Clin Endocrinol Metab* **87**: 5052–7
- Johns MW (1991) A new method for measuring daytime sleepiness: the Epworth Sleepiness Scale. *Sleep* **14**: 540–5
- Lurie A (2011) Obstructive sleep apnea in adults: epidemiology, clinical presentation, and treatment options. *Adv Cardiol* **46**: 1–42
- Mannarino MR, Di Filippo F, Pirro M (2012) Obstructive sleep apnea syndrome. *Eur J Intern Med* **23**: 586–93
- Marshall NS, Wong KK, Phillips CL et al (2009) Is sleep apnea an independent risk factor for prevalent and incident diabetes in the Busselton Health Study? *J Clin Sleep Med* **5**: 15–20
- Muraki I, Tanigawa T, Yamagishi K et al (2010) Nocturnal intermittent hypoxia and the development of type 2 diabetes: the Circulatory Risk in Communities Study (CIRCS). *Diabetologia* **53**: 481–8
- Netzer NC, Stoohs RA, Netzer CM et al (1999) Using the Berlin Questionnaire to identify patients at risk for the sleep apnea syndrome. *Ann Intern Med* **31**:485–91
- Oltmanns KM, Gehring H, Rudolf S et al (2004) Hypoxia causes glucose intolerance in humans. *Am J Respir Crit Care Med* **169**: 1231–7
- Pallayova M, Donic V, Tomori Z (2008) Beneficial effects of severe sleep apnea therapy on nocturnal glucose control in persons with type 2 diabetes mellitus. *Diab Res Clin Pract* **81**: e8–e11
- Pallayova M, Lazurova I, Donic V (2011) Hypoxic damage to pancreatic beta cells - the hidden link between sleep apnea and diabetes. *Med Hypotheses* **77**: 930–4
- Pallayova M, Taheri S (2013) Obstructive sleep apnoea in persons with diabetes: A clinical management perspective. *Diabetes in Practice* **2**: 62–71
- Papanas N, Steiropoulos P, Nena E et al (2009) HbA1c is associated with severity of obstructive sleep apnea hypopnea syndrome in nondiabetic men. *Vasc Health Risk Manag* **5**: 751–6
- Pillai A, Warren G, Gunathilake W, Idris I (2011) Effects of sleep apnea severity on glycemic control in patients with type 2 diabetes prior to continuous positive airway pressure treatment. *Diabetes Technol Ther* **13**: 945–9
- Priou P, Le Vaillant M, Meslier N et al (2012) IRSR Sleep Cohort Group. Independent association between obstructive sleep apnea severity and glycosylated hemoglobin in adults without diabetes. *Diabetes Care* **35**: 1902–6
- Punjabi NM, Shahar E, Redline S et al (2004) Sleep-disordered breathing, glucose intolerance, and insulin resistance: The Sleep Heart Health Study. *Am J Epidemiol* **160**: 521–30
- Punjabi NM, Polotsky VY (2005) Disorders of glucose metabolism in sleep apnea. *J Appl Physiol* **99**: 1998–2007
- Punjabi NM, Beamer BA (2009) Alterations in glucose disposal in sleep disordered breathing. *Am J Respir Crit Care Med* **179**: 235–40
- Selmi C, Montano N, Furlan R et al (2007) Inflammation and oxidative stress in obstructive sleep apnea syndrome. *Exp Biol Med (Maywood)* **232**: 1409–13
- Stamatidis KA, Punjabi NM (2010) Effects of sleep fragmentation on glucose metabolism in normal subjects. *Chest* **137**: 95–101