Sleep-disordered breathing - implications for health services

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Airway during sleep

**FIGURE 1A.** Normal airway. The soft palate and uvula are normal in length and total size. The tongue is normal in size and is angled forward. The upper airway at the level of the nasopharynx, oropharynx and hypopharynx is normal in size and contour.

**FIGURE 1B.** Abnormal airway during sleep. Multiple sites of obstruction often occur in patients with obstructive sleep apnea. An elongated and enlarged soft palate impinges on the posterior airway at the level of the nasopharynx and oral pharynx. In addition, a retruding jaw pushes an enlarged tongue posteriorly to impinge on the hypopharyngeal space.
The Fundamentals of Sleep and Obstructive Sleep Apnea

<table>
<thead>
<tr>
<th>Event Type</th>
<th>Normal Breathing</th>
<th>Flow Limitation</th>
<th>Obstructive Hypopnea</th>
<th>Obstructive Apnea</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Breaths are characterized by a semi-sinusoidal wave-like pattern. Transitions from inspiration to expiration, and vice versa, are rounded and smooth.</td>
<td>The rounded inspiratory portion of the breath starts to flatten.</td>
<td>A reduction in airflow of a 50% of baseline with a 3% desaturation OR a reduction in airflow of a 30% with a 4% desaturation AND lasting for at least 10 seconds.*</td>
<td>A reduction in airflow of 90% of baseline lasting for at least 10 seconds.*</td>
</tr>
</tbody>
</table>

- **Airway Cross-section**
  - No obstruction
  - Partially obstructed airway
  - Increasingly obstructed airway
  - Completely obstructed airway

- **Flow Through Airway**
  - Semi-sinusoidal – unobstructed flow
  - Flattening & reduced flow
  - Flattening & further reduced flow
  - Flat – minimal or zero flow

- **Inspiratory Flow Shape**
- **Flow Tracing**

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IS OSA HARMFUL?
SLEEP-Apnea

Physiologic Perturbations
- Chronic Intermittent Hypoxia
- Ventilatory Overshoot Hyperoxia
- Increased Sympathetic Nervous System Activity
- Intrathoracic Pressure Swings
- Hypercapnia
- Increased Arousals
- Reduced Sleep Duration

Intermediate Mechanisms
- Increased Inflammation
- Increased Oxidative Stress
- Metabolic Dysfunction/Insulin Resistance
- Hyper-coaguability
- Endothelial Dysfunction
- Autonomic Dysfunction

Clinical Outcomes
- Systemic Hypertension
- Atherosclerosis
- Diastolic Dysfunction
- Congestive Heart Failure
- Stroke
- Increased Mortality and Sudden Death
- Cardiac Arrhythmias

Mehra R
Curr Resp Med Rev
How big a problem is OSA?

“I’m going to hibernate in another cave. You have sleep apnea and your snoring kept me up all of last winter.”
Prevalence of OSA

### TABLE 1. STUDIES ON THE PREVALENCE OF OBSTRUCTIVE SLEEP APNEA

<table>
<thead>
<tr>
<th>Country</th>
<th>First Author (Reference)</th>
<th>N</th>
<th>Ethnicity</th>
<th>Diagnostic Method</th>
<th>Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Men</td>
</tr>
<tr>
<td>United States</td>
<td>Young (7)</td>
<td>602</td>
<td>White</td>
<td>Polysomnography</td>
<td>4.0%</td>
</tr>
<tr>
<td></td>
<td>Bixler (9)</td>
<td>1,741</td>
<td>White</td>
<td>Polysomnography</td>
<td>3.9%</td>
</tr>
<tr>
<td>Australia</td>
<td>Bearpark (10)</td>
<td>485</td>
<td>White</td>
<td>MESAM IV*</td>
<td>3.1%</td>
</tr>
<tr>
<td>India</td>
<td>Udwadia (15)</td>
<td>250</td>
<td>Indian</td>
<td>Polysomnography</td>
<td>7.5%</td>
</tr>
<tr>
<td>China</td>
<td>Ip (12)</td>
<td>258</td>
<td>Chinese</td>
<td>Polysomnography</td>
<td>4.1%</td>
</tr>
<tr>
<td></td>
<td>Ip (13)</td>
<td></td>
<td>Chinese</td>
<td>Polysomnography</td>
<td>–</td>
</tr>
<tr>
<td>Korea</td>
<td>Kim (14)</td>
<td>457</td>
<td>Korean</td>
<td>Polysomnography</td>
<td>4.5%</td>
</tr>
</tbody>
</table>

*MESAM IV (Madaus, Marburg, Germany) is a portable sleep monitoring system.
Investigating sleep apnea –
Will the health system have the capacity to cope?

- Reliable data on OSA prevalence in Australia is over 20 years old.
- Obesity has progressively increased over the past two decades.
- International studies suggest many people with OSA are undiagnosed.
- A recent Brazilian community study using polysomnography found 32.8% with OSA.
- The current prevalence of OSA in Australia is unknown.
Value of early diagnosis of OSA

- Recent study using Danish National Patient Registry data
- Results:
  
  Significantly higher rates of health service use, medication use, unemployment and accounted for increased socioeconomic costs, including lower income, compared with matched controls.

- These socio-economic impacts were seen up to 8 years before first diagnosis of OSA, emphasizing the potential benefits of early diagnosis.

Have a seat Kermit. What I'm about to tell you might come as big shock...
MAILES Study
(Men: Androgens, Inflammation, Lifestyle and Environment Study).

- Aims to assess obesity, sex steroids and inflammation in a broad bio-psycho-social and environmental context and contribution to cardiovascular disease (CVD) and diabetes.

- Combined men from 2 cohort studies:
  - North West Adelaide Health Study (NWAHS, B/L n=1368; F/U n= 1088)
  - Florey Adelaide Men’s Health Study (FAMAS, B/L n=1195; F/U n=950)

- Protocols established 2000, same methodology-random selection from EWP.

- North-Western region of Adelaide, South Australia; covers a broad range of socioeconomic areas. (assess priority conditions, risk factors and progression over time; in population-based community-dwelling cohorts)

- Measures:
  - biomedical data, demographic, risk factors, physical and mental health status, health service use, data linkage
MAILES – Sleep content

- All respondents – symptoms:
  - Feeling sleepy sitting quietly
  - Snoring, gasping, choking, waking overnight
  - Sleep time/wake up time
  - Ever diagnosed OSA with sleep

- Interested in separate sleep study
  - Yes 74.2%
MAILES – Sleep content

- Random sample selected n = 1000 of those **without** history of OSA
- Symptoms
  - Epworth sleepiness scale
  - Pittsburgh sleep quality index
  - Berlin questionnaire
- In-home sleep studies
  - 8-channel study Embletta X100 (EEG, EOG, EMG, nasal pressure, thoracic and abdominal effort, oximetry, body position, limb movements)
  - Staff visited home to apply equipment
Sleep studies

- All sleep studies with technically adequate EEG, airflow, thoraco-abdominal, SaO₂ and position sensor signals were scored by a single experienced scorer according to current AASM (alternate) criteria.

- AASM Alt - hypopneas were required to have ≥ 50% airflow reduction and ≥ 3% desaturation or arousal.

- N=851 men had successful sleep studies (unsuccessful studies n=12)
Results

- Self-report prior diagnosis of OSA on a sleep study among all MAILES participants \( n = 184 \) (11.3%)

  mean age : 62.0 (sd 10.1),

  prevalence of diabetes: 24%, metabolic syndrome: 63%,

  hypertension: 61%, and abdominal obesity: 66%.
Sleep in MAILES

- Sleep study participants (i.e. with no prior diagnosis of OSA) were younger with higher incomes but otherwise did not differ from the rest of the cohort in anthropometry or socio-economic status.

- Significantly less likely to have cardiovascular disease, to be current smokers or report fair/poor general health, but otherwise did not differ from the rest of the cohort for co-morbidities.

- Were more likely to report frequent snoring (>3 nights/week) : 15% vs 21%, but not afternoon/evening sleepiness.

- Mean age was 59.6 (sd 10.8) years.
**OSA Prevalence (%)** MAILES cohort

**OSA categorisation by AHI on in-home polysomnography**
- Mild: 10-20
- Moderate: 21-30
- Severe: >30

<table>
<thead>
<tr>
<th></th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall (n=851)</strong></td>
<td>26.7</td>
<td>14.0</td>
<td>12.3</td>
</tr>
<tr>
<td>40-50 years (n=207)</td>
<td>25.1</td>
<td>8.2</td>
<td>8.2</td>
</tr>
<tr>
<td>51-64 years (n=364)</td>
<td>27.2</td>
<td>13.7</td>
<td>12.4</td>
</tr>
<tr>
<td>65+ years (n=280)</td>
<td>27.1</td>
<td>18.6</td>
<td>15.4</td>
</tr>
</tbody>
</table>

**Body mass index (kg/m²)**

<table>
<thead>
<tr>
<th>Body mass index (kg/m²)</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;25</td>
<td>26.7</td>
<td>8.0</td>
<td>5.7</td>
</tr>
<tr>
<td>25-&lt;30</td>
<td>26.4</td>
<td>12.9</td>
<td>7.9</td>
</tr>
<tr>
<td>&gt;=30</td>
<td>26.9</td>
<td>19.2</td>
<td>20.3</td>
</tr>
</tbody>
</table>

*Note – Excludes men with self-reported OSA diagnosed by sleep study*
Co-morbidities associated with OSA*

<table>
<thead>
<tr>
<th></th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &gt;65 years</td>
<td>1.8</td>
<td>1.2, 2.8</td>
</tr>
<tr>
<td>Central adiposity (WC &gt; 102 cm)</td>
<td>2.2</td>
<td>1.5, 3.1</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1.5</td>
<td>1.1, 2.1</td>
</tr>
<tr>
<td>Depression</td>
<td>2.2</td>
<td>1.4, 3.6</td>
</tr>
<tr>
<td>Financial stress §</td>
<td>1.6</td>
<td>1.1, 2.7</td>
</tr>
</tbody>
</table>

*OSA = AHI >10

§ Financial stress = “usually spend more than earn / just getting by”
<table>
<thead>
<tr>
<th></th>
<th>No OSA (n=400)</th>
<th>Mild OSA (n=227)</th>
<th>Moderate/Severe (n=224)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sleepy day/evening</strong></td>
<td>38.3</td>
<td>40.1</td>
<td>48.2</td>
</tr>
<tr>
<td>40-50 yrs</td>
<td>37.2</td>
<td>38.5</td>
<td>50.0</td>
</tr>
<tr>
<td>51-64 yrs</td>
<td>37.6</td>
<td>43.4</td>
<td>48.4</td>
</tr>
<tr>
<td>65+ yrs</td>
<td>40.4</td>
<td>36.8</td>
<td>47.4</td>
</tr>
<tr>
<td><strong>Epworth &gt;10</strong></td>
<td>11.6</td>
<td>14.0</td>
<td>14.2</td>
</tr>
<tr>
<td>40-50 yrs</td>
<td>12.5</td>
<td>15.7</td>
<td>11.8</td>
</tr>
<tr>
<td>51-64 yrs</td>
<td>12.4</td>
<td>14.4</td>
<td>18.3</td>
</tr>
<tr>
<td>65+ yrs</td>
<td>9.2</td>
<td>12.2</td>
<td>10.9</td>
</tr>
<tr>
<td><strong>Pittsburgh &gt;5</strong></td>
<td>49.6</td>
<td>42.4</td>
<td>49.5</td>
</tr>
<tr>
<td>40-50 yrs</td>
<td>53.8</td>
<td>46.0</td>
<td>54.5</td>
</tr>
<tr>
<td>51-64 yrs</td>
<td>45.1</td>
<td>41.1</td>
<td>48.9</td>
</tr>
<tr>
<td>65+ yrs</td>
<td>51.9</td>
<td>41.7</td>
<td>48.4</td>
</tr>
</tbody>
</table>
### Quality of life – SF-36*

<table>
<thead>
<tr>
<th>SF-36 scales</th>
<th>No</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical functioning</td>
<td>-0.01 (.04)</td>
<td>-0.006 (.05)</td>
<td>0.06 (0.07)</td>
<td>-0.24* (0.08)</td>
</tr>
<tr>
<td>Role physical</td>
<td>0.05 (.05)</td>
<td>0.05 (0.06)</td>
<td>-0.02 (0.08)</td>
<td>-0.24* (0.09)</td>
</tr>
<tr>
<td>Bodily pain</td>
<td>-0.09 (.05)</td>
<td>-0.19 (0.06)</td>
<td>-0.13 (0.09)</td>
<td>-0.27 (0.10)</td>
</tr>
<tr>
<td>General health</td>
<td>-0.03 (.04)</td>
<td>-0.14 (0.06)</td>
<td>-0.05 (0.08)</td>
<td>-0.32* (0.09)</td>
</tr>
<tr>
<td>Vitality</td>
<td>0.09 (.05)</td>
<td>-0.01 (0.06)</td>
<td>0.09 (0.09)</td>
<td>-0.20* (0.10)</td>
</tr>
<tr>
<td>Social functioning</td>
<td>0.20 (.05)</td>
<td>0.07 (.06)</td>
<td>0.09 (0.08)</td>
<td>-0.03 (0.09)</td>
</tr>
<tr>
<td>Role emotional</td>
<td>0.23 (0.04)</td>
<td>0.11 (0.06)</td>
<td>0.15 (0.08)</td>
<td>0.004 (0.09)</td>
</tr>
<tr>
<td>Mental health</td>
<td>0.14 (0.05)</td>
<td>0.06 (0.06)</td>
<td>0.14 (0.08)</td>
<td>-0.09 (0.10)</td>
</tr>
<tr>
<td>PCS</td>
<td>50.5 (0.5)</td>
<td>49.5 (0.6)</td>
<td>49.9 (0.8)</td>
<td>46.9* (0.9)</td>
</tr>
<tr>
<td>MCS</td>
<td>51.5 (0.5)</td>
<td>50.1 (0.6)</td>
<td>50.7 (0.9)</td>
<td>48.1* (1.0)</td>
</tr>
</tbody>
</table>

*Mean scores, adjusted for age and obesity
Sleep – Discussion

- OSA is highly prevalent in men aged over 40 years, with most being undiagnosed.
- Men with undiagnosed OSA have concurrent cardiac risks similar to those expected in OSA.
- Depressive symptoms are common in undiagnosed OSA.
- The burden of undiagnosed OSA is substantial and demands innovative methods to extend screening and diagnosis in the community.
- The effect of OSA on HRQL is mostly seen in men who report sleepiness or decreased sleep quality, with moderate to large effect sizes reported that are comparable to other major chronic conditions.
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