



# Respiratory Consequences of Obesity

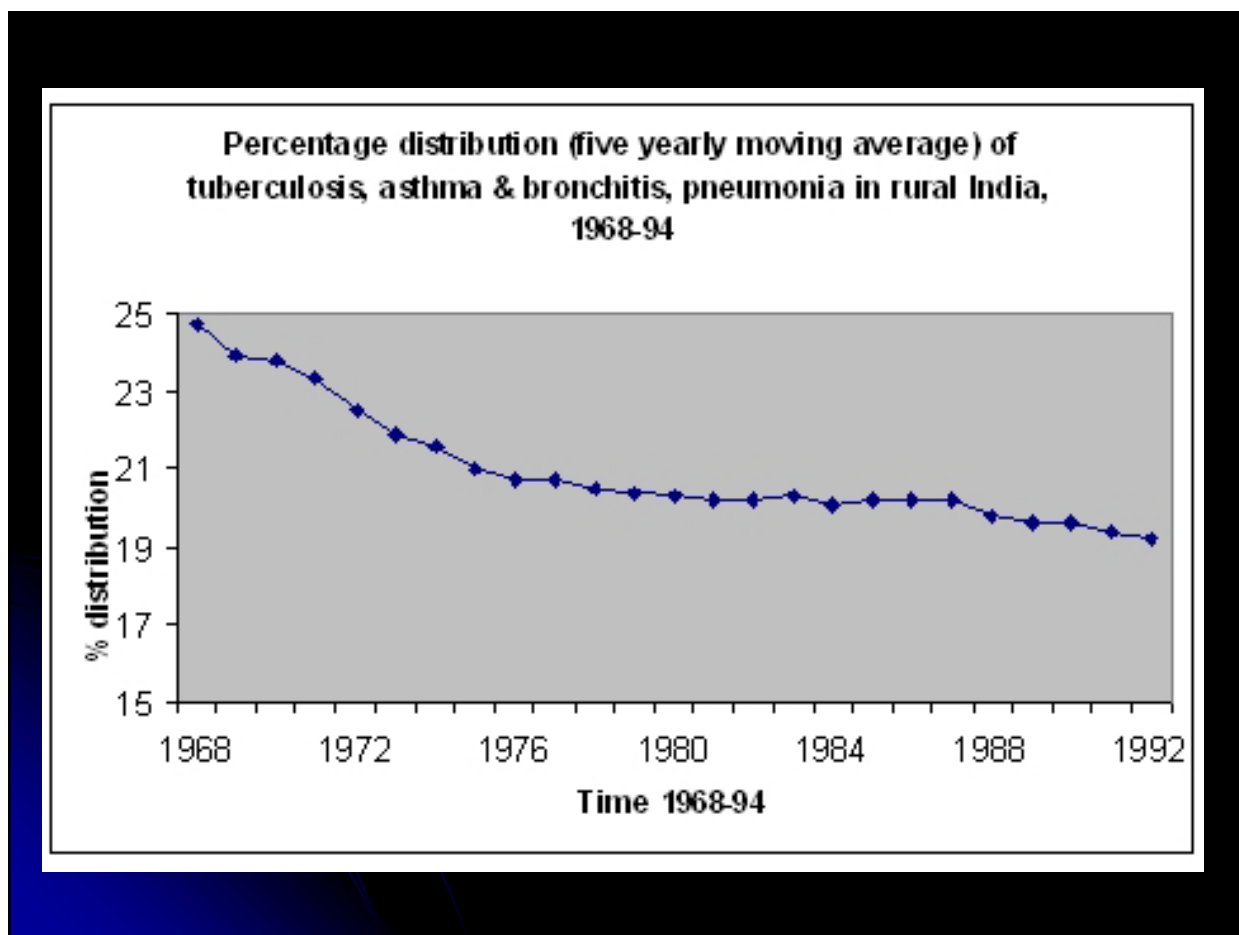
The Medical Update Group  
Burrenchobay Hall  
University of Mauritius

07.04.2010

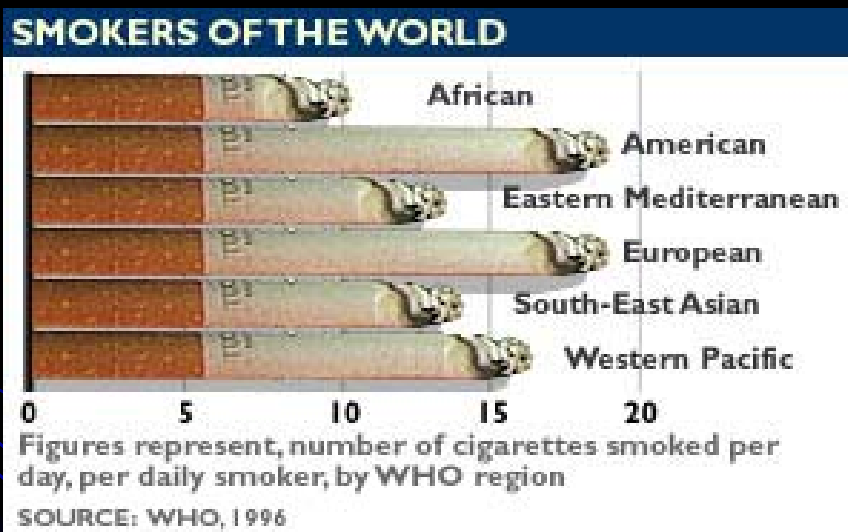
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## Respiratory Consequences of Obesity

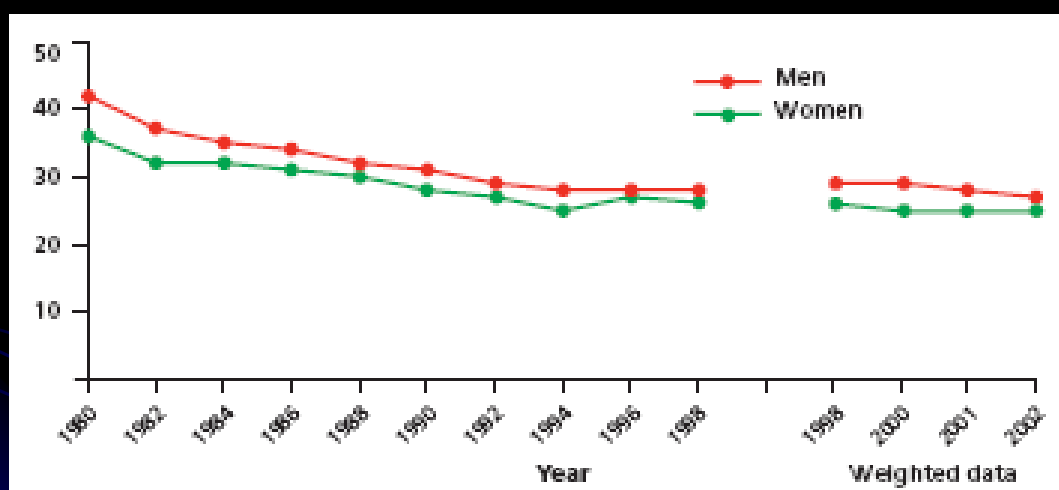
- 20<sup>th</sup> Century First Half –Respiratory infections/ Tuberculosis
- 20<sup>th</sup> century second half –smoking related respiratory diseases –COPD, Lung Cancer
- 21<sup>ST</sup> Century Respiratory consequences of obesity



# Prevalence of Smoking in World

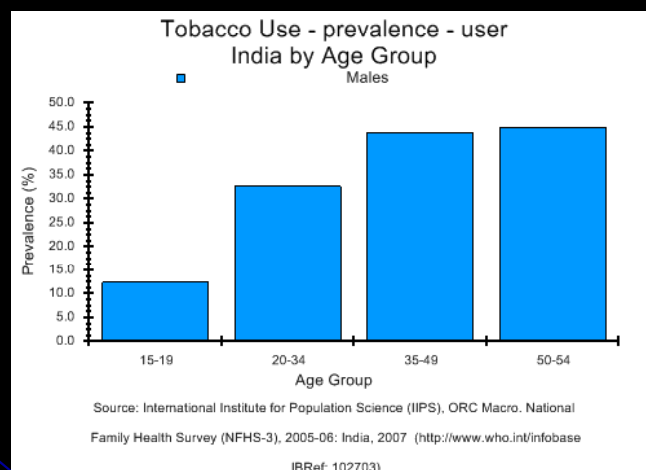


## Prevalence of Smoking in England



Prevalence of smoking is declining in England

# Prevalence of Smoking in India



17% of Smokers in the World are in India  
30% of men smoke in India

## Obesity (Globicity)

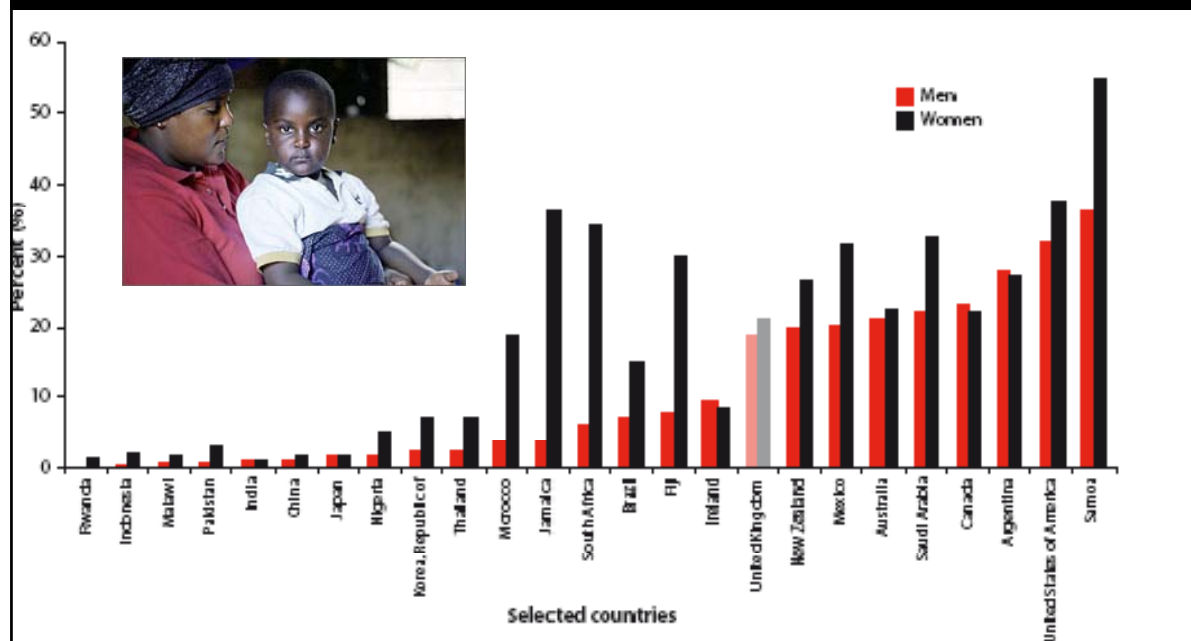
- World -400 Million (WHO 2006)
- Developed world -7% of Disease burden (WHO 2002)
  - Stroke, CHD –33%
  - Hypertension –60%
  - Western Europe –63% of Heart attacks

# Prevalence of obesity in the UK

- Obesity rates (BMI of more than 30 kg/m<sup>2</sup>)
  - England 23% and 24%
  - Scotland 22% and 26%
  - Wales 17% and 18%
- Deaths 30,000/year
- Cost NHS 70 billion



## Prevalence of Obesity in the World



Prevalence of obesity is very high in Western World but also rising in other parts of the world

## Prevalence of Obesity in Mauritius (WHO)

### Males

Age	Sample Size (n)	Prevalence (%)
25-74	1,555	34.7

### Females

Age	Sample Size (n)	Prevalence (%)
25-74	1,794	45.6

## Obesity-BMI

- Weight in Kilo per square meter of height
  - (Weight) kg/ (Height m)<sup>2</sup>
  - (75) kg/ (1.75m)<sup>2</sup> = 25
- BMI (WHO)
  - 20-25-Normal
  - 25-30 Overweight
  - 30-40 Obese
  - >40 Morbidly obese

# Obesity –Body Fat Measurement

Body fat >30% men, 25% in women

- Sophisticated Tests
  - CT scan
  - MRI scan
  - Dual energy X-ray absorptiometry (DXA)
- Simple Test
  - Skin fold test
  - Bioelectric impedance analysis

# Obesity -Fat distribution

- Anatomical site

- Neck
- Chest
- Abdomen

- Anatomical planes

- Subcutaneous
- Visceral

Time: 012 ms  
Slice: 540.182 mm  
Pos: 40  
FFS



# Obesity -Fat distribution

## Visceral Abdominal Obesity (Central Obesity/ Male-type or apple type)

- Metabolic syndrome  
(Insulin resistance)
- Cardiovascular Risk

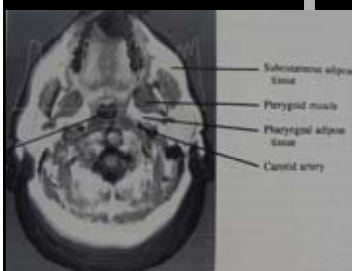


Waist (>102 cm in men and >88 cm in women) or  
Waist/hip (>0.9 for men and >0.85 for women)

# Respiratory Consequences of Neck Obesity

## Upper Airway Narrowing

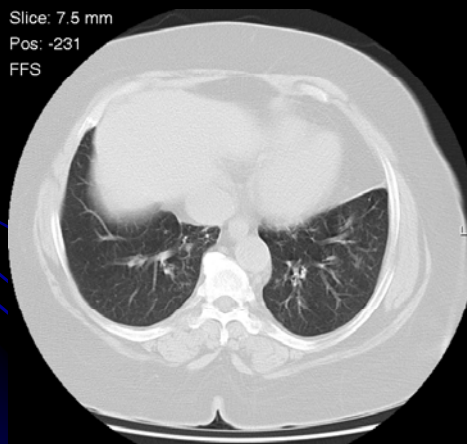
### *Imaging-MRI*



- Reduction in upper airway size, shape and volume
- Floppy

# Respiratory Consequences of Thoracic Obesity

## Physiological effects



**Subcutaneous Fat**  
Thoracic Compliance (Stiff)  
ERV  
FRC  
VC

**Muscle Fat**  
Weak+ increase in load



# Respiratory Consequences of Abdominal Obesity

## Physiological Effects

Slice: 7.5 mm  
Pos: -336  
FFS



### Visceral Fat

Diaphragm  
FRC=closing volume  
Closure of small airway  
Basal atelectasis  
V/Q mismatch  
Hypoxia

### Subcutaneous Fat

# Respiratory Consequences of Thoracic and Abdominal Obesity

## Pulmonary Physiology

### Summary

- Reduction in FRC
- V/Q mismatch at bases
- Reduced respiratory muscle strength and endurance
- Increase work of breathing

## **Reduced Pulmonary Reserve**

# Respiratory Consequences of Thoracic and Abdominal Obesity

## At Rest

### Clinical Features

- Symptoms
  - Nil
- Examination
  - Tachypnoea
  - Reduced chest wall expansion
  - Dullness on Percussion at lung base
  - Reduced breath sounds at lung base
- CXR
  - Raised diaphragm, small and grey l



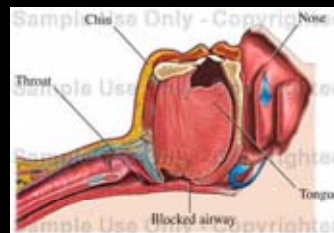
# Respiratory Consequences of Obesity - Exercise

## High cost of breathing

- **Breathlessness on exertion**
  - Obese vs. non-obese 80% vs. 16% Proportion to BMI
  - Disproportionately high if associated COPD and asthma
- **Unexplained breathlessness on exertion**
  - No associated respiratory symptoms
  - Normal cardio-respiratory examination
  - Mild extra-pulmonary restriction.

# Respiratory Consequences of Neck, Thoracic and Abdominal Obesity Supine

- Upper airways
  - upper airway size
- Lower airways
  - FRC
  - V/Q mismatch
  - SaO<sub>2</sub> (Hypoxia)



↓

↓

↑

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# Respiratory Consequences of Neck, Thoracic and Abdominal Obesity Supine

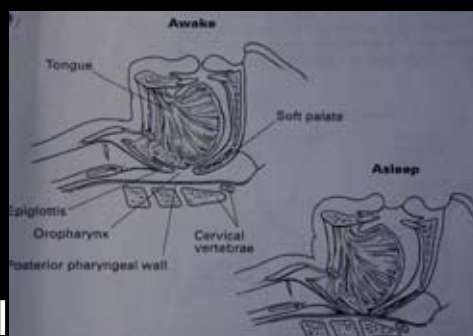
## Clinical Consequences

- **Anaesthesia**
  - Induction –Hypoxia (Reduced Pulmonary reserve)  
–Pre-oxygenation
  - Intubation Difficult/ Failure of Intubation (Narrow Upper airway)
  - Extubation /Post-operative period – Upper airway obstruction – apnoeas
- **Prolonged bed rest (fracture, illness)**
  - Basal atelectalsis (FRC), Respiratory infections, Respiratory failure

# Respiratory Consequences of Obesity: Supine +Sleep

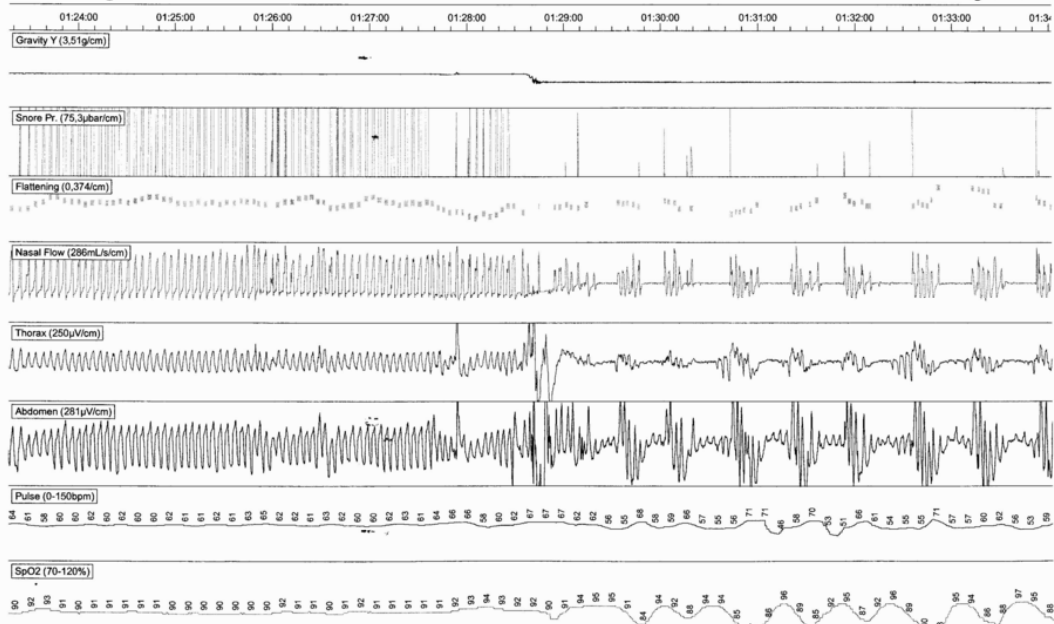
## Sleep (Stage related)

- Upper airway
- Respiratory drive ↓
  - Apnoea
    - longer duration,
    - deeper desaturation
- Respiratory rate and tidal volume ↓
  - Nocturnal hypercapnia



Somnologica

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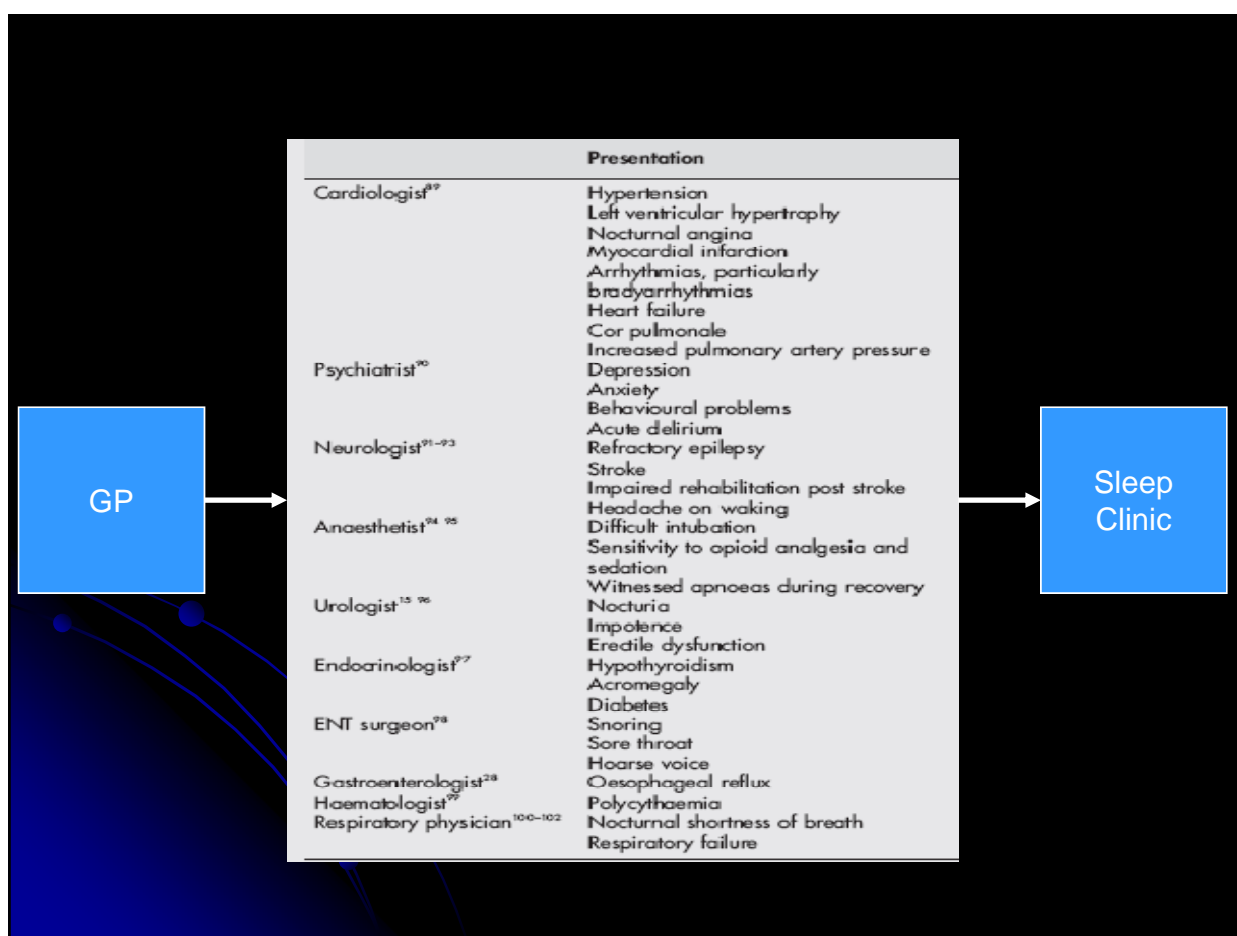
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# Obstructive Sleep Apnoea

- Common – 1-9%
- Health Consequences
  - Cardiovascular/ Cerebrovascular
  - Neuropsychological
  - Mortality
- Social consequences
  - Snoring
  - Excessive daytime sleepiness
  - Road Traffic Accidents
- Under-diagnosed & Under-treated



# Management of Respiratory Consequences of Obesity

## **Obstructive Sleep Apnoea**

- Continuous Positive Airway Pressure(CPAP)
- Mandibular advancement splint (MAS)
- Tracheostomy
- Mandibular-Maxillary Advancement
- Uvulo-palato-pharyngoplasty

## Obstructive Sleep Apnoea Management: CPAP



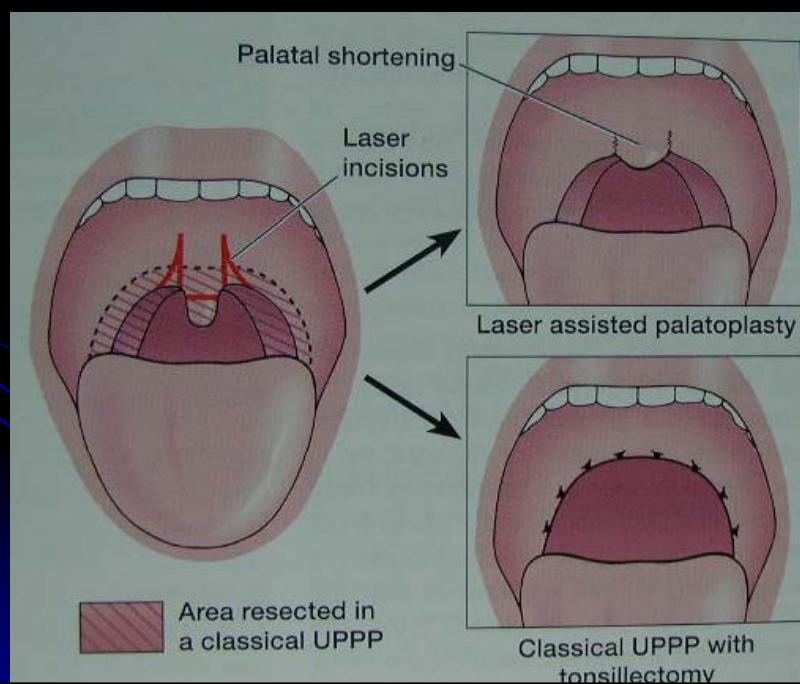
Spontaneous breathing

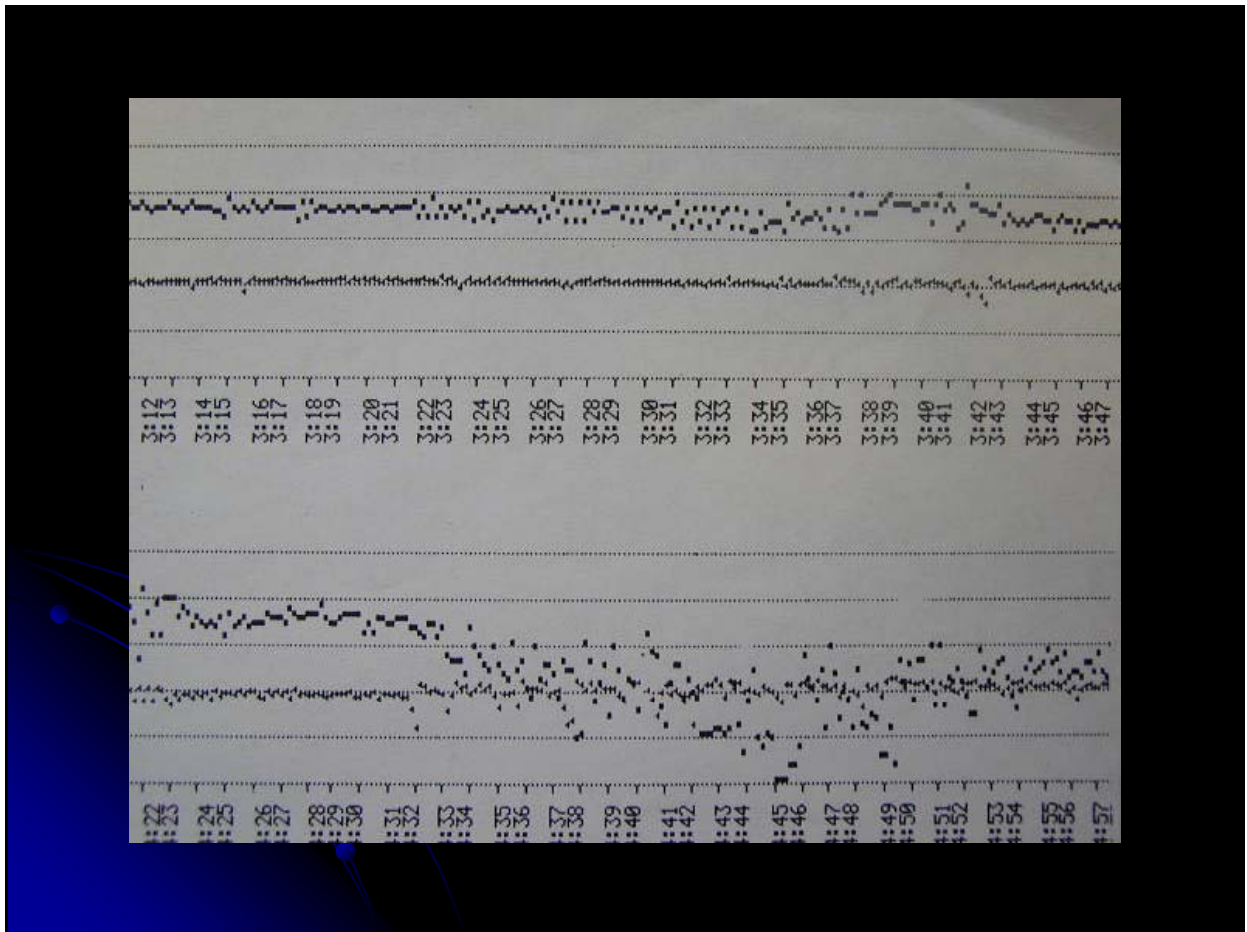


C.P.A.P



## Management of Respiratory Consequences of Obesity Obstructive Sleep Apnoea: UPPP





# Obesity Hypoventilation

## Visilab Case DB-17.4.44

- Pulmonary Function Test

	Predicted	Actual
FEV1	3.77	1.32(35%)
FVC	4.70	2.08(44%)
TLC	7.30	4.61 (63%)
FRC	3.58	2.64(73%)

ABG- pCO<sub>2</sub> 9.2, PO<sub>2</sub> 7.4, Ph 7.38, SaO<sub>2</sub> 87%, BE -11

# Obesity Hypoventilation Syndrome Pickwickian syndrome

## Presentation

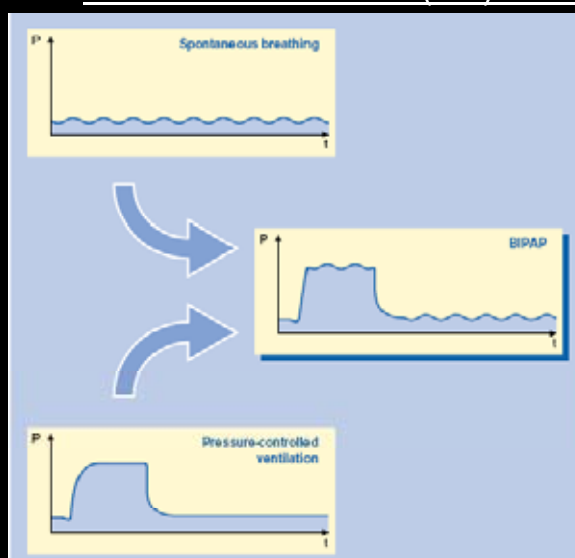
- Non-specific symptoms
  - Fatigue, Hypersomnolence, Impaired Neuropsychological function, Headaches
- Acute Hypercapnic Respiratory Failure-  
A&E
  - Drowsy, confusion, comatose
- Chronic Respiratory Failure
  - Peripheral oedema, Pulmonary Hypertension  
Cor Pulmonale, CCF



# Obesity Hypoventilation Syndrome Management -BiPAP



## Non-invasive Ventilation (NIV) BiPAP



# Obesity Hypoventilation Syndrome

## Treatment

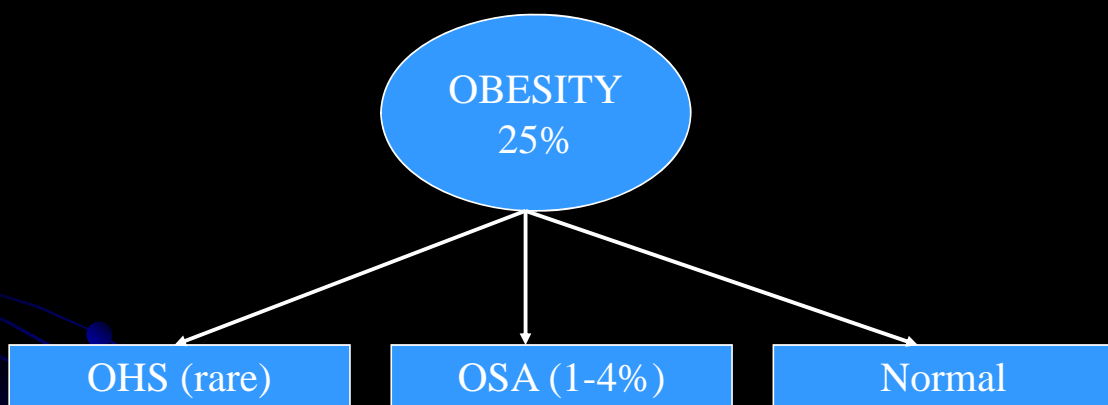
Standard Treatment BiPAP

### Randomised Trial BiPAP vs CPAP

(Piper AJ. Thorax 2008;63 May)

- Rationale CPAP simpler, cheaper, and easier to use than BiPAP
- 36 OHS - SaO<sub>2</sub> > 80%, CO<sub>2</sub> retention (< 10 mm Hg)
- Randomised – either CPAP (18) or BiPAP (18) for three months
- Both equally effective in improving daytime hypercapnia

# Obesity Hypoventilation Syndrome Pickwickian syndrome-Mechanism



# Obesity Hypoventilation Syndrome Pickwickian syndrome-Mechanism

**Co-factors**

Fat Distribution Neck Size  
Mandible size and shape  
Oestrogen/Testosterone

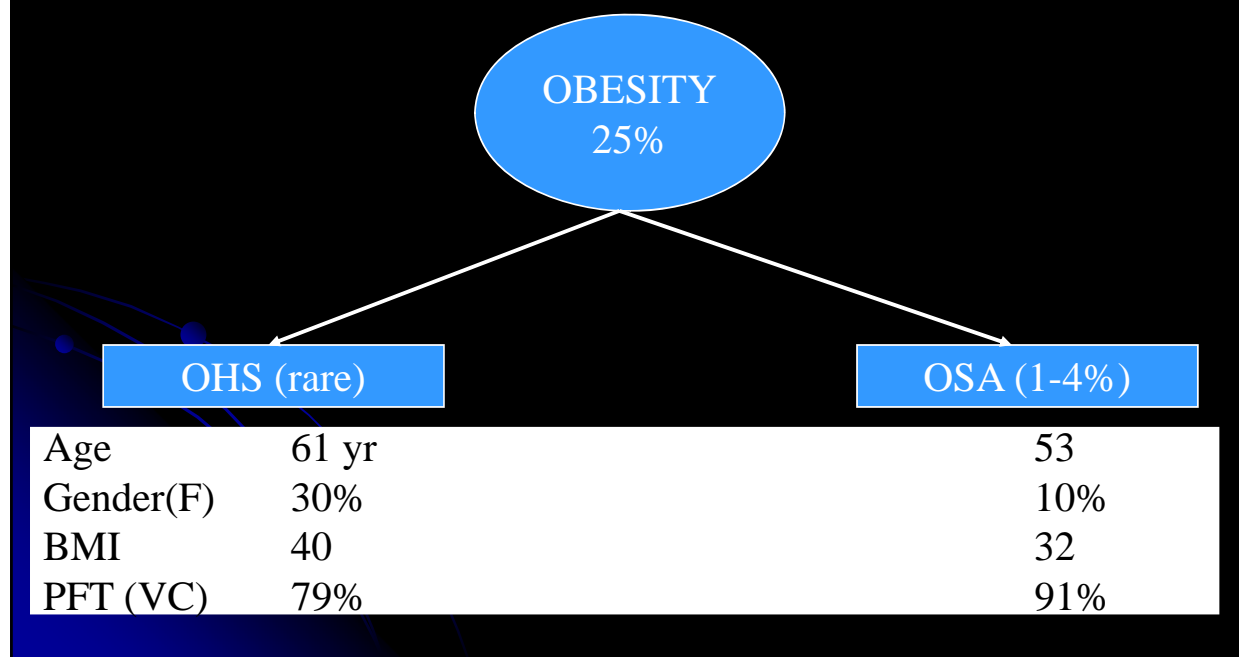
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OBESITY  
25%

OSA (1-4%)

Normal

## Obesity Hypoventilation Syndrome Pickwickian syndrome-Mechanism

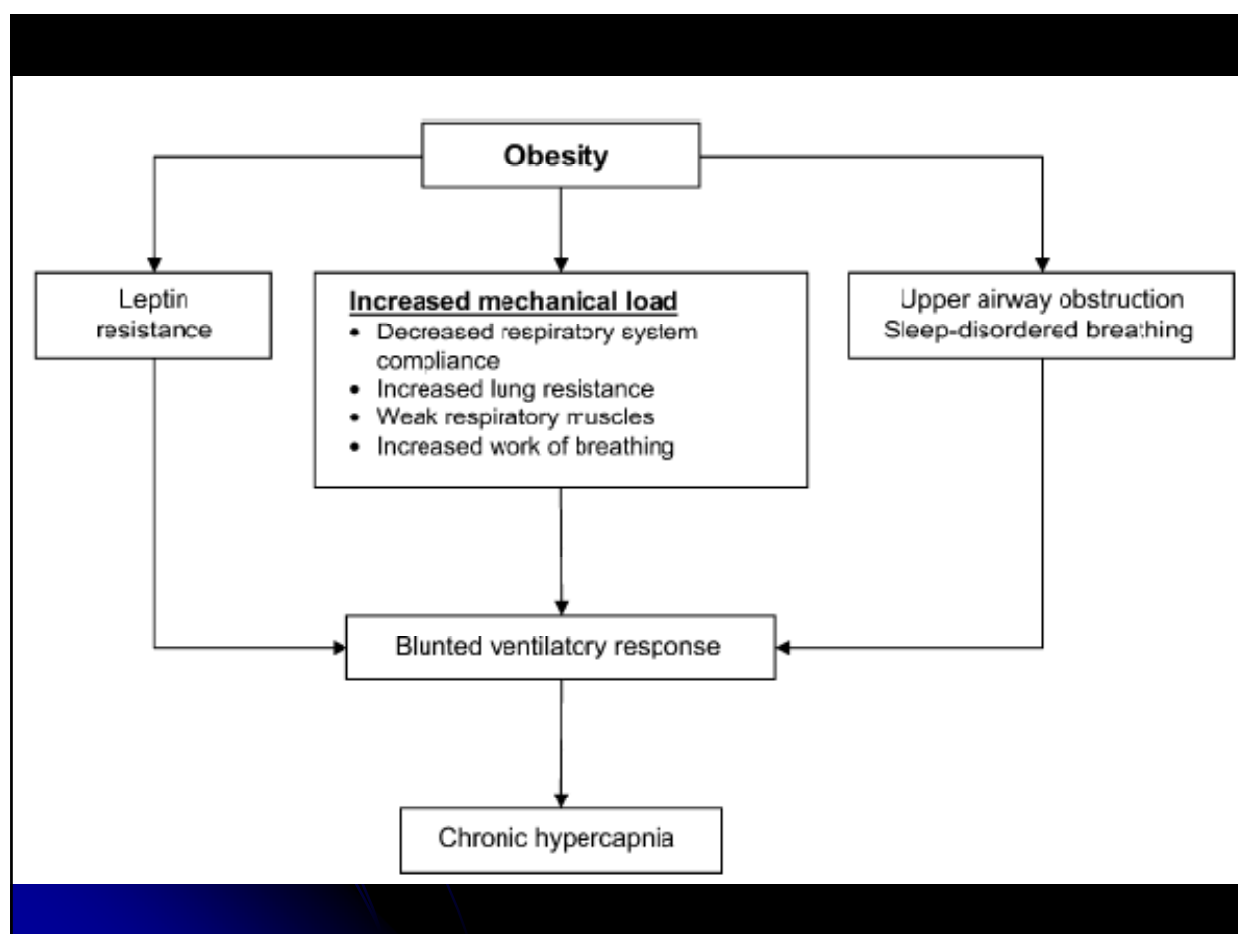


# Obesity Hypoventilation Syndrome Pickwickian syndrome Mechanism

## Central Control of Respiratory Drive

(Hypoxic and hypercapnic ventilatory response)

- Prader Willi Syndrome
  - Most common genetic abnormality –Obesity
  - Obese PWS vs obese control
    - Hypercapnic response blunted
    - Hypoxic ventilatory response –absent
- Genetically Obese mice (ob/ob)
  - Hypoventilation related to low levels of leptin
  - Correction of Leptin
    - restoration of ventilatory response to hypercapnia independent of change in BW



## Management of Respiratory Consequences of Obesity

### **Weight Reduction**

- Diet
- Exercise
- Pharmacological (Orlistat, Rimonabant)
- Surgical
- Psychological: Behaviour Modification



# Outcome of Bariatric Surgery

Meta analysis-*JAMA*. 2004;292:1724-1737.

- 136 Studies, 22,000 patients Age 39 yr, M:F 1:3
- Outcomes
  - Weight loss
  - Operative mortality
  - Obesity co-morbidities
    - diabetes,hyperlipidemia, hypertension, obstructive sleep apnea
- Outcomes
  - Weight loss 50-70%
  - Operative mortality 0.1-1%
  - 4 Obesity co-morbidities
 

● Diabetes	resolved	77%
● Hyperlipidemia	improved	70%
● hypertension	resolved	62%
● OSA	resolved	87%

## Respiratory Consequences of Obesity and their management - Summary

- Reduced Pulmonary Reserve- Increase risk of respiratory complication
- Obstructive Sleep Apnoea –CPAP
- Obesity-Hypoventilation Syndrome –Acute and Chronic Hypercapnic Respiratory Failure- NIV/BiPAP