Review of Literature
2: REVIEW OF LITERATURE

2.1: HISTORY OF RESPIRATORY PHYSIOLOGY

In the ancient Egyptian civilization from 310 BC to 332 BC the overall purpose of the respiration is described as to the air that penetrates into the nose. It enters into heart and the lungs and supplies the air to the body. In 570 BC ancient Greek philosopher Anaximenes clearly states that ‘pneuma” or air is the essential for the life (27).

Erasistratus (304–250BC), more widely renowned as the father of philosophy, was the first to apply scientific principles to explain breathing. His view was that air was taken into the lungs and passed to the heart along the pulmonary artery. In the heart, air was converted into a ‘vital spirit’ that was distributed to all parts of the body by the arteries. Roman Medicine and Galen (129–199AD), Galen was the first physician to apply the Hippocratic method of scientific thinking to physiology, and he ingeniously combined the knowledge of his predecessors (27).

In Galen’s descriptions, food was processed in the gut before being used by the liver to produce blood, which passed to the right heart. Much of this blood flowed into the pulmonary artery to nourish the lung, whilst the remainder passed across invisible pores in the inter-ventricular septum, to be combined with ‘pneuma’ brought from the lung via the pulmonary vein. In the left heart, the pneuma instilled the blood with vital spirit that was circulated to the body and brain as described by Erasistratus (27).

The primary function of the respiratory system is the continuous absorption of O\textsubscript{2} and the excretion of CO\textsubscript{2}. This exchange between the gas of the atmosphere and blood is termed external respiration. This process supports internal respiration, which is the exchange of gases between blood and tissue (27).
Air passes from the mouth or nose to the Larynx to the Trachea, then the Right and Left Bronchi to Bronchioles to the Terminal Bronchioles to the Respiratory Bronchioles to the Alveoli \(^{(27)}\).

Figure 1: Anatomy of trachea, carina and bronchus.
Figure 2: Different cells at alveoli and in capillary.

Figure 3: Conducting zone and respiratory zone
The region of the lungs where gas exchange with the blood occurs only in the respiratory bronchioles and alveoli is known as the respiratory zone. The Trachea (windpipe), Bronchi, and Bronchioles that deliver air to the respiratory zone comprising all other structures which makes up the conducting zone: Warms and humidifies inspired air. Mucus lining filters and cleans inspired air, Mucus moved by cilia will be expectorated or to remove dust and other particles out of the lungs\(^{(27)}\).

Gas Exchange occurs across the 300 million alveoli (60-80 m\(^2\) total surface area) Only 2 thin cells are between lung air and blood: one is alveolar and other is endothelial cell.

Type I alveolar cells- creates the air sac
Type II alveolar cells- secrete surfactant and absorb sodium and water\(^{(27)}\).

The various organs that supports gas exchange and comprise the respiratory system includes the upper airways, chest wall, respiratory muscles, lower airways, pulmonary blood vessels, and support nerves and lymphatic’s.

From the moment of conception the human body, including the respiratory system, undergoes tremendous growth and development, from embryo to fetus to infant and toddler, through puberty, and into young adulthood\(^{(28)}\).

The understanding of the normal anatomy and physiology of the respiratory system is crucial to the proper understanding of pulmonary disease and its treatment. Any respiratory care practitioner like nursing staff, chest physician, pulmonologist and respiratory physiotherapist requires a well-developed understanding of the structural and functional nature of the respiratory system\(^{(28)}\).
2.2: SURFACE FEATURES OF THE THORAX

Thoracic shape and dimension vary somewhat from individual to individual and are linked to age, gender, and race. Thoracic volume is greater in males than females. A series of imaginary lines are commonly used to establish reference points and identify landmarks on the thorax. These lines and points help identify the location of underlying structures and the location of abnormal findings. On the anterior chest, the midsternal line divides the thorax into equal halves. The left and right midclavicular lines are parallel to the midsternal lines. These are drawn through the midpoints of the left and right clavicles, respectively. The midaxillary line divides the lateral chest into equal halves. The anterior axillary line is parallel to the mid axillary line. It is situated along the anterolateral chest. The posterior axillary line is also parallel to the mid axillary line. It is located on the posterolateral chest wall. Three imaginary vertical lines are located on the posterior thorax (28).

Figure 4: Anterior axillary line, midclavicular line and mid sterna line
Figure 5: Anterior, mid and posterior axillary line

Figure 6: Anterior, mid and posterior axillary line
Figure 7: Anterior side of the lungs

Figure 8: Anterior side of the lungs land marks
Figure 9: Posterior side of the lungs

Figure 10: Posterior side of the lungs and its landmarks
Figure 11: Lateral side of the lungs

Figure 12: Lateral side of the lungs and its surface marks.
2.3: COMPONENTS OF THE THORACIC WALL

The thoracic cavity is formed by the tissue of the chest, upper back and the diaphragm. The thorax is covered by muscles of the pectoral region of the upper limb. In addition to these intercostals muscles and the other tissues like nerves, membrane fills the gap between the ribs and cartilage. The inner layer of the thoracic wall is lined with a serous membrane called the parietal pleura. It is apposed by another serous membrane called the visceral pleura, which covers the lung (29).

Twelve pairs of the ribs form rib cage. Rib pairs 1 through 7 are known as the true ribs attached to sternum. Ribs 8 through 12 are called false ribs because they are either indirectly attached to the sternum or not attached at all. Rib pairs 11 and 12 are called floating ribs because they are not attached to the sternum (30).

Figure 13: Thorax
2.3.1: RIB MOVEMENT

The various ribs move in different ways, and some may move more than others at different times. The movement increases the anteroposterior thoracic diameter is known as “pump handle” movement. The movement which increases the transverse diameter of the thoracic wall is known as “bucket handle” movement (31) (29).

2.3.2: RESPIRATORY MUSCLES

Changes in thoracic cavity dimension during breathing are produced by various skeletal muscle which collectively known as respiratory muscles. Their origin, insertion, nerve supply and action are shown in the picture below. The diaphragm and intercostals muscles are the primary muscles of ventilation. The accessory muscles of ventilation assist the diaphragm and intercostals when the ventilatory demand increases. The scalene, sternocleidomastoid, pectoral, and abdominal wall muscles are the chief accessory muscles.

Figure 14: Respiratory muscles and its attachments and function
The diaphragm is the chief inspiratory muscle for the inspiration which is thin musculotendinous dome shaped structure that separates the thoracic and abdominal cavity. It originates from the chest and the abdominal wall and converges in a central tendon at the top of its dome. The posterior portion arises from the first three lumbar vertebrae. The lateral costal portions arise from the inner surface of ribs 7 through 12 and transverse abdominal muscles on each side \(^{(32)}\).

<table>
<thead>
<tr>
<th>Sequence of events</th>
<th>Changes in anterior-posterior and superior-inferior dimensions</th>
<th>Changes in lateral dimensions (superior view)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Inspiratory muscles relax (diaphragm rises; rib cage descends due to recoil of costal cartilages).</td>
<td>Ribs and sternum are depressed as external intercostals relax.</td>
<td>External intercostals relax.</td>
</tr>
<tr>
<td>2 Thoracic cavity volume decreases.</td>
<td></td>
<td></td>
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<tr>
<td>3 Elastic lungs recoil passively; intrapulmonary volume decreases.</td>
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<tr>
<td>4 Intrapulmonary pressure rises (to +1 mm Hg).</td>
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<tr>
<td>5 Air (gases) flows out of lungs down its pressure gradient until intrapulmonary pressure is 0.</td>
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*Figure 15: Diaphragm its attachment and function*
During quiet breathing, the diaphragm does the majority of the work. Other muscles are slightly active during quiet breathing and become more active with forceful breathing \(^{(32)}\).

2.4: LUNGS

The lungs are multilobes, cone shaped, and sponge like organs that lie within the pleural cavity. At birth they are pink as the age advances they develop a gray color. The average adult lungs are able to occupy a volume of approximately 3.5 L and weigh approximately 900 Gm.

Each lung is divided into two or three lobes, which are separated by one or more fissures. The right lung has upper, middle and lower lobes. The left lung has only an upper and a lower lobe. Both lungs have an oblique fissure that begins on the anterior chest at approximately the sixth rib at the midclavicular line. These fissures extend laterally and
upward until they cross the fifth rib on the lateral chest in the midaxillary line. The fissures continue on the posterior chest to approximately the third thoracic vertebra. The right lung also has a horizontal or “minor” fissure that separates the upper and middle lobes. This horizontal fissure extends from the fourth rib at the sterna border around to the fifth rib at the midaxillary line.\(^\text{33}\).
The lungs are elastic organs that can expand and recoil when inflated with air. This elasticity results from surface tension forces in the alveoli and from the elastic properties of the tissues and various connective tissue fibers. The presence of elastin fibers in the alveolar walls, around the small airways, and in pulmonary capillaries produces elastic recoil. Collagen and reticulin fibers, located in the visceral pleurae and airway walls, combine to create a basket-like helical network of connective tissue fibers around the alveoli and airway walls that extends to the hilum. Collectively, these connective tissues fibers function to provide support to the airway walls (28).

2.5: PULMONARY VASCULAR SYSTEM

The pulmonary circulation has several different functions. Its primary function is to deliver blood to the alveolar capillary bed for the exchange of O$_2$ and CO$_2$ with alveolar gas and then to deliver it to the left heart (34).