Introduction

The world's population is not only growing larger, it is also becoming older. The proportion of older persons is increasing at a faster rate than any other age segment. In developed countries, the proportion of older people already exceeds that of children. In developing countries, the proportion of older people is increasing rapidly due to the faster pace of fertility decline that has resulted from the success of reproductive health and family planning programs ***(UNFPA, 2012).***

In 2010, an estimated 524 million people aged 65 or older represented 8 percent of the world's population. By 2050, this number is expected to nearly triple to about 1.5 billion, representing 16 percent of the world's population ***(Crimmins et al., 2010).***

Aging is a process of gradual change over time that is most noticeable in older people .Most physical changes associated with normal aging have little effect on a person's quality of life. Changes resulting from disease and lifestyle choices are not considered part of normal aging. Physiological changes occur with aging in all organ systems. The cardiac output decreases, blood pressure increases and arteriosclerosis develops, the lungs show impaired gas exchange, the creatinine clearance decreases, ,drug metabolism, elevation of blood glucose, skin atrophy, lean body mass declines, altered motility patterns, occur in the gastrointestinal system. These changes with age have important practical implications for the clinical management of elderly patient's changes ***(Gerry et al., 1981)***

Anatomical and physiologic evidence for pulmonary problems are most prevalent in elderly. The lungs begin to age in utero. True aging must be distinguished from chronic environmental damage. The clinical consequence of these age-related changes in the lung is disease risk in the elderly. Age-dependent pulmonary changes combine with non-pulmonary age prevalent changes to cause additional problems ***(Connolly, 2008).***

Chronic obstructive pulmonary disease (COPD) is a highly prevalent disease that has a large impact on quality of life for patients and their families and kills millions of people worldwide ***(Global Initiative for Chronic Obstructive Lung Disease, 2006).***

COPD is a major global health problem that increasingly constitutes a burden for the society and has large effects on health-care expenditure. Its socioeconomic burden is also expected to increase ***(European Respiratory Society, 2003).***

Patients with stable COPD show a reduction of their health related quality of life (HRQoL), even in mild stages of the disease. The factors determining the HRQoL include sex, forced expiratory volume in 1 second (FEV1), use of oxygen therapy, and number of visits to emergency rooms and hospital admissions ***(Pilar et al., 2006).***

Elderly people are especially prone to the adverse health effects of chronic obstructive pulmonary disease (COPD), which is a common disorder in that population. Although the prevalence and morbidity of COPD in the elderly are high, it is often undiagnosed ***(Medbo and Melbye, 2007).***

In its early stages COPD is sometimes missed, as COPD patients learn to limit their physical activities to escape the gradually emerging dyspnoea on exertion. So they may be asymptomatic in the early stages of the disease. Early diagnosis of the disease, elimination of the etiologic factors, and effective symptomatic treatment are important for improving the quality of life in COPD patients. One study found undiagnosed airflow obstruction to be more common than physician diagnosed COPD and asthma combined ***(Meral et al., 2012).***

Spirometry facilitates the measurement of airflow and lung volumes. It allows for volume assessment measured at the mouth and, together with lung volume measurement, gives a comprehensive evaluation of all lung compartments. It is an uncomplicated investigation and the equipment required is affordable and usually available in a chest unit and in many community-based primary and secondary care clinics. However, it is a volitional test of flow and volumes, and thus is directly dependent on the motivation of the patient and the experience of the staff ***(Shiner and Steier, 2013).***

Another technique, FOT (Forced Oscillation Technique) determines the relation between external forces in a respiratory disease and air flow conduction. FOT does not need forced expiratory maneuvers, or mouthpiece. It requires minimum patient cooperation ***(Al-Mutairi et al., 2007)***.

FOT underwent some modifications and was computerized to assess breathing impedance, total airway resistance (Rrs) and reactance (elastic properties of the lung) (Xrs) in specific oscillation frequencies during a measurement lasting several seconds and normal forced breathing. This technique is known as Impulse Oscillation System (IOS) ***(Pauwels et al., 2001)***.

IOS parameters correlated better with clinical symptoms and asthma control than spirometry indices ***(Takeda et al., 2010).***

Impulse oscillometry is a noninvasive, safe and validated technique that provides valid indices to explore lung function. IOS may play a complementary role in the diagnosis of airway obstruction and bronchodilatation in asthmatic ***(Ozdogan et al., 2014)***.

Computer-aided IOS enables clinicians to detect subtle changes in a patients airway function earlier than when using conventional and more expensive techniques and it is convenient for elderly patients with a low dependency on cooperation during tidal breathing ***(Mansur et al., 2008).***

Spirometry is a standard, objective lung function test for diagnosis of airflow limitation in chronic obstructive pulmonary disease (COPD) in accordance with the Global Initiative of Obstructive Lung Disease classification ***(GOLD, 2013)*** but it is highly dependent on the performance technique, as the maximal inspiration and forced expiratory maneuver require the patient's active cooperation ***(Kubota et al., 2009).***

Thoughasdd ,not widely used , IOS that can especially be recommended to elderly patients with physical and mental limitations or with poor pulmonary function, who may have difficulty in caring out the spirometry properly ***(Janssens et al. 2001).***

Aim of the Work

The aim of this study is to determine the role of Impulse Oscillometry in assessment of pulmonary function among elderly.

Respiratory System in Elderly

Aging of population is taking place in nearly all world countries. Decreasing mortality, and declining fertility lead to a relative reduction in the proportion of children and to an increase in the share of people in the main working ages and of older persons in the population ***(Chawla & Amonthep, 2008).***

Aging refers to the accumulation of physiological changes over time that result in increased risk of disease and death, however aging itself is not considered a disease ***(Fortney, 2004).***

Ageing process is associated with progressive constriction of the homeostatic reserve of every organ. The most important physiological changes associated with ageing are of respiratory system depicting the decrease in static elastic recoil of the lung, in respiratory muscle performance, and in compliance of the chest wall and respiratory system, resulting in increased work of breathing ***(Janssens, 2005).***

Lung Aging:

Primary aging refers to age-related changes that are intrinsic, progressive, and universal, i.e. these changes are built into the hard-wiring of the organism, but can occur at different rates in different individuals, and include changes such as wrinkling of skin, graying of hair, decrease in muscle strength and bone mass.

Secondary, i.e. impaired aging refers to age-related changes that are due to disease these do not occur in all individuals ***(Krauss and Whitbourne, 2005).***

Across the adult life span, there are reductions in the lung physiological capacity, including:

- Ventilatory control
- Respiratory muscle strength
- Respiratory mechanics
- Gas Exchange

1. Ventilatory Control:

Studies on minute ventilation VE has shown that healthy men aged 64-73 years had a ≥41% reduction in the response to hypoxemia and hypercapnia relative to those aged 22-30 years ***(Kronenberg et al., 1973)***.

Several studies involving healthy older persons have evaluated age-related changes in ventilatory control, as measured by the P100 and minute ventilation (VE) responses to hypoxemia and hypercapnia. The P100 is the inspiratory pressure that is generated at the mouth 100 ms (millisecond) after airway occlusion and is a validated index of central respiratory drive ***(Milic-Emili et al., 1975)***.

Based on the P100, prior studies has shown that healthy persons aged 65–79 years had a ≥50% reduction in the response to hypoxemia and hypercapnia relative to those aged 22–29 years ***(Peterson et al., 1981)***.

In another study that included men and women, healthy persons aged 65–76 years had a nearly one-third reduction in the VE response to hypercapnia relative to those aged 21-37 years ***(Brischetto et al., 1984)***.

Other studies have failed to confirm age-related differences in ventilatory control or shown instead that the age-related reduction in ventilatory control is due to a decrease in peripheral CO_2 sensitivity ***(Poulin et al., 1993).***

Cuttitta and his colleagues comparing older persons aged 60–80 years with those aged 20–46 years have shown an age-related reduction in the awareness of methacholine-provoked bronchoconstriction characterized by older persons having less severe respiratory symptoms, despite having greater reductions in lung function (FEV_1) ***(Cuttitta et al., 2001).***

2. Respiratory muscles:

Several studies have shown that advancing age is independently associated with a reduction in both the maximal inspiratory pressure, a measure of inspiratory muscle strength, and the maximal expiratory pressure ***(Sachs et al., 2009).***

The age-related reductions in maximal inspiratory pressure and maximal expiratory pressure are likely a consequence of impaired respiratory mechanics and sarcopenia ***(Janssens 2005).***

Sarcopenia refers to the loss of muscle mass and function, potentially due to the reduced muscle protein synthesis, increased muscle proteolysis, motor neuron loss, and/or increased muscle fat content ***(Cruz-Jentoft et al., 2010).***

3. Respiratory Mechanics:

Age-related reductions in physiological capacity are most pronounced in respiratory mechanics. Developmentally, over the course of the adult life span, there is a progressive increase in the rigidity of the chest wall and decrease in the elastic recoil of the lung ***(Meyer, 2005).***

These age-related changes in respiratory mechanics lead to airflow limitation, defined by a decreased forced expiratory volume in 1 second (FEV1) and ratio of FEV1 to forced vital capacity (FVC), as well as to air trapping and hyperinflation, defined by an increase in residual volume and functional residual capacity, respectively ***(Stanojevic et al., 2008).***

The more important effects of these age-related changes include a decline in FEV1 of up to 30 ml/year, an increase in residual volume of about 50% between ages 20 and 70 years, it approaches the functional residual capacity even during normal tidal breathing ***(Stanojevic et al., 2008).***

4. Gas Exchange:

Gas exchange is most often dependent on an appropriate matching of ventilation with lung perfusion ***(West, 2008).*** Using measures of ventilation and lung perfusion, study has shown an age-related increase in ventilation-perfusion inequality, characterized by a heterogeneous distribution of lung units having high and low *V*A/*Q* ratios ***(Levin et al., 2007).***

In a study involving 74 healthy older participants aged 69-104 years and 55 healthy young participants aged 20-40 years, there was a 50% reduction in the DLCO (Diffusion capacity for carbon monoxide) for older persons relative to younger persons ***(Guénard and Marthan, 1996).***

Subtle but important changes in the arterial tension for carbon dioxide (PaCO2) occur across the adult life span. To maintain the PaCO2 in the normal range, total minute ventilation (*V*E) must increase with advancing age. PaCO2 is largely dependent on the *V*E, which is the sum of alveolar ventilation (*V*A) and dead space ventilation (*V*D) ***(Levin et al., 2007).***

As a consequence of the age-related increase in ventilation-perfusion inequality, specifically in lung units having a high *V*A/*Q* ratio, normal aging is associated with an increase in *V*D ***(ATS and ACCP, 2003).***

Also changes in the arterial tension for oxygen (PaO2) occur across the adult life span. In the setting of the age-related increase in ventilation–perfusion inequality, specifically in lung units having a low *V*A/*Q* ratio, the PaO2 declines from an average of 100 mm Hg in young adults (18–24 years) to 89 mm Hg in older adults (≥65 years) ***(ATS and ACCP, 2003).***

These age-related changes have two important implications.

First, from a clinical perspective, the age-related decline in physiological reserve may increase the vulnerability of developing a respiratory impairment, particularly in response to tobacco smoke or a respiratory infection ***(Raherison et al., 2009).***

Second, from a diagnostic perspective, the age-related decline in physiological capacity must be considered before attributing a reduction in pulmonary function to a pathological process ***(Stanojevic et al., 2008).***

Singh and his colleagues established that the maximum size of the lungs (total lung capacity) does not change with age, but functional residual capacity (FRC) and residual volume (RV) both increase so that inspiratory capacity and vital capacity (VC) both decline and the increase in FRC is due to an increase in relaxation volume of the respiratory system, which arise from changes in the static recoil pressure of both the chest wall and the lungs ***(Singh et al., 2008).***

Nevertheless, adequate reference values for resistance have only been developed, based on increasing use of the simple forced oscillation technique, which measures the resistance of the total respiratory system (Rrs), including flow resistance of lung tissue and the chest wall, as well as the resistance of the extra- and intra-thoracic airways ***(Oostveen et al., 2003).***

Some reference values for Rrs have been developed for healthy children and for adults aged up to 70 yrs ***(Qato et al., 2008).***

Study of a large group of 223 healthy, nonsmoking subjects aged 65–100 yrs (mean age 83 yrs) reported that values of Rrs is slightly lower in aged subjects than previously reported in younger adults ***(Meyer, 2005).***

The most obvious explanation for retaining a normal or even reduced Rrs in old age is that changes in airway elasticity occur in parallel with those in alveolar elasticity, so that aged airways have a bigger circumference at a standard distending pressure than the airways of younger adults ***(Stephenson et al., 2008).***

The aging lung is likely to have experienced frequent exposures to environmental toxins, particularly tobacco smoke and respiratory infections, as well as substantial reductions in physiological capacity, particularly respiratory mechanics). Because of cumulative effects, older persons are at an increased risk of developing respiratory impairment ***(Qaseem et al., 2008).***

In addition to respiratory aging, lung diseases e.g. COPD are also prevalent among elderly.

Chronic obstructive pulmonary disease (COPD) is a serious multicomponent disease that involves airway obstruction, airway inflammation, airway structural changes, mucociliary dysfunction, and a systemic component ***(Agusti et al., 2003).***

The effects seen outside the lungs include systemic inflammation, weight loss and other nutritional problems, and skeletal muscle dysfunction ***(Agusti et al., 2003).***

The World Health Organisation (WHO) has estimated that 600 million people worldwide suffer from COPD and ranks COPD as the fifth leading cause of death in Europe, exceeded only by heart disease, stroke, lung cancer and lower respiratory tract infections ***(Murray et al., 2000).***

In Egypt, prior studies showed that the prevalence of COPD among high-risk individuals was 9.6 to 17.4% on the basis of GOLD ***(Azza et al., 2012).***

COPD was found to be less prevalent among people under 40 years of age. The proportion of COPD sufferers showed an incremental increase in prevalence with increasing age, reaching a peak in those aged 60-69 years, followed by a decrease in those aged older than 70 years. The declining rate of COPD after the age of 69 years may reflect the average life expectancy ***(World Bank, 2011).***

Studies from the last two decades indicate that 4-6% of subjects suffered from clinically relevant COPD. The prevalence largely increases with age and surveys show signs of diminishing differences between the two genders in this still predominantly male-related disease ***(Murray et al., 2005).***

The Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines propose a pragmatic system of staging COPD based on FEV1 values, Which have been developed in collaboration with the National Heart, Lung and Blood Institute and the World Health Organization define COPD as a condition involving progressive and not fully reversible airflow obstruction, associated with an abnormal inflammatory response to inhaled irritants ***(Global Initiative for Chronic Obstructive Lung Disease, 2003).***