

Influence of Central Obesity Assessed by Conicity Index on Lung Age in Young Adults

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ABSTRACT

Introduction: Central obesity is an emerging public health problem in young adults which compromises lung mechanics. Conicity Index (CI) is a simple anthropometric measure to assess central adiposity. The concept of lung age relates to a person's current lung function at which his/her lung function would be considered abnormal in relation to the present actual age.

Aim: To determine the effect of central obesity by CI on lung age in young adults.

Materials and Methods: A total of 319 young adults in the age group 18-25 years were recruited for this cross-sectional observational study. Written informed consent and Institutional Ethical Clearance (IEC) approval were obtained. Anthropometric parameters were measured and CI was calculated using the following formula: $CI =$

Waist Circumference (WC) (m)/ [0.109 X[√] {Bodyweight (kg)/ Height (m)}] where 0.109 is a constant. Spirometry was performed and all the lung volumes and capacities were obtained.

Results: There was a significant increase in mean values of CI in obese young adults compared to non obese (1.36±0.15 and 1.16±0.08, p<0.001). The effect of central obesity on lung age in young adults was compared using an independent t-test. Mean of lung age was significantly higher in centrally obese young adults compared to non obese 23.87±3.03 and 21.30±2.6, p<0.001) which was statistically significant.

Conclusion: Lung age is significantly increased in centrally obese young adults compared to non obese. Hence, lung age can be used as a potential psychological tool to show an individual with central obesity that there is premature aging of their lungs.

Keywords: Central adiposity, Body mass index, Public health

INTRODUCTION

Obesity is an emerging public health problem in the Indian population in young adults and its prevalence in developing countries has risen to epidemic proportions. Obesity increases morbidity and mortality due to many chronic health ailments, such as cardiovascular disease, type 2 diabetes, dyslipidaemia and fatty liver disease [1]. Less is known regarding influence of central obesity on respiratory functions. The concept of lung age relates a person's current lung function at which his/her lung function would be considered abnormal. Thus, an elevated lung function indicates as if the lungs have aged beyond the individual's chronological age. The concept of lung age was introduced by Morris JF and Temple W [2].

Body Mass Index (BMI) is for general obesity and is not an ideal measure for excess body weight as a predictor of pulmonary function compared with WC [3]. Despite its acknowledged importance, no unified definition exists for central obesity; several anthropometric indexes such as WC, Waist-Hip Ratio (WHR), index of central obesity, CI etc., are being used. CI is a simple method to assess abdominal obesity and its association with cardiovascular risk factors [4].

An individual with CI of 1.25 indicates that he/she has a WC 1.25 times larger than the circumference of a cylinder with height and weight of that person. The actual range of CI is 1.00-1.73. Greater conicity in Asian young adults of both sexes, than in Europeans, was observed in the top tertiles of weight and BMI [5]. CI has advantages over WHR such as, it has got a theoretical range, built in adjustment of WC for height and weight and does not require hip circumference to measure fat distribution [4].

Much less is the fact that influence of central obesity is linked with lung age in young adults. Thus, the aim of this study was to determine central obesity by CI and its influence on lung age in young adults.

MATERIALS AND METHODS

Sample size: Sample size was estimated based on the prevalence of central obesity at 73%. By using the formula = $(1.96)^2 pq/d^2$. n= 287 at 10% error and 95% Confidence interval.

The final adjusted sample size, allowing non response rate of 10% in, the adjusted sample size was $n = 287/0.90 = 319$ subjects.

A total of 319 young adults in the age group 18-25 years were recruited for this cross-sectional observational study done during the period Dec 2015-June 2016. Written informed consent and IEC was obtained. The subjects were recruited from in and around Kolar district, Karnataka, India who had sedentary lifestyle.

Anthropometric parameters like BMI, WC, height, and weight was measured. Weight and height was measured with minimal attire. BMI was calculated by dividing weight (kg) with the square of height (m²). WC (m) was taken horizontally within 1 mm, using plastic tape measuring at mid point between costal margin and iliac crest in the mid axillary line with the subject standing and at the end of gentle expiration. CI was calculated using the following formula:

$CI = WC (m) / [0.109 X^{\sqrt{\{Bodyweight (kg) / Height (m)\}}}]$.

where 0.109 is a constant which results from the conversion of units of volume and mass into units of length [6].

Based on CI, they were classified into obese and non obese. For males 1.25 and for females 1.18 cut offs were used to classify CI into normal and high categories [6].

Prerequisites for spirometry: History regarding exercise within the preceding hour was enquired and that individual was requested to avoid exercise for 24 hours. Before starting the lung function tests, the subjects were asked to loosen their tight clothing. The study was conducted at the same time for all the days to rule out diurnal variations. Spirometry was performed using the instrument

SPIROTECH and was carried out after demonstrating the procedure to the participants. The subjects were asked to take deep inspiration from the external air followed by forceful expiration into the mouthpiece of the SPIROTECH in a standing posture. It was ensured that the mouthpiece was inserted without any leakage of air or obstruction by the lips or teeth and forced expiration continued to completion without a pause. The subjects inspired rapidly again to maximum capacity. The subjects were asked to repeat the procedure three times and the best one was taken. All the lung volumes and capacities obtained (FVC, FEV₁, PEFR and FEV₁/FVC ratio, lung-age, forced expiratory flow from 25-75% of vital capacity (FEF25-75%) were expressed with correction for Body Temperature at the Ambient Pressure, Saturated with Water Vapour (BTPS). The lung age difference was estimated by subtracting lung age obtained by Pulmonary Function Test (PFT) with chronological age. The subjects who were smokers or suffering from neuromuscular disorders, kyphoscoliosis and with any respiratory illness were excluded from the study [7].

STATISTICAL ANALYSIS

The Statistical Package for the Social Sciences (SPSS) version 17.0 was used for the statistical analysis. The data were presented as a mean±standard deviation. Independent t-test was applied to compare the measured general characteristics and pulmonary function values between obese and non obese young adults. Paired t-test was applied between chronological age and lung age in obese and non obese young adults. Pearson's correlation test was used to determine the relationship between CI and pulmonary function variables. Chi-square test was used for analysing categorical variables. Level of significance was set at p<0.05.

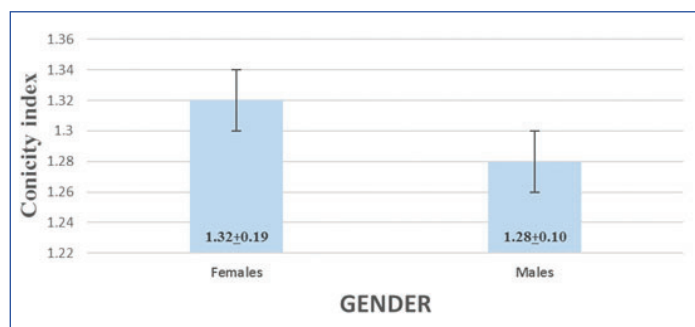
RESULTS

Values are expressed as Mean±SD. The p-value is of independent t-test where p<0.05 is significant.

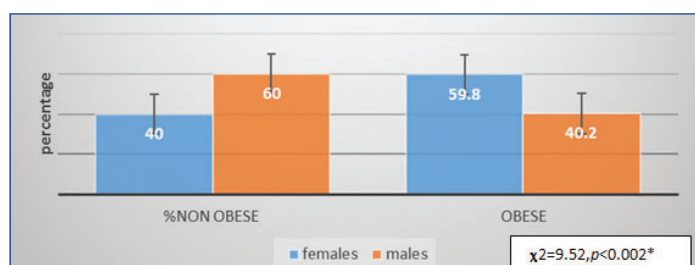
[Table/Fig-1] shows a significant increase in mean values of CI between females and males (t=2.34, p<0.02).

[Table/Fig-2] shows χ^2 of 9.52 with 2df and p<0.002 with 95% CI females are obese compared to males assessed by CI. Females were more obese compared to males.

In total 319 subjects were enrolled; 80 (25%) were non obese and 239 (75%) were obese. Comparison of the mean values of the anthropometric and pulmonary function parameters between obese



[Table/Fig-1]: Mean of CI in males and females.



[Table/Fig-2]: Percentage of obese and non obese, according to gender, determined by CI.

Parameter's	Non obese (n=80) Mean±SD	Obese (n=239) Mean±SD	t-value	p-value
Age (years)	19.25±1.30	19.33±1.65	-0.44	0.657
BMI (kg/m ²)	23.19±3.89	23.28±5.35	-0.15	0.880
WC (m)	0.78±0.10	0.90±0.13	-8.3	0.001*
Conicity index	1.16±0.08	1.36±0.15	-14.81	0.001
FVC (l)	2.64±0.67	2.37±0.62	3.13	0.002
FEV ₁ (l)	2.55±0.62	2.31±0.59	3.08	0.002
FEV ₁ /FVC %	96.89±4.31	97.06±4.09	-0.30	0.760
FEF25-75 (l/s)	5.27±8.70	3.78±1.09	1.53	0.010
PEFR (l/s)	5.71±1.85	4.22±0.97	6.86	0.001
Lung age (years)	21.30±2.64	23.87±3.03	-7.2	0.001*
Lung age difference (years)	2.05±2.75	4.54±3.20	-6.67	0.001*

[Table/Fig-3]: Independent t-test comparing anthropometric and pulmonary function test in obese and non obese young adults obtained by CI (males<1.25, females <1.18 are non obese).

* Significant

Groups	Chronological age(years)	Lung age (years)	t-value	p-value
Non obese	19.25±1.30	21.30±2.64	-6.66	0.001*
Obese	19.33±1.65	23.87±3.03	-21.50	0.001*

[Table/Fig-4]: Paired t-test of chronological age and lung age in obese and non obese young adults based on conicity index.

* Significant

Parameters	Non obese		Obese	
	r	p	r	p
WC (m)	0.506	0.001*	0.613	0.001*
BMI (kg/m ²)	0.090	0.426	-0.081	0.214
FVC (l)	0.217	0.053	-0.072	0.266
FEV ₁ (l)	0.182	0.105	-0.601	0.359
FEV ₁ /FVC%	-0.262	0.019*	0.020	0.760
FEF25-75 (l/s)	0.048	0.675	0.005	0.935
PEFR (l/s)	0.090	0.426	0.013	0.841
Lung age (years)	-0.023	0.841	0.098	0.129

[Table/Fig-5]: Pearson's correlation between CI and anthropometric, pulmonary function parameter's in non obese and obese young adults.

* Significant

Parameters	Non obese		Obese	
	r	p	r	p
FVC(l)	-0.275	0.013*	-0.126	0.052
FEV ₁ (l)	-0.307	0.006*	-0.149	0.021*
FEV ₁ /FVC%	-0.066	0.561	0.141	0.030*
EFR(l/s)	0.165	0.144	0.083	0.20

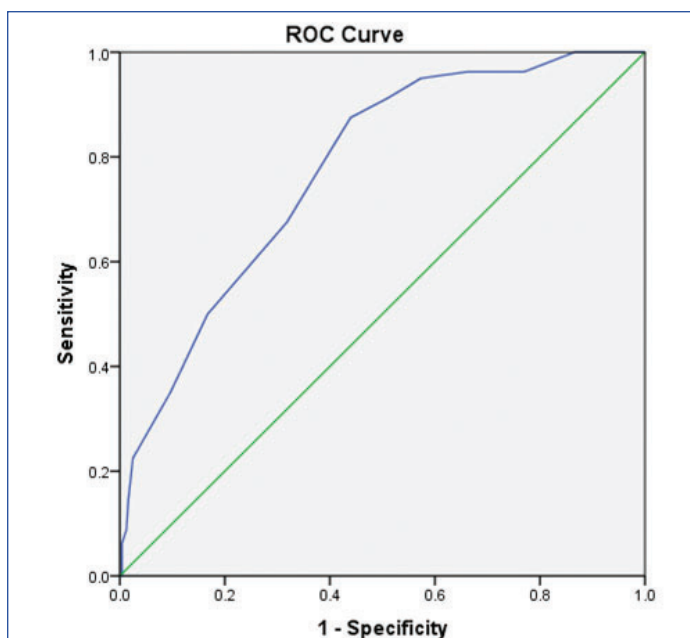
[Table/Fig-6]: Pearson's correlation between lung age difference and other pulmonary function parameters in non obese and obese young adults obtained by CI.

* Significant

and non obese individuals are shown in [Table/Fig-3]. There was a significant increase (p<0.05) in the mean values of CI, lung age and lung age difference in obese young adults compared to non obese. The other PFT parameters i.e., FVC, FEV₁, PEFR, FEF 25-75% showed significant decrease in obese young adults compared to non obese.

In [Table/Fig-4], paired t-test was applied between chronological age and lung age in obese and non obese young adults based on CI, which showed significant increase in lung age in both groups.

[Table/Fig-5] shows that there was a weak positive correlation between CI and lung age (years) in obese group but statistically non significant. In non obese young adults, the lung-age showed negative weak correlation. FEV₁/FVC% showed weak positive correlation (r=0.020) in obese young adults compared to non obese.



[Table/Fig-7]: ROC analysis of lungage (years) in obese and non obese young adults assessed by CI.

[Table/Fig-6] shows that FEV₁/FVC% exhibited a significant positive correlation in obese young adults compared to non obese.

[Table/Fig-7] ROC analysis of lung age (years) in obese and non obese young adults assessed by CI showed an accuracy of 77.5% (AUC-0.775 at 95% CI-0.720 to 0.830) which is statistically significant ($p < 0.001$). The optimal cut off value to discriminate lung age (years) in young individuals in the age group of 18-25 years was 23.5 years, the sensitivity being 87.5% and specificity being 43.9%.

DISCUSSION

The present study was conducted to assess the effect of central obesity on lung age in young adults. This study was carried out in 319 young individuals whose age was matched in obese (75%) and non obese (25%) young adults and obesity criteria was taken based on their CI. Females (59.8%) were significantly more obese compared to males (40.2%). The mean CI in females is significantly increased ($p < 0.05$) compared to males which is consistent with other studies [8].

In our study, central obesity, assessed by CI was significantly increased in obese compared to non obese individuals. Its rationale is to quantify the excess abdominal fat for a person with a prescribed WC in relation to the circumference of the cylinder generated with that persons weight and height based on a constant body density. CI has a theoretical range $1.0 < CI < 1.73$ representing perfect cylindrical and perfect biconal body shapes, respectively.

In the present study, CI in obese was towards biconal body shape indicating central obesity. The CI estimates fat accumulation in the abdomen which leads to a deviation of body shape from a cylindrical to a double-cone shape, i.e., two cones with a common base at the waist level [6]. This abnormal deposition of fat in the abdomen has been described as the type of obesity that greatly threatens the individual's health leading to metabolic derangements, coronary heart disease, and poor lung function [9,10]. In our study, the BMI was found to be non significant and an increase in CI in the presence of normal BMI was observed. Few studies indicate that measures of central obesity are better discriminators of morbidity compared to BMI. As opposed to BMI, which does not differentiate between muscle and fat, CI may be a useful tool to identify individuals with central obesity, but who are not necessarily obese or overweight.

Based on CI, no studies have been done to assess the influence of central obesity on lung functions, particularly lung age. There is significant increase in mean values of lung age and lung age

difference in obese young adults compared to non obese. The other PFT parameters FVC, FEV₁, PEFR, FEF 25-75%, showed significant difference in obese young adults compared to non obese ($p < 0.05$) [Table/Fig-3]. There was significant increase in lung age compared to the chronological age in both the groups [Table/Fig-4].

The idea of "lung age" was developed as a way of making spirometric parameters easier to understand and also as a potential psychological tool to show an individual who is at risk of apparent premature ageing of their lungs. Increased lung age in obese young adults is a clear message that the lungs are undergoing accelerated deterioration and a way of expressing lung damage rather than using mathematical concepts of a percentage of the expected value of FEV₁ for height, age and gender [11]. The optimal cut off value to discriminate lung age in young adults who are obese and non obese in the chronological age group of 18-25 years is 23.5 years [Table/Fig-7].

In the present study, spirometric variables such as FEV₁ and FVC has decreased with increased CI; however the effect is small and both FEV₁ and FVC were usually within normal range in healthy obese young adults. FEV₁/FVC was increased and showed a weak positive correlation in obese young adults, indicating both FEV₁ and FVC are affected to same extent. PEFR was significantly decreased in obese young adults, which indicates decrease in the strength of the expiratory muscles generating the force of contraction, the elastic recoil pressure of the lungs and the airway size [12]. In our study, correlation between lung age difference and FEV₁/FVC showed a significant positive correlation in obese young adults indicating mild restrictive lung disorder [Table/Fig-6].

Central obesity affects respiratory functions by various mechanics. Central obesity in particular compromises lung mechanics by restricting lung volumes, reducing chest wall compliance, and attenuating respiratory muscle efficiency [12]. Central accumulation of fat mechanically affects the expansion of the diaphragm or impedes the descent of the diaphragm during forced inspiration. The published literature mostly indicates that abdominal fat alters the pulmonary mechanics, causing restriction during breathing, potentially reducing respiratory volumes mainly FEV₁ and FVC. Alteration in mechanical effect, decrease in compliance and increase in the resistance of the respiratory system is more prominent in central obesity than overall body fat distribution leading to increased respiratory demand.

CI shows strong positive correlation with WC ($r = 0.613$, $p < 0.001$) in obese individuals. [Table/Fig-5] indicating that WC has a strong effect on the diaphragm by limiting its movements.

Few imaging studies reveal abnormality in regional ventilation in obese individuals. Normally in an upright non obese individual the distribution of regional ventilation is greatest in the lower, and decreases towards the upper zones. In obese individuals, this distribution may be reversed so that ventilation is preferentially distributed in the upper zones of the lung, leaving lower dependent zones relatively under-ventilated [13]. In addition, visceral adipose tissue influences circulating concentrations of Interleukin-6 (IL-6), Tumour Necrosis Factor α (TNF- α), leptin, and adiponectin, which are cytokines that may act through systemic inflammation, thus, negatively affecting pulmonary function [14-17]. Investigators have reported an indirect association of serum leptin concentrations with FEV₁, as well as increased levels of C-Reactive Protein (CRP), leucocytes, and fibrinogen, which are markers of systemic inflammation. This indicates that inflammation may be the link between visceral obesity and pulmonary function [18].

LIMITATION

The limitation of this study is that the obesity in younger individuals, which is influenced by physical activity, lifestyle modification and dietary habits, has not been assessed which might influence the pulmonary function.

CONCLUSION

CI can be used as a new index of anthropometric measure to assess central obesity, than BMI which might not be a reliable anthropometric measure as it indicates overall body fat distribution and muscle mass. The present study shows that CI is increased in obese though their BMI is normal. Thus, an individual can calculate CI and see whether obesity is towards cylindrical or biconal shape and take appropriate measures to reduce weight.

In our study, spirometry results in young adults expressed as "lung age" gives a clear message that increase in lung-age indicates that lungs are undergoing a gradual deterioration. Thus, it can be slowed if they take proper measures to reduce obesity which influences pulmonary function. So, lung age can be used as a psychological tool to explain to the person how his/her lungs are deteriorating in a simple way, instead of explaining the individual the mathematical equation of % predicted FEV₁ or FEV₁/FVC ratio.

REFERENCES

- [1] McClean KM, Kee F, Young IS, Elborn JS. Obesity and the lung: 1. *Epidemiology, Thorax*. 2008;63:649-54.
- [2] Morris JF, Temple W. Spirometric lung age estimation for motivating smoking cessation. *Preventive Medicine*. 1985;14:655-62.
- [3] Mamtani MR, Kulkarni HR. Predictive performance of anthropometric indexes of central obesity for the risk of type 2 diabetes. *Arch Med Res*. 2005;36:581-89.
- [4] Valdez R, Seidell JC, Ahn YI, Weiss KM. A new index of abdominal adiposity as an indicator of risk for cardiovascular disease. A cross-population study. *Int J Obes*. 1993;17:77-82.
- [5] Flora MS, Mascie-Taylor CGN, Rahman M. Conicity index of adult Bangladeshi population and their socio-demographic characteristics. *Ibrahim Med Coll J*. 2009;3(1):01-08.
- [6] Pintanga FJG, Lessa I. Anthropometric indexes of obesity as an instrument of screening for high coronary risk in adults in the city of Salvador-Bahia. *Arquivos Brasileiros de Cardiologia*. 2005;85:01-05.
- [7] Ghai CL. Editor. *Spirometry: A text book of practical physiology*. New Delhi: Jaypee Brothers 2005.
- [8] Hodge AM, Brown M, Cunningham J, Boyle J, Dunbar T, Weeramanthri T, et al. Abdominal obesity and other risk factors largely explain the high CRP in indigenous Australians relative to the general population, but not gender differences: A cross-sectional study. *BMC Public Health*. 2010;10:700-07.
- [9] Liu Y, Tong G, Tong W, Lu L, Qin X. Can body mass index, waist circumference, waist-hip ratio and waist-height ratio predict the presence of multiple metabolic risk factors in Chinese subjects? *BMC Public Health*. 2011;11:01-10.
- [10] Helal OF. Impact of smoking on adults lung age and ventilatory function. *Int J Physiother Res*. 2014;2:453-59.
- [11] Saxena Y, Purwar B, Upmanyu R. Adiposity: determinant of peak expiratory flow rate in young Indian adults male. *Indian J Chest Dis Allied Sci*. 2011;53:29-33.
- [12] Mancuso P. Obesity and lung inflammation. *J Appl Physiol*. 2010;108:722-28.
- [13] Salome MC, King GG, Berend N. Physiology of obesity and effects on lung function. *J Appl Physiol*. 2010;108:206-11.
- [14] Kern PA, Rangnathan S, Li C, Wood L, Rangnathan G. Adipose tissue tumor necrosis factor and interleukin-6 expression in human obesity and insulin resistance. *Am J Physiol Endocrinol Metab*. 2001;280:745-51.
- [15] Staiger H, Tschritter O, Machann J, Thamer C, Fritzsche A, Maerker E, et al. Relationship of serum adiponectin and leptin concentrations with body fat distribution in humans. *Obes Res*. 2003;11:268-72.
- [16] Gasteyer C, Tremblay A. Metabolic impact of body fat distribution. *J Endocrinol Invest*. 2002;25:876-83.
- [17] Kern PA, DiGregorio GB, Lu T, Rassouli N, Ranganathan G. Adiponectin expression from human adipose tissue: relation to obesity, insulin resistance, and tumor necrosis factor-alpha expression. *Diabetes*. 2003;52:1779-85.
- [18] Sin DD, Man SF. Impaired lung function and serum leptin in men and women with normal body weight: a population based study. *Thorax*. 2003;58:695-98.

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