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RELATIONSHIP BETWEEN CARDIO METABOLIC RISK FACTORS AND PULMONARY FUNCTION IN YOUNG ADULTS

Physiology

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ABSTRACT

Presence of cardio-metabolic risk factors may influence pulmonary function of an individual during different stages of their life. Data on relationship between cardio-metabolic risk factors and pulmonary function in young adult subjects are sparse. Hence, the purpose of the study was to investigate the association between various cardio-metabolic risk factors and pulmonary function parameters in young adults. Cardio-metabolic risk and pulmonary function parameters were assessed in 347 randomly selected young adults (age 18-25 years) residing in Tripura, a North-eastern state of India. Cardio-metabolic risk of the subject was evaluated following National Cholesterol Education Programme Adult Treatment Panel III (NCEP ATP III) criteria. Pulmonary function of the subject were evaluated according to American Thoracic Society (ATS) guidelines. Most of the cardio-metabolic parameters differ significantly between subjects with and without profound cardio metabolic risk except systolic, diastolic blood pressure and total cholesterol in females and fasting blood sugar in males. All the pulmonary function parameters like FVC, FEV1, FEV1/FVC ratio showed lower values in subjects with profound cardio-metabolic risk. In males, FVC, FEV1 and FEV1/FVC ratio significantly correlated with BMI, waist circumference and triglyceride level whereas in females all the lung function parameters varied significantly with BMI, waist circumference, triglyceride and HDL-C level. There was over all impairment of the pulmonary function in subjects with profound cardio-metabolic risk. Various cardio-metabolic risk factors varied independently with different pulmonary function parameters.

KEYWORDS

Mets, Ncep Atp Iii, Ats, Fvc, Fev, Fev1/fvc Ratio.

Cardio-metabolic risk factors include central obesity, hypertension, hyperglycemia, and dyslipidemia. Constellation of these factors in an individual increases the risk of future development of cardiovascular disease and type II diabetes mellitus (Amiri et al., 2014). Recent findings suggest that prevalence of cardio-metabolic risk factors in population has emerged as a major public health problem world over (Phipps et al., 2015). Emerging evidences reveal that impaired pulmonary function is also a risk factor for cardiovascular mortality, independent of smoking and other potential cofactors (Sin, Wu & Man, 2005).

In recent years there has been an increased attention on role of cardio-metabolic risk factors in prediction of pulmonary function impairment. Even when gender, age, smoking status, alcohol drinking and physical activity factors were restricted, pulmonary function deterioration showed independent relevance to increased cardio metabolic risk (Lin, Yao, Wang & Huang, 2006). It has also been found to be related to hypertension, type II diabetes, low density lipoprotein, cholesterol, overall obesity, abdominal obesity and insulin resistance (Melo, Mendonça da Silva & Calles, 2014).

Cardio-metabolic risk in a subject is associated with pro-thrombotic and pro inflammatory state, similarly individuals with moderate airflow limitations like in case of chronic obstructive pulmonary disease may have co existing systemic inflammation (Chen et al., 2014). However, the mechanism underlying relationship between impaired lung function and cardio metabolic risk is still unclear.

Both the cardio-metabolic risk and pulmonary function parameters varies according to race and ethnicity of the subject (Lee, Chung, Lopez, Wong, 2009 and Yoshimura et al., 2012). Moreover, both the parameters show correlation with sex and age of the subject (Choi, Park, Shin, Kim, Lee, 2011 and Fimognari et al., 2007).Till now little information is available on relationship between pulmonary function parameters and cardio-metabolic risk components in young Indian male and female subjects. In view of the above facts, the present study is designed to evaluate the relationship between various cardio-metabolic risk components and pulmonary function parameters in young adult subjects from India.

MATERIALS AND METHODS

STUDY DESIGN

The study was designed to obtained a cross sectional population-based data from three fourty seven (347) randomly selected young adults (age 18-25 years) residing in Tripura, a North - Eastern state of India. Out of 183 male subjects, 78 were tribal and 105 were non-tribal whereas, out of 164 females, 75 were tribal and 89 were from non-tribal population.

History of any disease and past or present medication was recorded to exclude the subjects having any cardio-metabolic disorder from the study. Subjects having diabetes mellitus, hypertension, polycystic ovary and any other cardiovascular disorders were excluded from the study. A questionnaire was formulated for the purpose. All the participants in this study signed a written consent to participate in the study. Ethical clearance for the study was obtained from Institutional Human Ethical Committee.

EVALUATION OF ANTHROPOMETRIC PARAMETERS AND CARDIO METABOLIC RISK COMPONENTS

All anthropometric parameters were recorded following standard procedure (Weiner & Lourie, 1981) Body weight was measured by using weighing machine with subject standing erect on the machine without shoes and in normal clothing. Body height was measured using a stadiometer with subject standing erect without any footwear. Waist circumference was measured by positioning the measuring tap between coastal margin and iliac crest of the subject. Body mass index (BMI) was calculated for obesity level by using the standard expression:
BMI = weight (kg)/height $(m)^2$ (Barba & Cavalli-Sforza, 2004). Waist to hip ratio (WHR), waist to height ratio (WHtR) were calculated by using formula. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) of the subject was recorded in supine position by using aneroid sphygmomanometer. Both systolic and diastolic pressures were recorded. Mean and pulse pressure were calculated.

The fasting blood sugar (FBS) level, serum total cholesterol (TC), triglyceride (TG), high density lipoprotein-cholesterol (HDL-C), low density lipoprotein cholesterol (LDL-C) and were estimated by using kits in a biochemical analyzer. Atherogenic indices calculated include HDL-C/TC, HDL-C/LDL-C and TG/ HDL-C ratio (Nwagha, 2010).

Cardio metabolic risk of the subject was assessed according to National Cholesterol Education Programme Adult Treatment Panel III [NCEP ATPIII] criteria (Alberti et al., 2009). Individuals were considered to have profound cardio metabolic risk if they had any three or more of the following conditions according to NCEP ATP III criteria: Central Obesity: waist circumference(≥88 cm Female, ≥102

cm Male); Hyper-triglyceridema: serum TG level(≥1.7 mmol/L or specific treatment for this lipid abnormality); Serum HDL-C level(<1.29 mmol/L for Female,<1.03 mmol/L for Male or drug treatment for this lipid abnormality); Elevated Blood Pressure:(≥130/85 mmHg or treatment for hypertension); and Hyperglycaemia: FBS level(≥5.6 mmol/L or on treatment for elevated glucose).

ASSESSMENT OF PULMONARY FUNCTION

A complete spirogram was performed by using an expirograph (Helios 702, RMS,India) according to American Thoracic Society (ATS) guidelines (Salome, King & Berend, 2010). The test was carried out in a private and quiet room in standing position with the nose clip held in position on the nose. The flow, volume/timed graph were taken out in accordance to the ATS criteria. The subject was instructed to take a deep breath until the lung were full and then blow out through mouth as forcibly and as fast and as long as possible till the maximum capacity was achieved. Best of the three acceptable curves were selected. Spirometric parameters recorded for analysis were forced vital capacity (FVC), forced expiratory volume during the 1st second of expiration (FEV1), and FEV1/FVC ratio.

STATISTICAL ANALYSIS:

Statistical analysis was performed using SPSS 16.0 (statistical program for the Social Sciences) for Windows. Continuous variables were reported as mean±SD. t- test was used for testing the significance of difference in measurements between various groups. Pearson's correlation coefficients were calculated to establish relationship between pulmonary function parameters and cardio metabolic risk factors.

RESULTS:

The average age of our subject was 22.39 ±2.29 for male and 22.09 ±2.43 for female. The average BMI of our subject was found to be significantly higher in female than male subjects. Cardio metabolic parameters including waist circumference and systolic blood pressure were significantly higher in male than female subjects. The diastolic blood pressure and HDL-C level were significantly higher in female than the male subjects. Other parameters did not show any significant difference between male and female subjects. All the pulmonary function parameters were significantly less in females in comparison to male subjects (Table 1).

Most of the cardio metabolic parameters except systolic, diastolic blood pressure and total cholesterol in females and fasting blood sugar in males differ significantly between subjects with and without profound cardio metabolic risk. The subjects with profound cardio-metabolic risk also reported lower scores in all pulmonary function parameters like FVC, FEV1, FEV1/FVC ratio. Compared with young male, female subjects with profound risk showed significantly lower values of FVC, FEV1, FEV1/FVC ratio (Table 2).

The correlation of lung function parameters with BMI and metabolic syndrome components of young male and female subjects showed, in males, FVC, FEV1 and FEV1/FVC ratio significantly correlated with BMI, waist circumference and triglyceride level while in females all the lung function parameters varies significantly with BMI, waist circumference, triglyceride and HDL-C level (Table 3).

DISCUSSION:

The study evaluated relationship between components of cardio metabolic risk and pulmonary function in a sample of young adults (age 18-25 years); both male and female population residing in Tripura, a north eastern state of India. Subjects were screened for cardio metabolic risk according to NCEP-ATP III criteria. Our findings showed significant decrease in pulmonary function parameters like FEV1, FVC, FEV1/FVC ratio in subjects with profound cardio metabolic risk in comparison to the subjects without profound risk. In agreement with our study, Chen et.al. in their study with US population aged 20 – 60 years observed that participants with increased number of metabolic syndrome components had lower predicted values of FVC and FEV1 (Chen et al., 2014). In an Australian study also poorer pulmonary function was noted as metabolic syndrome components accumulated (Yu & Simmons, 2014). The Strong Heart Study (SHS) among American Indian revealed reduced lung function was independently associated with metabolic syndrome and diabetes mellitus, and impaired lung function presents before the development of metabolic syndrome and diabetes mellitus (Yeh et al., 2011). Recently a prospective study conducted over six years revealed decline in lung function rather than base line lung function was associated with future development of metabolic syndrome (Kim et al., 2017). Studies also revealed lung function impairment in subjects with metabolic syndrome increases with age (Lin, Yao, Wang & Huang, 2006).

In our study, reverse correlation was observed between various cardio metabolic risk components and pulmonary function parameters. Both the obesity markers- BMI and waist circumference showed highly significant negative correlation with FVC, FEV1 and FEV1/FVC ratio in both male and female subjects. Various earlier studies observed inverse relationship between markers of obesity and pulmonary function parameters. Thyagarajan et. al, in a cohort study observed decline in FEV1 with increased BMI (Thyagarajan et al., 2008). Saliman et al. found significant reduction in predicted values in morbid obese persons, both male and female (Saliman et al., 2008). Leone et al. showed that abdominal obesity was the more powerful predictor of pulmonary function (Leone et al., 2009). Chen et al. observed a negative correlation between FEV1/FVC ratio and waist circumference in both male and female even after age, height, weight, workload, energy consumption and smoking were factored in (Chen, Tunstall-Pedoe, Bolton-Smith, Hannah & Morrison, 2001). Canoy et al. observed a negative correlation of both FEV1 and FVC with waist – hip ratio in both male and female (Canoy et al., 2004). This association may result from mechanical effects of truncal obesity and /or the metabolic effects of adipose tissue (McClean, Kee, Young & Elborn, 2008). Abdominal obesity may mechanically affect the diaphragm and chest wall compliance with decreased lung volumes (Choudhuri & Sutradhar, 2015). Lower levels of ventilation at the lung base may lead to closure of peripheral lung units, ventilation- perfusion ratio abnormalities, and arterial hypoxemia (Zureik, 2001).

Among other cardio-metabolic risk components, we observed a significant negative correlation of triglyceride with lung function parameters in both young male and female subjects. There was no significant correlation with systolic or diastolic blood pressure and fasting blood sugar in both male and female subjects. HDL-C, in our study correlated significantly with FVC, FEV1 and FEV1/FVC ratio of young female subjects only. In an Italian study HDL-C was found to be the main predictor for pulmonary function impairment (Rogliani, 2010). Earlier, a US and a Korean study showed pulmonary function parameters were associated with all the metabolic syndrome components including abdominal obesity, high blood pressure, high triglyceride, low HDL-C (Choi, Park, Shin, Kim & Lee, 2011). Some studies had established a weak link between lung function impairment and glucose – blood pressure. Some studies showed restrictive ventilator defects were associated with developing high risk of diabetes (Ford & Mannino, 2004). Other studies have reported diabetes to be frequently co morbid with chronic obstructive pulmonary diseases (Mannino, Thorn, Swensen & Holguin, 2008). We have not found a significant clear correlation between lung function and blood pressure or glycemic status. However, we observed a clear significant correlation between HDL-C level and pulmonary function in young females.

Results of our study indicate overall decline in values of pulmonary function parameters in subjects with metabolic syndrome. In addition, components of metabolic syndrome, particularly the markers of both general and abdominal adiposity are negatively correlated with various pulmonary function parameters. As not much data is available on relationship between cardio metabolic risk components and pulmonary function in young adults particularly in Indian context, the finding of the present study can provide a lead to further investigate this relationship and on how to manage the influence of cardio metabolic factors on pulmonary function parameters. However, cross sectional nature of the study and limited sample size is a limitation. Future study need to include a larger sample size keeping both gender and racial factors in view.

CONCLUSION AND FUTURE STUDY:

Our study revealed a relationship between metabolic syndrome components especially abdominal obesity and pulmonary function impairment. The relationship requires further investigation with inclusion of larger sample of subjects. This might help to take appropriate measures to reduce the burden of respiratory comorbidities of metabolic syndrome and possibility of inclusion of pulmonary function testing as an additional evaluation of metabolic

syndrome in clinical setting.

Table – 1:Baseline characteristics of anthropometric, cardio metabolic components and pulmonary parameters in young (18 to 25 yrs age) male and female subjects:

Parameters	Male subjects (183)	Female subjects (164)	P value
Age (yrs)	22.39±2.29	22.09±2.43	0.24
BMI (kg/m^2)	22.13±2.42	22.93±2.12	0.001**
WC (cm)	96.03±11.87	84.95±7.52	0.000***
SBP (mm/Hg)	123.42±9.59	122.98±7.5	0.04*
DBP (mm/Hg)	78.74±7.13	80.10±4.33	0.03*
TG (mg/dL)	139.38±27.06	142.88±20.09	0.18
HDL-C (mg/dL)	38.20±6.19	46.41±9.49	0.000***
LDL-C (mg/dL)	110.94±23.75	115.00±16.61	0.07
FBS (mg/dL)	86.83±12.77	85.49±13.55	0.34
FVC	3.54±0.28	3.22±0.22	0.000***
FEV1	2.87±0.31	2.79±0.22	0.006**
FEV1%	80.95±2.77	86.42±1.17	0.000***

BMI- body mass index, WC- waist circumference, SBP- systolic blood pressure, DBP- diastolic blood pressure, TG- triglyceride, HDL-C- high density lipoprotein cholesterol, LDL-C- low density lipoprotein cholesterol, FBS- fasting blood sugar, FVC- forced vital capacity, FEV1- forced expiratory volume for 1 sec. Values are in Mean ± SD; *p<0.05, **p<0.01, ***p<0.001

Table 2: Comparison of cardio metabolic parameters in young subjects with and without metabolic syndrome:

Parameters	Male subjects (183)		Female subjects (164)	
	With MetS (41)	Without MetS (142)	With MetS (38)	Without MetS (126)
Age	23.29±2.28	22.13±2.22**	21.74±2.12	21.83± 2.46*
BMI	24.01±2.0	21.69±2.30**	23.78±1.76	22.78±2.24***
WC (cm)	106.54±4.17	93.00±11.64***	90.88±2.22	83.16±7.63***
SBP (mmHg)	130.83±8.54	121.40±8.75***	122.92±8.88	123±7.03$^{\#}$
DBP (mmHg)	83.24±6.2	77.91±6.72***	80.21±5.4	80.07±3.96$^{\#}$
FBS (mg/dl)	89.05±14.76	86.15±12.07$^{\#}$	92.87±16.39	83.26±11.68***
TG (mg/dl)	165.94±15.69	131.71±24.71***	164.9±16.34	136.24±15.96***
TC (mg/dl)	178.1±23.20	176.34±25.38$^{\#}$	193.80±23.53	188.84±20.36$^{\#}$
HLDL-C (mg/dl)	35.53±4.01	38.98±6.49**	38.08±7.15	48.92±8.63***
LDL-C (mg/dl)	110.08±22.63	111.01±23.92$^{\#}$	122.74±17.75	112.67±15.51***
FVC(L)	3.41±0.27	3.57±0.28***	3.12±0.17,	3.25 ±0.22
FEV1(L)	2.70±0.26	2.92± 0.30***	2.70±0.17,	2.84±0.20
FEV1%	77.89±1.57	81.54±2.76***	86.51±0.74,	87.33±0.22

BMI- body mass index, WC- waist circumference, SBP- systolic blood pressure, DBP- diastolic blood pressure, TG- triglyceride, TC- total cholesterol, HDL-C- high density lipoprotein cholesterol, LDL-C- low density lipoprotein cholesterol, FBS- fasting blood sugar, FVC- Forced vital capacity, FEV1- Forced expiratory volume for 1 second. Values are in Mean ± SD; *p<0.05, **p<0.01, ***p<0.001

Table 3: Correlation between pulmonary function parameters and cardio-metabolic risk parameters in male and female subjects (*p<0.05, **p<0.01, ***p<0.001):

Variables	FVC		FEV1		FEV1%	
	Male	Female	Male	Female	Male	Female
BMI (kg/m^2)	r =-0.161 p = 0.029*	r =-0.183 p = 0.019*	r = -0.193 p = 0.008**	r =-0.196 p = 0.012*	r = -0.253 p = 0.000***	r = -0.296 p = 0.000***
WC (cm)	r = -0.190 p = 0.009**	r =-0.138 p = 0.078$^{\#}$	r =-0.245 p= 0.000***	r =-0.153 p = 0.050*	r = 0.318 p = 0.000***	r = -0.240 p = 0.002**
SBP (mmHg)	r = -0.122 p = 0.099$^{\#}$	r =0.146 p = 0.062$^{\#}$	r = -0.127 p = 0.087$^{\#}$	r = 0.149 p = 0.057$^{\#}$	r = -0.129 p = 0.082$^{\#}$	r = 0.118 p = 0.132$^{\#}$
DBP(mmHg)	r =-0.091 p = 0.221$^{\#}$	r =-0.024 p = 0.760$^{\#}$	r = -0.100 p = 0.178$^{\#}$	r = -0.022 p = 0.780$^{\#}$	r = -0.113 p = 0.128$^{\#}$	r =-0.006 p = 0.939$^{\#}$
TG (mg/dl)	r = -0.176 p = 0.017*	r = -0.178 p = 0.023*	r = -0.211 p = 0.084$^{\#}$	r =-0.188 p = 0.016*	r = -0.264 p = 0.000***	r = -0.237 p = 0.002**
HDL-C (mg/dl)	r =-0.003 p = 0.968$^{\#}$	r =0.188 p = 0.016*	r = -0.046 p = 0.536$^{\#}$	r = 0.184 p = 0.018*	r = -0.142 p = 0.055$^{\#}$	r = 0.178 p = 0.023*
FBS (mg/dl)	r = -0.039 p = 0.600$^{\#}$	r = 0.022 p = 0.780$^{\#}$	r = -0.042 p = 0.572$^{\#}$	r = 0.016 p = 0.839$^{\#}$	r = 0.032 p = 0.667$^{\#}$	r = 0.015 p = 0.849$^{\#}$

BMI-Body mass index, WC- Waist circumference, SBP- Systolic blood pressure, DBP-Diastolic blood pressure, FBS-Fasting blood sugar, TG-Triglyceride, HDL-C– High density lipoprotein- Cholesterol. Values are expressed as mean ± SD for continuous variables, *p<0.05,**p<0.01

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