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METABOLIC SYNDROME AND PULMONARY FUNCTION INDICES

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Abstract

Background and aims: *Metabolic syndrome (MetS) is a collection of metabolic risk factors including increased waist circumference (WC), elevated blood pressure (BP), increased triglyceride (TG), decreased high density lipoprotein (HDL-C) and increased fasting blood sugar (FBS). We aimed to examine the relevance between the MetS and its components with reduced lung functions in adult men.* ***Material and method:*** *A total of 3899 adult men underwent screening examination between 2015- 2016 in a cross-sectional survey.* ***Results:*** *The mean (± SD) age of our population was 37.25 (± 4.9) years. The overall prevalence of MetS was 7.6%. The total prevalence of reduced lung function in men with MetS was 13.8%. The most common type of reduced lung function was the restrictive pattern (7.1%). The forced expiratory volume of first second (FEV1) and forced vital capacity (FVC) values were significantly lower in men with MetS (both p<0.001). Also these values were significantly lower in diabetic men compared to non-diabetics and those with impaired fasting glucose (IFG). WC and HDL were the most potent predictors of reduced FEV1 and FVC.* ***Conclusions:*** *We obtained a positive independent association between MetS and reduced lung function in adult men which may be related mainly due to increased WC and decreased HDL.*

key words: *metabolic syndrome, pulmonary function test, reduced lung function, cross-sectional*

Background and aims

MetS is defined by a grouping of clinical characteristics including increased waist circumference (WC), increased blood pressure (BP), and increased triglyceride (TG), decreased high density lipoprotein (HDL-C) and increased fasting blood sugar (FBS). The latest criteria of the National Cholesterol Education Program (NCEP), third update Adult Panel ATP 3, define the MetS as the existence of at least three of the following five components in men: Abdominal obesity, defined as a WC ≥102 cm, TG ≥150 mg/dl or drug therapy for elevated TG, HDL-C <40 mg/dl or drug therapy for low HDL-C ,BP ≥130/85 mmHg or drug therapy for elevated BP, FBS ≥100 mg/dl named as impaired fasting glucose (IFG) or drug therapy for elevated FBS. MetS is accompanied with doubling risk of cardiovascular diseases (CVD) and a 5 fold risk

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of type 2 diabetes mellitus [1]. In addition, reduced lung function is associated with progression of atherosclerosis [2] and CVD [3] and mortality [4]. A few evidence shows that MetS may also be associated with reduced lung function. We performed an Iranian population-based study to analyze the relevance between reduced lung function and MetS and its specific components.

Material and method

In this cross-sectional study, adult men referred to health care occupational medicine clinic were examined. Measurement of BP was performed with a calibrated mercurial sphygmomanometer. The mean value of the two independent systolic blood pressure (SBP) and diastolic blood pressure (DBP) were taken after resting for 5 minute in a sitting position. WC was measured by an expert operator using a non-elastic tape midway between the lowest rib and the top of the iliac crest. BMI was computed by dividing the person's weight in kilograms divided by the square of height in meters. The morning venous blood sample (07:30-09:30 AM) was collected from all subjects in fasting situation. FBS, TG, HDL-C, were determined with standard laboratory methods.

Pulmonary function test was performed in the morning (8-10 AM) using two similar calibrated spirometry (MIR Spirobank II) based on National Health and Nutrition Examination Survey (NHANES) III data. The spirometry was taken by an experienced doctor, in seated position. At least three and at most eight forced expiratory maneuvers were done to concordance with American Thoracic Society (ATS) standards. The measured values were forced expiratory volume of first second (FEV1), forced vital capacity (FVC), ratio of FEV1 to FVC (FEV1/FVC %) forced expiratory flow during the middle segment of FVC (FEF25%-75%) and peak expiratory flow (PEF). The largest FVC and FEV1 values of tests with acceptable curves were used in the analysis. Other indices determined from maneuver with the largest sum of FEV1 and FVC [5]. We classified values of spirometry based on GOLD criteria [6] into four categories: Normal (FEV1/FVC ≥70% and FVC ≥ 80% predicted), restrictive (FEV1/FVC ≥ 70% and FVC <80% predicted), obstructive (FEV1/FVC <70% predicted) and mixed pattern (FEV1/FVC < 70% and FVC <80% predicted) [7].

This study was directed based on the Declaration of Helsinki (DoH) for human research ethics and approved by Research Ethics Committee Tehran University of Medical Science (TUMS).

Study objectives

This cross-sectional study was conducted to assess the relationship between MetS and its components of MetS with pulmonary function indices.

Statistical analysis

All statistical study were done using SPSS software, version v. 22.0 (IBM Corporation). The p–value of 0.05 was considered as the cutoff of significance.

Sample size

The number of 3899 Iranian adult men who have been consecutively referred from car factory to health care occupational medicine clinic for routine screening program between November 2015 and August 2016.

Results

The baseline characteristics of total participant with and without MetS are summarized in Table 1. The mean (± SD) age of men was 37.25(± 4.9) years with the range of 23-73 years. The components of MetS including

FBS, TG, WC, SBP, DBP as well as non-metabolic parameters such as BMI ,age ,smoking status (pack/year) statistically significantly higher in those with MetS (all parameter p<0.001,except smoking status p=0.03). Interestingly, HDL-C was significantly lower in those with MetS (p<0.001). In addition, FEV1 % predicted and FVC1 % predicted were significantly lower in subjects with MetS (both p<0.001) but the difference in values of FEV1, FVC, FEV1/FVC% , FEV1/FVC % predicted, PEF, PEF % predicted ,FEF and FEF 25%75 % predicted were not significant in those with MetS compared to those without MetS.

Table 1. Baseline characteristics of total subjects versus with and without MetS.

Variables	Total (n=3899)	With MetS (7.6% ,n=297)	Without MetS (92.4%,n=3602)	P-value
FBS (mg/dl)	84.04±17.1	90.7±32.0	83.5±15.1	<0.001
TG (mg/dl)	149.7±84.3	223.5±88.9	143.6±81.0	<0.001
HDL-C (mg/dl)	43.23±10.64	34.62±9.21	43.94±10.44	<0.001
Age(yr)	37.25±4.9	38.1±5.2	37.2±4.9	<0.001
WC (cm)	92.96±9.2	102.6±10.2	92.2±8.63	<0.001
BMI(kg/m^2)	27.03±3.42	30.2±3.5	26.8±3.3	<0.001
Smoking status(pack/year)	2.07±4.6	2.8±5.8	2.0±4.5	=0.03
SBP (mmHg)	113.95±10.01	122.9±11.8	113.2±9.5	<0.001
DBP (mmHg)	74.8±6.9	80.8±8.2	74.4±6.5	<0.001
FVC (liter)	4.93±0.69	4.90±0.74	4.94±0.69	=0.34
FEV1 (liter)	3.89±0.56	3.83±0.60	3.89±0.56	=0.07
FEV1/FVC%	78.9±5.37	78.35±5.82	78.93±5.34	=0.099
PEF (ml/s)	9.64±1.51	9.81±1.64	9.63±1.50	=0.051
FEF2575 (ml/s)	3.71±0.96	3.63±1.01	3.71±0.96	=0.148
FVC%	0.94±0.10	0.92±0.10	0.95±0.10	<0.001
FEV %	0.93±0.11	0.90±0.11	0.93±0.11	<0.001
FEV/FVC %	0.97±0.06	0.97±0.07	0.98±0.07	=0.215
PEF %	0.96±0.14	0.97±0.15	0.97±0.14	=0.686
FEF 25%75 %	0.91±0.23	0.89±0.25	0.92±0.23	=0.055
FVC Predicted	5.20±0.44	5.30±0.46	5.20±0.44	<0.001
FEV1 Predicted	4.18±0.36	4.24±0.38	4.18±0.36	=0.009
FEV1/FVC Predicted	80.57±1.86	80.44±1.58	80.58±1.88	=0.214
PEF Predicted	9.98±0.59	10.11±0.60	9.97±0.59	<0.001
FEF25%-75% Predicted	4.06±0.39	4.10±0.48	4.06±0.38	=0.119

MetS=metabolic syndrome; BMI=body mass index; FBS=fasting blood sugar; TG=triglyceride; HDL= high density lipoprotein; WC=waist circumference; SBP=systolic blood pressure; DBP=diastolic blood pressure; FEV1=forced expiratory flow of first second; FVC=forced vital capacity; FEF=forced expiratory flow; PEF=peak expiratory flow

The overall prevalence of MetS was 7.6% (n=297). In men with MetS, the most common component were increased TG (90.2%, n=268), decreased HDL-C (77.8%, n=231), increased WC (65%, n=193), elevated BP (52.2%, n=155), elevated SBP (34%, n=101), elevated DBP (38.4%, n=114), increased FBS (30.3%, n=90), respectively. The total prevalence of reduced lung function in subjects with MetS was 13.8% (n=41) among those, the most prevalence was restrictive patterns (7.1%, n=21) and obstructive pattern (5.4%, n=16) and mixed pattern (1.3%, n=4) were in next places.

In one way ANOVA, there was considerable difference in the values of WC (p<.001), DBP (p=.043), SBP (p=.006) and BMI (p=.001), age (p=.005) among respiratory patterns. The greatest values of BMI were observed in restrictive pattern (27.95±4.23 kg/m2), but; the greatest value of WC (97.69 ± 8.52 cm). SBP (118.85±10.2mmHg) and DBP (76.35±6.18mmHg), the most pack/year history

of smoking (4.23±5.98 pack/yr) and the oldest age (39.92±6.4 yr) were seen in mixed pattern. There was no statistically considerable difference in the values of FBS (p=.675), HDL-C (p=.392), TG (p=.673) among respiratory patterns.

Also, there was considerable difference in the value of FEV1, FVC (both p=.003) among non-diabetic, IFG and DM men. The lowest values of FEV1 and FVC were seen in subject with DM (4.69±.71, 3.69±.57); respectively. These values were significantly lower compared to normal subjects (both p=.006) but not compared to those with IFG (p=.140, p=.143 respectively). There were no considerable difference in the value of FEV1/FVC (P=.956), FEF25%-75% (P=.932), PEF (P=.395) among non-diabetics, diabetics and subjects with IFG.

In one way analysis of covariance (ANCOVA), after adjusting the factors including age, BMI, height, weight, smoking status, cardiopulmonary and thyroid diseases, MetS were independently associated with reduced FVC(p=.004) and FEV1, (p=.007), but there was no considerable association between MetS and FEV1/FVC(p=.942), FEF 25%75%(p=.363) and PEF (p=.746).

Table 2 show the partial correlation analysis between components of MetS and pulmonary indices after adjusting age, height, weight, BMI and smoking status. There was weak but considerable positive correlation between HDL-C and FEV1(r=.043, p=.007), HDL-C and FVC(r=.070, p<.001), SBP and PEF(r=.038,p=.018), DBP and PEF(r=.046,p=.004). On the other hand, There was weak but considerable negative correlation between TG and FV1(r=-.041,p=.010), TG and FVC(r=-.037,p=.021), HDL-C and FEV1/FVC(r=-.035,p=.027) and WC with each of FEV1(r=-.139,p<.001), FVC (r=-.161,p<.001), FEF25%-75% (r=-.057,p<.001) and PEF(r=-.035,p=.030).

Table 2. Partial correlation between components of MetS and pulmonary parameters analysis after adjusting age, height, weight, and BMI and smoking status based on Pearson correlation coefficient R (p-value in parenthesis)

	FEV1(liter)	FVC(liter)	FEV1/FVC %	FEF25%75%(ml/s)	PEF(ml/s)
FBS(mg/dl)	-.016(p=.317)	-.016(p=.314)	-.002(p=.885)	-.006(p=.706)	.011(p=.492)
TG(mg/dl)	-.041(p=.010*)	-.037(p=.021*)	-.010(p=.538)	-.026(p=.109)	-.008(p=.600)
HDL(mg/dl)	.043(p=.007*)	.070(p<.001*)	-.035(p=.027*)	-.008(p=.624)	.012(p=.469)
WC(mg/dl)	-.139(p<.001*)	-.161(p<.001*)	.023(p=.154)	-.057(p<.001*)	-.035(p=.030*)
SBP(mmHg)	-.020(p=.206)	-.025(p=.113)	.007(p=.642)	.007(p=.671)	.038(p=.018*)
DBP(mmHg)	-.019(p=.241)	-.030(p=.065)	.017(p=.294)	.008(p=.614)	.046(p=.004*)

MetS=metabolic syndrome; BMI=body mass index; FBS=fasting blood sugar; TG=triglyceride; HDL= high density lipoprotein; WC=waist circumference; SBP=systolic blood pressure; DBP=diastolic blood pressure; FEV1=forced expiratory flow of first second; FVC=forced vital capacity; FEF=forced expiratory flow; PEF=peak expiratory flow
*=p<.05 was significant

We used stepwise five models linear regression analysis with progressive degree of adjustment to predict pulmonary indices from metabolic values (FBS, TG, HDL-C, WC, DBP, SBP) and demographic variables. Model 1 was adjusted for age, BMI, smoking status and history of cardiopulmonary and thyroid diseases and metabolic values. Model 2 was resembling

the model 1 except for adding the weight and dropping the BMI Model 3 was resembling the model 1 except for adding the height and dropping the BMI. Model 4 was resembling the model 1 except for adding the height and weight and dropping the BMI. Model 5 was resembling the model 1, but concurrent height, weight and BMI was considered.

Table 3. Stepwise five linear regression models with progressive degree of adjustment to predict pulmonary parameters from metabolic values (FBS, TG, HDL-C, WC, DBP, SBP) and demographic variables (Age, Height, Weight, BMI, Smoking status, Cardiopulmonary and thyroid diseases).

	FEV1(liter)				FVC(liter)				FEV1/FVC %				FEF25%75%(ml/s)				PEF(ml/s)			
	R	Adjusted R^2	SEE	Sig	R	Adjusted R^2	SEE	Sig	R	Adjusted R^2	SEE	Sig	R	Adjusted R^2	SEE	Sig	R	Adjusted R^2	SEE	Sig
Model 1	.339[a]	.113	.52758	.000	.319[a]	.099	.65507	.000	.153[a]	.021	5.319	.000	.228[a]	.050	.93829	.000	.206[a]	.040	1.47733	.000
Model 2	.468[b]	.217	.49558	.000	.495[b]	.243	.60068	.000	.180[b]	.030	5.294	.000	.261[b]	.066	.93034	.000	.286[b]	.080	1.44628	.000
Model 3	.601[c]	.359	.44834	.000	650[c]	.421	.52533	.000	.190[c]	.034	5.284	.000	.301[c]	.088	.91898	.000	.357[c]	.125	1.40996	.000
Model 4	.605[d]	.364	.44658	.000	.656[d]	.429	.52160	.000	.194[d]	.035	5.281	.000	.302[d]	.089	.91872	.000	.361[d]	.128	1.40800	.000
Model 5	.605[e]	.364	.44663	.000	.656[e]	.429	.52164	.000	.194[e]	.035	5.281	.000	.302[e]	.089	.91883	.000	.361[e]	.128	1.40817	.000

a. Predictors: Age, BMI, Smoking status, Cardiopulmonary and thyroid diseases, FBS, TG, HDL-C, WC, SBP, DBP
b. Predictors: Age, Weight, Smoking status, Cardiopulmonary and thyroid diseases, FBS, TG, HDL-C, WC, SBP, DBP
c. Predictors: Age, Height, Smoking status, Cardiopulmonary and thyroid diseases, FBS, TG, HDL-C, WC, SBP, DBP
d. Predictors: Age, Height, Weight, Smoking status, Cardiopulmonary and thyroid diseases, FBS, TG, HDL-C, WC, SBP, DBP
e. Predictors: Age, Height, Weight, BMI, Smoking status, Cardiopulmonary and thyroid diseases, FBS, TG, HDL-C, WC, SBP, DBP
BMI=body mass index; FBS=fasting blood sugar; TG=triglyceride; HDL= high density lipoprotein; WC=waist circumference; SBP=systolic blood pressure; DBP=diastolic blood pressure; R2=R squared; FEV1=forced expiratory flow of first second; FVC=forced vital capacity; FEF=forced expiratory flow; PEF=peak expiratory flow; SEE=standard error of estimate; Sig=significance

As shown in Table 3 all five models were statistically significant (p<.000) for predicting pulmonary indices but sequential increase in R and adjusted R-squared in first four models were seen. This means, the sequential increasing role of anthropometric values including BMI, weight, height, and concurrent height and weight in predicting the pulmonary indices. Also, model 5, shows that simultaneous adjustment of BMI, height and weight had no additional effect in predicting the pulmonary indices in comparison with height and weight only.

Based on linear regression analysis, among the components of MetS (Table 4), WC was the most powerful predictor for FEV1, FVC, FEF25%-75% (all p <.001) and PEF (P=.024) but not for FEV1/FVC (P=.158). This means that a 1 cm increment in WC was accompanied with 13 ml decrement in FEV1 and 18 ml decrement in FVC and 11 ml/s decrement in both FEF25%-75% and PEF. HDL-C was the second most powerful predictors for FEV1 (p=.027), FVC (p=.000) and FEV1/FVC (p=.015) but not for FEF25%-75% (P=.398) and PEF (p=.555).This means that a 1 mg/dl increment in HDL-C was accompanied with 2 ml increment in FEV1 and 3 ml increment in FVC and 0.02% decrement in FEV1/FVC. None of metabolic components including SBP, DBP, FBS and TG, were a good predictors for pulmonary indices (all p>.05). Among the non-metabolic components, age was the most powerful predictors for pulmonary

indices (all p <.000) and height was the second most powerful predictor for FVC, FEV1 (both p<.001) and PEF (P=.029) but not for FEV1/FVC (p=.112) and FEF25%-75% (p=.079). Smoking history of pack-year was associated with significant reduction in FEV1, FEV1/FVC, FEF25%-75% and PEF (all p <.001) but not for FVC (p=.962). In contrast to WC, weight and BMI were not good predictors for any of the pulmonary indices (all p>.05). Among the anthropometric values (height, weight, BMI, WC), height was the most powerful predictor of FEV1, FVC, PEF with positive association. Also, WC was the most powerful predictor of FEF25%-75% with negative association. None of anthropometric values were a good predictor of FEV1/FVC. Importantly, WC as a marker of abdominal fat accumulation was a better predictor of reduced lung function than BMI as a marker of total body fat accumulation.

Table 4. Linear regression analysis between the components of MetS and baseline characteristics with pulmonary parameters.

	FEV1(liter)			FVC(liter)			FEV1/FVC %			FEF25%75%(ml/s)			PEF(ml/s)		
	β	SEE	Sig	β	SEE	Sig	β	SEE	Sig	β	SEE	Sig	β	SEE	Sig
Age	-.022	.002	.000	-.021	.002	.000	-.107	.018	.000	-.029	.003	.000	-.022	.005	.000
Height(cm)	.047	.009	.000	.066	.010	.000	-.166	.104	.112	.032	.018	.079	.061	.028	.029
Weight(kg)	.004	.009	.698	.005	.011	.614	.054	.109	.620	.002	.019	.903	.020	.029	.487
BMI	.012	.028	.679	.019	.033	.570	-.289	.336	.390	.008	.059	.895	-.019	.090	.833
Smoking status (pack / year)	-.005	.002	.000	-.005	.002	.962	-.113	.018	.000	-.017	.003	.000	-.025	.005	.000
Cardiopulmonary and thyroid diseases	-.036	.014	.009	-.032	.016	.042	-.250	.162	.121	-.042	.028	.139	-.141	.043	.001
FBS	.000	.000	.714	.000	.000	.761	-.001	.005	.839	.000	.001	.868	.001	.001	.506
TG	.000	.000	.057	.000	.000	.204	-.001	.001	.279	.000	.000	.098	.000	.000	.664
HDL	.002	.001	.027	.003	.001	.000	-.020	.008	.015	-.001	.001	.398	.001	.002	.555
WC	-.013	.002	.000	-.018	.002	.000	.026	.018	.158	-.011	.003	.000	-.011	.005	.024
SBP	.000	.001	.721	.000	.001	.979	-.007	.013	.598	.000	.002	.912	.002	.003	.640
DBP	.000	.002	.669	-.002	.002	.249	.021	.018	.256	.001	.003	.713	.008	.005	.092

MetS=metabolic syndrome; BMI=body mass index; FBS=fasting blood sugar; TG=triglyceride; HDL= high density lipoprotein; WC=waist circumference; SBP=systolic blood pressure; DBP=diastolic blood pressure; FEV1=forced expiratory flow of first second; FVC=forced vital capacity; FEF=forced expiratory flow; PEF=peak expiratory flow, β= regression coefficient; SEE=standard error of estimate

Discussion

In the current study, the total prevalence of MetS was 7.6%. Worldwide prevalence of MetS ranges between less than 10% to 84% [8]. Age, sex, ethnicity, diet, physical activity, environmental factor and type of definition of MetS used, all influence the prevalence of the MetS and its components [9]. Based on the review article by Alizade et al. (2016), the prevalence of MetS in Iran is reported between 20% and 35.8% [10]. The reason of low frequency of MetS in our study could be due to possible healthy worker effect [11]. And younger age population and less obesity. The prevalence of reduced lung function in MetS in our study (13.8%) is similar to cross-sectional French survey by Leone et al. (2009) in which the prevalence of 15% was reported [12]. Based on our survey, the most common abnormal respiratory pattern was restrictive (7.1%). Also, the prevalence of obstructive pattern and mixed pattern were 5.4% and 1.3%, respectively. In cross-sectional survey by Choudhary et al. (2016) in India, the 50% prevalence of reduced lung function in subjects with MetS was reported with 33% restrictive patterns (most common),13% obstructive pattern and 4% mixed pattern. Also this study showed that pulmonary function indices are significantly decreased in

subject wit MetS compared to non-MetS subjects [13].

Our data show that values of FVC% predicted, FEV% predicted were considerably lower in men with MetS than those without MetS. Also, there was significant lower values FEV1 and FVC but not FEV1/FVC, FEF25%-75%. PEF in diabetics compared to non-diabetics and IFG subjects. This results was similar to case-control Pakistani survey by Irfan et al. (2011), in which there was considerable decrement in FVC and FEV1 but not FEV1/FVC in diabetic men compared to non-diabetic subject [14]. In cohort study, over American-Indians population in USA, Yeh, Fawn et al. (2011) indicated that reduced FEV1 and FVC were independently accompanied with MetS and DM, and reduced lung function presents before the development of MS or DM [15]. Also, Korean survey by Kim CH et al. (2015) demonstrated that, the reduced FVC, but not FEV1, was accompanied with incremental risk of IFG and type 2 DM [16]. Recent Swedish cohort study by Suneela Zaigham et al. (2016) showed that low FEV1 significantly predicts future DM [17] In Germany Mr.Buchmann et al. (2016) in cross-sectional analysis found that, the FEV1 and FVC values were declined in participants with type2 DM and MetS, anthropometric values such as WC and BMI had a considerable consequences on lung volumes, independent of MetS or type 2 DM [18].

In our study, among the metabolic components, WC was the most important predictor of pulmonary function. A 1-cm increment in WC was accompanied with a 13-mL decrement in FEV1, 18-mL decrement in FVC, 11 mL/s decrement in both FEF25%-75% and PEF without affecting FEV1/FVC. These results are consistent with a Canadian cross-sectional survey by Yue Chen et al. (2007), that a 1-cm increment in WC was associated with a, 11-mL decrement in FEV1 and 13-mL decrement in FVC [19]. In another cross-sectional study by Leone et al. (2009) in France, increment in WC was the strongest predictor of reduced lung function for FEV1 and FVC in both sexes [12]. Also, Wehrmeister et al. (2012) in systematic review and meta-analysis, over 10 paper indicated that increment in WC result in decrement FEV1 and FVC in people older than 18 years with greater effect in men compared with women, without affecting the FEV1/FVC [20]. One theory by which the increment in WC may contribute to reduced lung function include the mechanical impact of abdominal obesity on diaphragm and limiting the diaphragm expansion and descending into abdominal cavity [21-22]. However MetS is associated with inflammation [23] and systemic inflammation caused by MetS may lead to reduced lung function [24].

Based on our result, HDL-C was the second most powerful significant predictor of FEV1 and FVC. Also higher HDL-C was accompanied with considerable higher FEV1 and FVC values (positive correlation) and considerable lower FEV1/FVC values (reverse correlation). Our results were consistent with cohort study reported by Kristin M Burkart et al. (2014) in USA [25] and cross-sectional study by WEI YE et al. (2014) in china over adult obese men (BMI>32 kg/m2) [26]. However, Rogliani et al. (2010) in an Italian cross-sectional study found that HDL-C was the most powerful predictor of FEV1 and FVC changes, with reverse correlation [27].

Our study indicated that, there was no significant difference in the value FEV1/FVC in men with or without MetS. Also none of metabolic components including WC and anthropometric variable including BMI, height and weight were significant predictor of FEV1/ FVC. In cross-sectional American study by Ford ES et al. (2014) subjects with MetS had a higher

FEV1/FVC ratio than those without MetS [28]. In contrary, Van Huisstedeet al. (2013) in cross-sectional study in the Netherlands over morbidly obese patients found there was relatively small but significant lower values of FEV1/FVC in subjects with MetS compared to non-MetS subjects [29].

Our finding indicated that MetS were independently accompanied with decrement in FVC and FEV1 values, without considerable effect on FEV1/FVC, FEF 25%75% and PEF. Similar to our study, Lin WY et al. (2006) in a cross-sectional study in Taiwan [30] and Yue Chen et al. (2007) in a cross-sectional Canadian survey [19] reported that FVC was independently associated with increased risk of MetS.

Myoung-Sook Bae et al. (2012) in cross-sectional Korean survey found WC and TG levels had significant negative correlation with FVC among males, but positive correlation between FVC with HDL-C. Also TG levels showed negative correlation with FEV1, while WC showed positive correlation with FEV1/FVC ratio [31]. This was compatible with our study.

Conclusions

We found a positive independent association between MetS and reduced lung function in adult men, mainly due to increased WC and decreased HDL. Pulmonary function test may be used as a complementary exam in the evaluation of MetS.

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