Metabolic Syndrome in Military Aircrew Using a Candidate Definition

Sanjiv Sharma; AM Chandrashekar; Vishal Singh

INTRODUCTION: Prevalence of metabolic syndrome (MetS) in the Indian population varies from 31.6 to 41.1%. Indians, without being conventionally obese, but inherently insulin resistant, have higher risk of developing cardiovascular diseases and diabetes. Since military aircrew, belonging to the same ethnic pool, may reflect similar prevalence of MetS as the general Indian populace, this study was undertaken to find the prevalence of MetS among Indian military aircrew using one candidate definition.

METHODS: In this cross sectional descriptive study, 210 military aircrew voluntarily participated. Besides demographic and lifestyle related details, their anthropometric measurements, including height, weight, waist circumference, hip circumference, and skin fold thickness were recorded. Body mass index and waist-to-hip ratio were deduced from the recorded measurements. Resting heart rate and blood pressure were recorded and appropriate laboratory investigations were undertaken.

RESULTS: Prevalence of MetS, as per chosen definition, was 33.3% ($N = 70$), which had moderate, fair, and slight agreement with NCEP ATP III ($k = 0.43$), IDF ($k = 0.27$), and WHO ($k = 0.15$) definitions, respectively. Decadal prevalence of MetS was found to be highest in the fourth decade (46.8%), followed by the third decade (41.3%).

CONCLUSION: Reported prevalence of MetS highlights an urgent need to define preventive strategies to minimize loss of trained manpower among military aircrew. Flight surgeons have an important role to play to educate aircrew about modifying their lifestyle to reduce morbidity and mortality among themselves in the future.

KEYWORDS: metabolic syndrome, prevalence, ethnicity, Indian, morbidity, mortality.

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India has the largest burden of diabetes mellitus (DM), which continues to increase[27] while cardiovascular disease (CVD) is the leading cause of mortality among all noncommunicable diseases.[28] This shift in disease pattern towards noncommunicable diseases is likely due to changing socioeconomic conditions affecting nutrition and lifestyle, along with an increase in obesity.[17] Abdominal adiposity among South Asians is significantly more than other ethnic groups.[1,3,4] South Asians, unlike other ethnicities, are apparently inherently insulin resistant[3] without being conventionally obese.

Metabolic syndrome (MetS) is a "constellation of metabolic risk factors" of atherogenic dyslipidemia, elevated blood pressure, and raised plasma glucose, along with underlying risk factors, such as abdominal obesity and insulin resistance, that may lead to atherosclerotic CVD and DM.[5,6] It would not be inappropriate to state that Asians, including Indians, could be classified as 'metabolically obese'[25] since they have several metabolic derangements despite being not obese by conventional body mass index (BMI) standards.[17] This has resulted in both the International Diabetes Federation (IDF)[13] and the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III)[20] taking waist circumference into consideration to modify the definition of metabolic syndrome.

Prevalence of MetS is rising in the Indian population. It varies from 31.6% (NCEP ATP III)[9] to 41.1% (Modified NCEP ATP III).[23] Making a strong argument for modifying BMI, Misra et al.[16] modified NCEP-ATP III criteria to include measurement of subscapular skinfold thickness, in addition to

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using modified waist circumference and BMI cut-off, to compare eight candidate definitions (MS-1 to MS-8).[19] Maximum prevalence (29.9%) of MetS was reported with the MS-4 definition among Indians, offering a greater gain of 20.7% in prevalence as compared to NCEP ATP III criteria. Misra's MS-4 definition is considered most suitable for defining MetS among Asian Indians.[19] As per this candidate definition, MetS is considered to be present if three or more of the following criteria are present: 1) waist circumference $>$ 90 cm for men and $>$ 80 cm for women; 2) serum triglyceride $> 150\ \text{mg} \cdot \text{dl}^{-1}$ ($1.7\ \text{mmol} \cdot \text{L}^{-1}$); 3) HDL cholesterol $< 40\ \text{mg} \cdot \text{dl}^{-1}$ ($1.1\ \text{mmol} \cdot \text{L}^{-1}$) in men and $< 50\ \text{mg} \cdot \text{dl}^{-1}$ ($1.3\ \text{mmol} \cdot \text{L}^{-1}$) in women or treatment for low HDL; 4) blood pressure $>$ 130/85 mmHg or treatment for high blood pressure; 5) serum fasting glucose $> 100\ \text{mg} \cdot \text{dl}^{-1}$ (instead of $110\ \text{mg} \cdot \text{dl}^{-1}$); 6) BMI $> 23\ \text{mg} \cdot \text{kg}^{-2}$ (for both males and females); and 7) subscapular skin fold thickness $>$ 18 mm.

It is essential that military aircrew maintain high standard of physical fitness[11] and be free from diseases or disabilities for optimal performance in their operational roles. It was hypothesized that, coming from the same ethnic pool as the general population, they may have similar prevalence of diseases as in the larger populace. This could be especially true of lifestyle related disease entities like MetS, especially in view of their higher socio-economic status,[2,12] which in turn may also influence their dietary habits. Thus, knowing the prevalence of MetS could be the first step to prevent future morbidity due to impending CVD and DM to conserve this highly trained manpower. Particularly so, flight surgeons or squadron medical officers conducting periodic medical examination of aircrew could play a proactive role in identifying and advocating lifestyle modifications in those aircrew affected by MetS. Hence, this study was undertaken to find the prevalence of MetS among Indian military aircrew using one candidate definition, MS-4,[19] and comparing it with conventional NCEP ATT III, IDF, and World Health Organization (WHO) definitions, respectively.

METHODS

Subjects

This study, a cross sectional descriptive study using single-stage cluster sampling, was undertaken at the Institute of Aerospace Medicine, Bangalore, India, after obtaining ethics clearance from the Institute Ethical Committee. Informed consent to participate in this study was obtained from the volunteering subjects, who were serving Indian military aircrew from all three streams, that is, fighter, helicopter, and transport. During a calendar year 206 men and 4 women, in the age group between 20 to 50 yr, participated in this study.

Procedure

After recording personal details, including name, age, and sex, professional details like medical category and flying experience in hours, relevant history of previous illness or existing comorbidity, if any, such as lipid abnormalities, DM, hypertension, coronary artery disease, etc., were recorded. Relevant history on lifestyle patterns such as smoking habit, alcohol consumption, and physical activity were also noted. Anthropometric measurements, including height, weight, waist circumference, hip circumference, and skin fold thickness from four sites (biceps, triceps, subscapular, and suprailiac), were recorded as per conventional methods. BMI and waist-to-hip ratio (WHR) were deduced from the recorded measurements.

Clinical parameters, including resting heart rate and resting blood pressure in the right arm in a sitting position, were recorded as per conventional clinical methods. Hematological (Sysmex XP-300®, Lincolnshire, IL) and biochemical (ERBA Chem - 5 plus V2®, Mumbai, India) investigations, i.e., fasting blood sugar and lipid profile including total cholesterol, triglyceride, and high density lipoprotein, were undertaken, as per the Institute's standard laboratory procedures. The equipment used were flexible and nonstretchable inch tape, a portable stadiometer with movable head piece mounted on balanced beam scales, an electronic weighing platform, a mercury sphygmomanometer, and calipers (GPM Co.®, Zurich, Switzerland) for measuring skin fold thickness.

Statistical Analysis

The results of this study were analyzed using prevalence rate and decadal prevalence rate. Statistical methods used were the Fischer Exact probability test to find the relationship between MS-4 and other definitions, and Kappa coefficient to find the agreement between two classifications. A P-value of less than 0.05 was considered significant. Statistical analysis was performed using SPSS 16.0® (IBM Corp., India).

RESULTS

The sample population ($N = 210$) included 47% fighter pilots ($N = 98$), 27% helicopter pilots ($N = 58$), 18% transport pilots ($N = 37$), and 8% non-pilot aircrew ($N = 16$). There were 42% smokers and 57% who routinely consumed alcohol, and almost all exercised regularly. Only 24 subjects (11.4%) offered any history of preexisting comorbidity.

Prevalence of MetS, as per MS-4 definition, was 33.3% ($N = 70$) in the sample population (**Table I**). As compared to the MS-4 definition, there was moderate, fair, and slight agreement with NCEP ATP III (k = 0.43, $P = <0.0001$), IDF (k = 0.27, $P = <0.0001$), and WHO (k = 0.15, $P = <0.0001$) definitions, respectively. Decadal prevalence of MetS was found to be highest in the fourth decade (46.8%), followed by the third decade (41.3%), as per MS-4 and also NCEP ATP III definitions (21.3% and 15%, respectively). It was found to be almost the same in both the third (6.3%) and fourth (6.4%) decades using the WHO definition, while it had the highest prevalence in the third decade (11.3%) as per the IDF definition (**Table II**). For the third and the fourth decade, there was moderate and fair agreement between MS-4 with NCEP ATP III (k = 0.40 and

Table I. Gain in Prevalence of Metabolic Syndrome as per the MS-4 Definition and Its Agreement with Conventional Definitions.

METABOLIC SYNDROME	PREVALENCE (*N*)	% GAIN IN PREVALENCE	KAPPA	*P*-VALUE
MS-4	33.3% (70)			
NCEP ATP III	11.9% (25)	21.4	0.43^{+++}	<0.0001***
WHO	3.8% (8)	29.5	0.15^{+}	<0.0001***
IDF	7.1% (15)	26.2	0.27^{++}	<0.0001***

*** Highly significant; Fischer exact probability test.
$^{+}$ Slight, $^{++}$fair, $^{+++}$moderate; Kappa coefficient.

k = 0.47, respectively) and IDF (k = 0.31 and k = 0.24, respectively) definitions, while it had slight agreement with the WHO definition (k = 0.17 and k = 0.14, respectively)

DISCUSSION

This cross-sectional nonrandomized study revealed that almost one-third of Indian military pilots have MetS as per the MS-4 definition.[19] Studies elsewhere found that the prevalence of MetS among Royal Jordanian Air Force pilots ($N = 111$) was 18%,[15] while it was 9.9% among Republic of Korea Air Force aviators ($N = 911$)[24] using NCEP ATP III criteria. Interestingly, a study of "possible future metabolics" among approximately 10,000 German military aircrew members did not find them to have MetS. Though they had single or combined risk factors of obesity, dyslipoprotenemia, and hypertension, their health status was comparable to civilian flying personnel and a military control group.[14] The differences in prevalence found in our study as compared to others are because of the choice of modified definition used to define MetS.[19]

In this study the gain using MS-4 compared to other definitions was 21.4% over NCEP ATP-III, 29.5% over WHO, and 26.2% over IDF definitions, respectively. Prevalence of MetS by the MS-4 definition was maximum and closer to the reported prevalence of 29.9% among the Indian population.[19] Thus, as compared to NCEP, IDF, and WHO, the gain is significant for Indian military personnel using the chosen candidate definition. This definition of MetS incorporates a lower cut-off for waist circumference (>90 cm for men and >80 cm for women) and includes BMI and skin fold thickness to the standard parameters defined by NCEP-ATP III.[19] The IDF also recommended ethnic-specific cut-off of waist circumferences. In addition, skin fold thickness is an important marker of obesity. More importantly, thick truncal subcutaneous tissue is a distinctive feature of the obesity phenotype of South Asians and an important correlate of insulin resistance evident in this ethnic group.[21] The build of Indians is small as compared to the western population and BMI is considered to be a more appropriate tool for evaluation. South Asians have high percentage of body fat and lower muscle mass, despite lower average BMI as compared to Caucasians and African-Americans.[4,17] Interestingly, in this study as well, abdominal obesity, measured by waist circumference,[22] was found even among those with BMI less than 25 $kg \cdot m^{-2}$.

The findings of this study could probably be explained on the basis of lifestyle of the military aircrew, including their relatively higher standard of living with likely indulgence in rich diet. Rapid urbanization and rising incomes in India is leading to an increase in consumption of calorie dense foods and sedentary lifestyle.[18] This could be compounded by probable lack of adequate exercise, despite almost all of them reporting being physically active. Such clustering of risk factors among Indians does not bode well, as is apparent with almost one-third of the sample population being found to have MetS in this study. However, in absence of a study of epidemiological factors of MetS in this study, it is not possible to comment on the likely lifestyle, including nutrition-related factors, to explain the prevalence of MetS reported.

The findings of this study need to be seen in light of Indian ethnicity being known to be more susceptible to CVD and DM.[6,10,26] Especially important is the evident trend of increasing prevalence in the third and fourth decades, when such aircrew, experienced and in supervisory positions, have higher risk of developing CVD or DM. Hence an appropriate definition, like MS-4, the candidate definition in this study, is needed to detect MetS among trained personnel. So the reported prevalence also highlights an urgent need to define preventive strategies to minimize loss of trained personnel among military pilots.

There were several limitations of this study. The data was not randomized because of the small sample size. Aircrew with preexisting medical problems were also included, which could have affected the results. In addition, considering India being a multiethnic nation, there could be wide demographic variations among the sample population studied, which could be a confounder in this study.[18,21]

The existing medical evaluation and disposition policies in the armed forces are restricted to the diagnosis of specific disabilities rather than MetS, since

Table II. Decadal Prevalence of Metabolic Syndrome as per the MS-4 Definition, and Its Agreement with Conventional Definitions.

AGE GROUP ($N = 210$) (NUMBER IN PARENTHESES)	MS-4	NCEP-ATP III	WHO	IDF
20-29 (83)	18.1% (15)	3.6% (3)	0% (0)	1.2% (1)
Kappa		0.29^{+}	--	0.11^{+}
30-39 (80)	41.3% (33)	15% (12)	6.3% (5)	11.3% (9)
Kappa		0.40^{+++}	0.17^{+}	0.31^{++}
40-50 (47)	46.8% (22)	21.3% (10)	6.4% (3)	1.6% (5)
Kappa		0.47^{+++}	0.14^{+}	0.24^{++}

$^{+}$ Slight, $^{++}$fair, $^{+++}$moderate; Kappa coefficient.

the latter is not considered to be a disease entity for determining medical fitness. Flight surgeons/squadron medical officers, being both medical examiner and medical attendant to aircrew under their care, in absence of a medical policy, have an important role to play by offering appropriate lifestyle modification advice to those suffering from MetS.[7] Their most important contribution would be timely detection of MetS and close monitoring to ensure physiological and biochemical fitness of aircrew to ensure their fitness for aviation duties.

Medical authority needs to note the prevalence reported in this study to plan future preventive strategies in view of the predictive progression of MetS to DM, hypertension, coronary artery disease, and its attendant implications on morbidity and mortality.[5] Accordingly, there is a need to draft a protocol for evaluation and medical disposition policy for MetS to ensure flying fitness of aircrew, with emphasis on prevention based on the available body of evidence suggesting long-term morbidity due to CVD and DM.[7,8,10] Toward this, as the first step prior to policy formulation for prevention of MetS, it is recommended that a large scale study be planned.

In conclusion, the prevalence of MetS in military aircrew found in this study was almost similar to that reported in the general Indian population. MetS, a cluster of several metabolic risk factors associated with DM and CVD, is likely to become a major public health concern in the future. A study with a larger sample population may provide a global estimate of the total burden of MetS in the aircrew population. This in turn will help define preventive strategies, with active lifestyle modification and pharmacological intervention, if required, to conserve highly trained personnel in aviation.

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