



## Determinants of metabolic syndrome: a population survey at Bizerte military garrison in 2015-2017.

### Déterminants du syndrome métabolique : étude populationnelle à la garnison de Bizerte en 2015-2017

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#### RÉSUMÉ

**Introduction :** Le syndrome métabolique (SM) est un problème majeur de santé publique à l'échelle mondiale. En Tunisie, peu d'études se sont intéressées à cette pathologie dans la population générale et en particulier en milieu militaire.

**Objectif :** Estimer la prévalence du SM en milieu militaire à la garnison de Bizerte (Tunisie) et d'identifier les facteurs qui lui sont associés.

**Méthodologie :** Une étude transversale analytique a été menée dans la garnison de Bizerte entre 2015 et 2017. La population d'étude était la population militaire active présente au moment de l'enquête et affectée à l'une des 3 principales unités de la garnison et relevant respectivement de la marine, de l'armée de l'air et de l'armée de terre.

La définition adoptée pour le diagnostic du SM était celle de la Fédération Internationale du Diabète 2005 (IDF 2005). Une analyse multivariée par régression logistique binaire a été menée pour déterminer les facteurs indépendamment associés au SM (variable d'intérêt). La saisie et l'analyse des données ont été effectuées à l'aide du logiciel SPSS (version 20.0).

**Résultats :** Durant la période de l'étude, 2500 militaires actifs ont été inclus parmi eux 2418 masculins. L'âge moyen était de  $36,6 \pm 9,1$  ans [20,0 – 59,0]. La prévalence du SM était de 17,7%. Le SM était plus fréquent chez les sujets âgés de 40 ans et plus (23,8% vs 13,1%), célibataires (21,6% vs 13,7%), diabétiques (38,5% vs 15,5%) et chez ceux affectés à l'armée de l'air (23,1% vs 14,6%) en comparaison au reste de la population d'étude. Les facteurs indépendamment associés au SM en analyse multivariée étaient ; l'âge, le statut matrimonial et les forces armées d'appartenance.

**Conclusion :** La prévalence du SM dans notre population militaire était relativement élevée malgré les critères médicaux de sélection imposés avant l'incorporation. Les approches populationnelle et ciblée sont essentielles pour prévenir l'apparition de ce fléau et de prévenir ses complications.

**Mots clés :** Syndrome métabolique ; prévalence; épidémiologie ; population militaire ;Bizerte

#### SUMMARY

**Introduction:** Metabolic syndrome (MetS) is a worldwide major public health problem. In Tunisia, few studies have focused on MetS in general population and in military setting in particular.

**Aim:** To determine the prevalence of the MetS in a military population at Bizerte garrison (Tunisia) and to identify its associated factors.

**Methods:** An analytical cross sectional study was conducted in Bizerte military garrison during the period 2015-2017. The study population was the active military persons who were presents during the time of the survey and assigned at the three main navy, air force and army units of Bizerte garrison. The adopted definition for the diagnosis of MetS was the International Diabetes Federation 2005 (IDF 2005). Multivariate analysis using a binary logistic regression model to identify independent factors to MetS (variable of interest) was performed. Data entry and analysis were performed using SPSS 20.0 Software.

**Results:** During the study period, 2500 active military were enrolled among them 2418 men. The mean age was  $36.6 \pm 9.1$  years [20.0 – 59.0]. The prevalence of MetS was 17.7%. MetS was significantly higher among participants aged 40 and above, (23.8% vs 13.1%), single (21.6% vs 13.7%), diabetic (38.5% vs 15.5%), and assigned in the air force (23.1% vs 14.6%) compared to the rest of the study population. The independent factors identified in multivariate analysis were age, armed forces' affiliation and marital status.

**Conclusion:** The prevalence of MetS in our military population was relatively high despite of the medical criteria imposed before incorporation. Population and targeted approach are needed to prevent this scourge and to protect from the complications.

**Keys words:** Metabolic syndrome; prevalence; epidemiology ; military population ;Bizerte

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## INTRODUCTION

Metabolic syndrome (MetS) is a world major public health problem more and more affecting young people. It increases the cardiovascular risk by a factor of three and the risk of type 2 diabetes by a factor of nine. Its pathophysiology is not unambiguous. Psychological stress, insulin resistance, central obesity are involved [1]. In recent years, Tunisia has begun a triple demographic, nutritional and epidemiological transition linked to many factors such as changes in lifestyle, improvement of socio-economic level and also urbanization. This transition was characterized by an increase in non-communicable diseases, including metabolic disorders [2]. Unfortunately, their prevalence keeps on increasing in Tunisia [3].

Despite the particularities of military population, characterized by the young age, medical selection before the incorporation and active lifestyle, militaries are not spared of these health problems. In fact, non-communicable diseases and cardiovascular risk factors are beginning to emerge and they become a priority for the military health services [4,5]. Few studies have focused on MetS in military settings. Their frequencies are lower compared to those in general population. Moreover, their screening remains justified since this environment is not preserved [6,7]. The implementation of a global strategy that would preserve the low prevalence of MetS seems unavoidable.

The objective of this study was to estimate the prevalence of the MetS and its determinants in a military population at Bizerte garrison in Tunisia according to the International Diabetes Federation definition (IDF 2005).

## METHODS

The data source of this study was based on the "2015 Bizerte military garrison cardiovascular risk factors' survey". It consisted on an analytical cross-sectional survey conducted among active military personnel working in Bizerte garrison (Tunisia) during the period from June 2015 to May 2017.

We included in this survey all soldiers assigned at the three main units of Bizerte garrison and who were present on base during the survey's period. It covered population from both sexes belonging to the Army, Navy or Air Forces units. Recruitment of the surveyed soldiers was done in collaboration with the units' doctors from an exhaustive

nominative listing data bases including all unit personnel. The dates of the investigation were set sufficiently in advance in coordination with the unit commander and after sensitization and awareness sessions to ensure the availability of the personnel.

We not included National Service soldiers due to a recent medical selection (<1 year) at the time of incorporation. Individuals who were on secondment for extended missions or who refused to appear at the various passages in front of the survey team after two successive convocations were also not included.

The most common exclusion criteria included individuals who were transferred to a new assignment far from Bizerte garrison during the study period without ending the interview, the physical examination and/or the biological check-ups of their survey forms.

The survey required the participation of several types of previously trained personnel on how to conduct the survey. Doctors and nurses from the same units carried out detailed physical examination and filled in the survey forms. Biologists and nurses of Military Hospital of Bizerte (MHB) were in charge of blood sampling and screening. Each surveyed subject benefited from a medical questioning, a physical examination and a biological assessment. It included among other things, the age, personal medical history and habits (physical activity, smoking, alcohol consumption), anthropometric measurements (weight, height, waist & hip circumferences and abdominal perimeter) and systolic and diastolic blood pressure (SBP & DBP). Blood sampling was taken on total venous blood after 12 hours of fasting and aimed to explore blood glucose, triglycerides, cholesterol, HDL and LDL-cholesterol. IDF 2005 definition was adopted for MetS [8]. The criteria retained for MetS diagnosis according to IDF definition were: central (abdominal) obesity (mandatory criteria): waist circumference  $\geq 94$  cm for Men (M) and  $\geq 80$  cm for Women (W). And 2 or more of the four here after criteria: Raised concentration of triglycerides:  $\geq 1.50$ g/l (1.7 mmol/L) or specific treatment of this lipid abnormality. Reduced concentration of HDL-cholesterol: HDL-C  $< 0.4$ g/l (1.03 mmol/L) (M) and  $< 0.5$ g/l (1.29 mmol /L) (W) or specific treatment for this lipid abnormality. Raised blood pressure: SBP  $\geq 130$  mmHg or DBP  $\geq 85$ mmHg or treatment of previously diagnosed hypertension. Raised concentration of fasting plasma glucose (FPG) or FHG (Fasting Hyperglycemia):  $\geq 1$ g/l (5.6 mmol/l) or previously

diagnosed type 2 diabetes or treatment of this abnormality. According to WHO (World Health Organization) definition [9]: overweight BMI [25-30] kg/m<sup>2</sup>; obesity: BMI ≥ 30 Kg/m<sup>2</sup> with BMI (Body Mass Index): weight(Kg) / height<sup>2</sup> (meters). Diabetes was defined using the American Diabetes Association (ADA) 2017 definition [10]: FPG ≥ 1.26 g/L (7.0 mmol/L).

Data entry and analysis were achieved using SPSS 20.0 software. The variables were described by a central trend indicator (percentages or means) and a dispersion indicator (standard deviation for quantitative variables). The comparison of the different percentages was made using chi-squared test whereas the comparison of the different means was achieved with a Student's test and with one-way analysis of variance. We measure the association between qualitative variables and the outcome variable (MetS) using crude Odds Ratio (OR) and their 95% confidence interval (95% CI) (precision of the OR) for univariate analysis. The significance level retained was 5%. In order to determine the MetS risk factors, a multivariate logistic regression analysis was performed. In the regression model, we introduced explanatory variables which significance level (p-value) were less than 0.2 in the univariate analysis. Validity conditions of the logistic regression were checked so that we had at least five events per introduced explanatory variable. Moreover, the adequacy of the model was verified with non-significance Hosmer-Lomeshow tests (the null hypothesis of this test was that the theoretical probabilities were close to the observed ones). Adjusted Odds-Ratios (aOR) and their 95% CI were presented for the independent variables retained in the final model.

## RESULTS

### Population's characteristics:

During the study period, a total of 2500 active militaries were included among them 2418 men. The mean age was 36.6 ± 9.1 years [20.0 – 59.0] years old and 56.9% were aged under 40 years old. Most of them (87.0%) were educated to secondary level. Less than half (45.4%) were native of Bizerte city. Table 1 presented the distribution of the study population in terms of age classes, rank category and belonging armed forces. No medical history was reported in 80.1% of individuals at the time of the survey. The most common antecedent was obesity or overweight

(16.0%) followed by diabetes in 2.3% of cases. More than half of the surveyed individuals (52.4%) practiced regular physical activity and 51.3% were smokers; 12.3% of them either consumed or they were still consuming alcohol.

**Table 1.** Population distribution by age group, rank category and armed forces, Bizerte military garrison, 2015-2017

	a. Number (n)	c. Valid
<b>c. Age groups (years)</b>		
d. < 25	e. 255	f. 10.4
g. 25-34	h. 830	i. 33.7
j. 35-44	k. 810	l. 32.9
m. 45-55	n. 547	o. 22.2
p. >55	q. 20	r. 0.8
<b>s. Rank category</b>		
t. Troopers (corporals)	u. 790	v. 32.30
w. Non-commissioned officers	x. 1498	y. 61.20
z. Officers	aa. 160	ab. 6.50
<b>ac. Armed Forces</b>		
ad. Navy	ae. 1230	af. 49.20
ag. Air force	ah. 920	ai. 36.80
aj. army	ak. 350	al. 14

### Metabolic syndrome components' abnormalities

Abdominal obesity prevalence was 49.5%. It increased significantly with age (58.5% among those aged 40 and above, p < 0.0001). Waist Circumference mean was 92.3 ± 14.3 cm. High blood pressure (HBP) prevalence was 11.9% and reached 17.0% among those aged 40 and above (p < 0.0001). Prevalence of FHG was 14.2% and increased to 20.4% in individuals aged 40 and above (p < 0.0001). This prevalence was 19.3% among Navy personnel, whereas it was 11.3% among those of air force and 3.46% among army personnel (p < 0.0001). About one quarter of obese subjects had FHG (24.7%). Hypertriglyceridemia prevalence was 28.2% with a prevalence of hypo-HDL-cholesterolemia of 46.7% (Table 2).

**Table 2.** Frequencies of metabolic syndrome components' abnormalities, Bizerte military garrison, 2015-2017

Component	Valid frequency (%)
Abdominal obesity	49.5
High blood pressure	11.9
Fast Hyperglycemia	14.2
Hypertriglyceridemia	28.2
Hypo-HDL-cholesterolemia	46.7

### Prevalence of metabolic syndrome

Prevalence of MetS was 17.7% in our study population: 17.9% among men vs 8.3% among women ( $p=0.08$ ). It varied significantly with age (from 4.8% among participant aged < 25 years, to 15.8% among those aged >55 years;  $p < 0.0001$ ). This prevalence reached 23.8% among individuals aged 40 and above, while it was 13.1% for those aged less than 40 years ( $p < 0.0001$ ). It was 21.6% in single persons and 13.7% among married ones ( $p < 0.0001$ ). Among air force soldiers, this prevalence was 23.2%. However, it was respectively 15.8% and 10.1% at Navy and Army personnel ( $p < 0.001$ ). Troops were the least affected by MetS (12.4%), whereas officers were the most affected (22.1%) followed by non-commissioned officers (20.2%) ( $p < 0.0001$ ). MetS prevalence was higher among military members who lived at home (19.2%) compared to those who lived in military barracks (13.1%) ( $p = 0.001$ ).

Among diabetics, prevalence of MetS was 38.5%. However, it was 15.5% for individuals without diabetes history ( $p < 0.0001$ ). Among obese or overweight individuals, the prevalence was 25.1%. Regarding dyslipidemic patients, MetS prevalence was 58.5%. Among participants with sedentary lifestyle, this prevalence was 46.7% ( $p = 0.011$ ). Besides, the prevalence varied significantly according to the history of tobacco consumption (12.3% for  $\leq 10$  years & 27.6% for  $> 20$  years,  $p = 0.001$ ).

The logistic regression identified "age, armed forces and marital status" as independent variables predictive of MetS: The association between MetS and age persisted after adjusting for the other variables in the final model. In fact, surveyed subjects aged 40 and above were twice as

likely to have MetS as those under 40 (aOR = 2.0; 95% CI [1.6-2.5]). Single members were at a higher risk of having a MetS than those married (aOR = 1.4; 95% CI [1.1-1.8]). Air Force and Navy personnel had a higher risk of having a MetS than Army personnel with respectively aOR = 1.9; 95% CI [1.3-2.7] and 1.3; 95% CI [1.2-1.8]) (Table 3).

**Table 3:** Crude and adjusted odds ratios (and 95% confidence intervals) from logistic regression analyses identifying associations between selected characteristics and metabolic syndrome, Bizerte military garrison, 2015-2017

Factors <sup>1</sup>	Crude OR <sup>2</sup> [95% CI] <sup>3</sup>	Adjusted OR <sup>2</sup> [95% CI] <sup>3</sup>	p-value
<b>Advanced age</b>			<b>&lt;0.001</b>
< 40 years (Ref)	1	1	
$\geq 40$ years	2.1 [1.7-2.6]	2.0 [1.6-2.5]	
<b>Marital status</b>			<b>0.002</b>
Married (Ref)	1	1	
Single	1.8 [1.4-2.2]	1.4 [1.1-1.8]	
<b>Armed forces</b>			<b>&lt; 0.001</b>
Army (Ref)	1	1	
Navy	1.4 [1.1-2.0]	1.3 [1.2-1.8]	
Air	2.3 [1.6-3.2]	1.9 [1.3-2.7]	

<sup>1</sup>Analysed factors: age, marital status, army, grade, educational level, place of residence, working history, tobacco use.

<sup>2</sup>OR: Odds- Ratio of the category compared to the reference category.

<sup>3</sup>CI: Confidence interval (95%).

## DISCUSSION

The cross-sectional study conducted in 2015-2017 among 2500 active military in Bizerte garrison (Navy, Army and Air Force) demonstrated that MetS prevalence was 17.7% according to the IDF 2005 definition. This prevalence is considered as relatively high for a military population where recruitment is based on medical selection. In fact, those developed a high risk for cardiovascular diseases are declared inaptness for incorporation.

The independent risk factors of MetS revealed in multivariate analysis were age above or equal to 40 years, single marital status and air and navy armed forces.

To the best of our Knowledge, this study was the first military MetS survey in Bizerte region. Few studies had addressed military MetS nationally and internationally. A multi-varied analysis by logistic regression of the various factors made it possible to retain an association between MetS and advanced age, marital status, armed forces and unit belonging and seniority of consumption.

Over the past two decades, MetS has become more and more frequent. This frequency increase has been associated with an epidemic of obesity and diabetes [11]. Several studies have been conducted all over the world in order to determine the prevalence of MetS in a particular population, a particular region or a whole country. A study conducted in Great Tunis in 2004-2005 on individuals aged 35 to 70 years old concluded to a MetS prevalence of 31.2% based on NCEP-ATPIII definition. This prevalence was 23.9% for men and 37.3% for women [12]. Another study conducted on 2680 Tunisian adults during the same period showed a prevalence of 35.9% according to the same definition [13]. In our study, people aged 40+ were twice as likely to develop a MetS as the people aged under 40s. In Tunisia, this perception has been reported by Belfki and al. for both men and women, but this increase was greater among women [14]. Risk of developing a MetS was higher in our study among singles. It seems to be linked to their unhealthy lifestyle based on unbalanced diet, smoking, stress, heavy drinking and lack of physical exercise.

It appears that military population was not spared from MetS public health problem despite its particularities in terms of medical selection imposed on recruitment and lifestyle based on regular and often sustained physical activity. A survey conducted on a Tunisian military cohort in 2008 reported a MetS prevalence of 17.6% [15]. Recently, a national survey was conducted in Tunisia in 2016 (representative sample, Tunisian Health Examination Survey) among 839 subject aged 20 years and above: the prevalence of MetS was 39.7% ; 95% CI [35.7%-43.9%] according to IDF 2005 definition and it was significantly associated with female gender (aOR=1.8; 95% CI [1.2-2.7]), age group 60-69 years (aOR=23.9; 95% CI [8.8-64.9]) and illiterate/primary education (aOR=1.7; 95% CI [1.2-2.5]) and sedentariness (aOR =1.15; 95% CI [1.07-1.2]) [16]. This prevalence was 20.8% in male Saudi soldiers aged 20 to 60 years old and 18% in Jordanian Royal Air Force pilots in 2007 [17,18]. A French study,

conducted in 2003-2004 among 2045 soldiers, showed a prevalence of 9.0%. This prevalence increased from 5.0% in militaries aged 25-29 years old to 21.0% among those aged 50-54 years old [19]. In the United States, data generated from a sample of 312 US army soldiers in 2010 estimates MetS prevalence at about 26.0% [20]. This prevalence was 17.6% in the Brazilian Navy is and nearly one-third of the participants had two or more risk factors of this syndrome [21].

Our study noticed that MetS prevalence was more than double in air base personnel compared to army group (10.1%) who had also a lower risk of developing a MetS compared to those at the naval base (OR = 0.5; 95% CI [0.3-0.7]). The influence of urban or rural residency has not been studied, however 54% of individuals with MetS were smokers. These differences may be related to the particularities of each armed force category (nature of the daily tasks, mandatory regular physical activity, lifestyle, nature of the diet). These results were consistent with those of Sharma and al [22]. who noted that the high MetS prevalence was the result of Indian Air Force personnel lifestyle. It was based on a diet rich in calories and a high frequency of sedentary lifestyle. On the other hand, they concluded that there was a lack of physical activity in this population, despite the fact that most of the participants claimed to be physically active. MetS prevalence among diabetic patients was 38.5% compared to 15.3% for those no diabetic. A survey conducted in 2005 over a sample of 8007 subjects in Ariana region concluded that among the total population the prevalence of the MetS was higher in urban areas compared to rural areas (34.0% vs. 24.2%) [14]. Kiani and al estimated MetS prevalence in 300 type 2 diabetic patients about 83% [23]. Therefore, the tobacco role in MetS development was not statistically significant. Relationship between MetS and smoking has been well established, in fact the causal association between smoking and the MetS components was confirmed as well [24]. However, in EPIMIL study conducted in the French army, smokers were more frequent in the population presenting MetS (30.3% against 24.0% for those unhurt by MetS). Moreover, the average smoking consumption (evaluated in pack-year) was also higher within this population ( $7.8 \pm 11.0$  pack-year versus  $3.9 \pm 8.0$  pack-year) [6]. The pooled prevalence of MetS in military population based on IDF definition highlighted by systematic reviews and metanalysis varied between 9.6% (95% CI [4.7%–18.8%]) to 21% (95% CI [17%–25%]) [25,26].

At national level, a strategy to fight obesity was in pilot phase in the city of Bizerte (pilot city) and Mahdia (control city) with the prospect of being extended to other regions (5 strategic axes of the program to fight obesity (2013-2017) [27]. In addition, the implementation of the National Multisectoral Strategy for Prevention and Control of Non-Communicable Diseases (NCDs) 2018-2025 allow to reduce the prevalence of modifiable risk factors (tobacco consumption, physical inactivity and unhealthy diet) and to promote a healthy lifestyle [28].

### CONCLUSION

The prevalence of MetS in this study was relatively high but below the national average. Our military population was not spared from this scourge despite the selection imposed on its personnel before the recruitment, its lower average age and its professional lifestyle based on a regular physical training.

The determinants of this syndrome as identified in our study were extrinsic and could be targeted by preventive measures. Changes in lifestyle, eating habits and economic progress in Tunisia, contributed to the genesis of several metabolic disorders that represent MetS building blocks.

MetS in military population encourage to set up a global strategy combining two approaches. A population approach based on a primary prevention which is important in order to avoid or to postpone the appearance of risk factors and associate military unit physicians to sensitize soldiers to adapt a healthy lifestyle based on a balanced diet, regular physical activity and to quit smoking intoxication. Moreover, regular screening programs may also allow to detect metabolic abnormalities and to introduce a medication treatment in time in order to avoid or to minimize the cardiovascular complications of these metabolic disorders. Others studies should be conducted in military population to follow MetS prevalence trend (prospective cohort studies). A high-risk (targeted) approach that aims to early detect these factors and to take an energetic care of subjects who already have metabolic abnormalities.

### REFERENCES

1. Delarue J, Allain G, Guillem S. Le syndrome métabolique. *Nutrition Clinique et Métabolisme*. 2006;20(2):114-7.
2. Ben Romdhane H, Khaldi R, Oueslati A, Skhiri Aouinallah H. La transition épidémiologique en Tunisie, ses déterminants et son impact sur les systèmes de santé. *2002*;(41):7-28.
3. Essais O, Jabrane J, Bouguerra R, El Ati J, Ben Rayana C, Gaigi S, et al. Distribution et prévalence des dyslipidémies en Tunisie : Résultats de l'enquête nationale de nutrition. *Tunis Med*. 2009;87(8):505-10.
4. Allani R, Skhiri H, Bachrouh S, Mouaoui N, Ghyoula M, Ben Romdhane H. Les facteurs de risque cardio-vasculaire chez une population militaire : Le point de vue du médecin d'unité. *Revue Tunisienne de la Santé Militaire*. 2005;7:320-6.
5. Gotto AM, Whitney E, Stein EA, Shapiro DR, Clearfield M, Weis S, et al. Relation between baseline and on-treatment lipid parameters and first acute major coronary events in the Air Force/Texas Coronary Atherosclerosis Prevention Study (AFCAPS/TexCAPS). *Circulation*. 2000 Feb 8;101(5):477-84.
6. Bauduceau B, Baigts F, Bordier L, Burnat P, Ceppa F, Dumenil V, et al. Epidemiology of the metabolic syndrome in 2045 French military personnel (EPIMIL study). *Diabetes Metab*. 2005 Sep;31(4 Pt 1):353-9.
7. Ceppa F, Merens A, Burnat P, Mayaudon H, Bauduceau B. Military community: a privileged site for clinical research: Epidemiological Study of Metabolic Syndrome Risk Factors in the Military Environment. *Mil Med*. 2008 Oct;173(10):960-7.
8. Yadav D, Mahajan S, Subramanian SK, Bisen PS, Chung CH, Prasad G. Prevalence of Metabolic Syndrome in Type 2 Diabetes Mellitus Using NCEP-ATPIII, IDF and WHO Definition and Its Agreement in Gwalior Chambal Region of Central India. *Glob J Health Sci [Internet]*. 2013 Nov [cited 2021 May 30];5(6):142-55. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4776883/>
9. World Health Organization. Obesity [Internet]. [cited 2021 May 30]. Available from: <https://www.who.int/westernpacific/health-topics/obesity>
10. American Diabetes Association. Standards of Medical Care in Diabetes 2017. United States: ADA; 2017.
11. Eckel RH, Grundy SM, Zimmet PZ. The metabolic syndrome. *The Lancet [Internet]*. 2005 Apr 16 [cited 2021 May 30];365(9468):1415-28. Available from: [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(05\)66378-7/abstract](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(05)66378-7/abstract)
12. Allal-Elasmi M, Haj Taieb S, Hsairi M, Zayani Y, Omar S, Sanhaji H, et al. The metabolic syndrome: Prevalence, main characteristics and association with socio-economic status in adults living in Great Tunis. *Diabetes & Metabolism [Internet]*. 2010 Jun [cited 2021 May 30];36(3):204-8. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S1262363610000303>
13. Ben Ali S, Belfki H, Aounallah-Skhiri H, Traissac P, Maire B, Delpeuch F, et al. Prevalence and determinants of the metabolic syndrome among Tunisian adults. *Revue d'Épidémiologie et de Santé Publique*. 2012 Sep 1;60:S98-9.

14. Belfki H, Ben Ali S, Aounallah-Skhiri H, Traissac P, Bougateg S, Maire B, et al. Prevalence and determinants of the metabolic syndrome among Tunisian adults: results of the Transition and Health Impact in North Africa (TAHINA) project. *Public Health Nutr.* 2013 Apr;16(4):582–90.
15. Allani R, Bouomrani S, A M, R B, Saidi O, Asli S, et al. Prévalence du syndrome métabolique dans une cohorte de militaire du sud tunisien. *Revue internationale des services de santé des forces armées: organe du Comité international de médecine et de pharmacie militaires = International review of the armed forces medical services: organ of the International Committee of Military Medicine and Pharmacy.* 2014 Jan 1;87:5–11.
16. Tunisian national public health institute. results Tunisian health examination survey 2016. Tunis:INSP; 2019.
17. Al-Qahtani D, Imtiaz M. Prevalence of metabolic syndrome in Saudi adult soldiers. *Saudi medical journal.* 2005 Oct 1;26:1360–6.
18. Khazale NS, Haddad F. Prevalence and characteristics of metabolic syndrome in 111 Royal Jordanian Air Force pilots. *Aviat Space Environ Med.* 2007 Oct;78(10):968–72.
19. Bauduceau B, Baigts F, Bordier L, Burnat P, Ceppa F, Dumenil V, et al. Epidemiology of the metabolic syndrome in 2045 French military personnel (EPIMIL study). *Diabetes Metab.* 2005 Sep;31(4 Pt 1):353–9.
20. Crombie AP, Sanders LF, Sigris LS, Walker LA, Young AJ. Prevalence of the Metabolic Syndrome in Active Duty Soldiers Enrolled in the Army Weight Control Program. *Journal of the American Dietetic Association [Internet].* 2010 Sep 1 [cited 2021 May 30];110(9, Supplement):A28. Available from: <https://www.sciencedirect.com/science/article/pii/S0002822310008059>
21. Costa FF da, Montenegro VB, Lopes TJA, Costa EC. Combination of risk factors for metabolic syndrome in the military personnel of the Brazilian Navy. *Arq Bras Cardiol.* 2011 Dec;97(6):485–92.
22. Sharma S, Chandrashekar AM, Singh V. Metabolic Syndrome in Military Aircrew Using a Candidate Definition. *Aerosp Med Hum Perform.* 2016 Sep;87(9):790–4.
23. Kiani IG, Khan AN, Yasir S, Baluch UT. FREQUENCY OF METABOLIC SYNDROME IN TYPE-2 DIABETES MELLITUS. *J Ayub Med Coll Abbottabad.* 2016 Mar;28(1):59–62.
24. Balhara YPS, Kalra S, Bajaj S, Kuppili PP, Himanshu D, Atam V, et al. Uttar Pradesh Association of Physicians of India Position Statement: Tobacco Use and Metabolic Syndrome. *J Assoc Physicians India.* 2017 Dec;65(12):66–72.
25. Baygi F, Herttua K, Jensen OC, Djalalinia S, Mahdavi Ghorabi A, Asayesh H, et al. Global prevalence of cardiometabolic risk factors in the military population: a systematic review and meta-analysis. *BMC Endocrine Disorders [Internet].* 2020 Jan 13 [cited 2021 May 30];20(1):8. Available from: <https://doi.org/10.1186/s12902-020-0489-6>
26. Rostami H, Tavakoli H, Rahimi M, Mohammadi M. Metabolic Syndrome Prevalence among Armed Forces Personnel (Military Personnel and Police Officers): A Systematic Review and Meta-Analysis. *Military Medicine.* 2019 Jun 27;184.
27. El Ati J, Zouari B, Delpuch F, Hsairi M, Alouane L, Aounallah Skhiri H, et al. Stratégie Nationale de Prévention et de Lutte contre l'Obésité. Tunis: MSP; 2016.
28. Ministère de la Santé. Stratégie Nationale Multisectorielle de Prévention et Contrôle des Maladies Non Transmissibles(MNT) 2018-2025. Tunis: MSP; 2020.