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Full Length Research Paper

The relationship between physical inactivity and bad snacking on metabolic syndrome

Sihem Souissi[1], Fethi Ben Slama[2], Asma Ayed[3], Habib Askri[3], Tohami khelifi[3], Nabil Guermezi[3] and Omrane Belhadj[1]

[1]University Tunis El Manar, Faculty of Science of Tunis, Laboratory of Biochemistry and Technobiology.
[2]National Institute of Public Health of Tunisia
[3]Expertise Centre for Aviation Medicine of Tunis

*Corresponding Author E-mail: sihemsouissi2000@gmail.com; Telephone: 96543543

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The study is to evaluate the influence of an unhealthy lifestyle mainly physical inactivity and bad snacking on the development of obesity and metabolic syndrome in a Tunisian civil air navigating population. The study was conducted at the Aviation Medical Expertise Center, over a period of three years; it derived from a going on prospective study. This study focused on three groups of male subjects aged between 25 and 65 years. Their selection is based on BMI and FID criteria of metabolic syndrome. P1 (n = 35): population with metabolic syndrome only, P2 (n = 38) population with metabolic syndrome and obesity, P3 (n = 48) obese population. The three groups (P1, P2 and P3) have low regular physical activity, less than 150'/week, respectively 40 % vs. 26, 3% vs. 43, 8 % (the difference are not significant p = 0.07), only P1 have a frequency for physical activity (greater than 3 times per week) than P2 and P3 (p=0.001). But the benefits of exercise can be neutralized by a snacking based at high glycemic index or fat and simple carbohydrates foods at P1. Also P1 have the less percentage for snaking in front TV or computer than P2 and P3. Therefore P1 have a BMI <30 kg/m^2, but the waist size is greater than 94 cm as much as P2 and P3. This type of practice (activity and snacking) conducted by P1 can save obesity (BMI), but not visceral obesity. P1 and P2 are older than P3 and have a function of captain, which requires more vigilance of responsibility and a lot of stress mainly than P3. These explain why P1 are not obese but have a metabolic syndrome. This study will continue on other parameters defining the lifestyle, including tobacco, alcohol consumption and diet imbalance; to specify which of these parameters leads to visceral obesity (waist size greater than 94 cm).

Keywords: Obesity, metabolic syndrome, physical activity, inactivity, snacking

INTRODUCTION

Obesity has become a major public health problem threatening the quality of life of many people. It leads to other metabolic disorders and constitutes a major cardiovascular risk. In fact, 50% to 66% of the world population is overweight or obese (Balkau et al., 2007) and more than 17 million people die per year due to obesity and excess of abdominal fat (major criteria of metabolic syndrome) which increase significantly the risk of cardiovascular diseases and Type 2 Diabetes Mellitus (OMS, 2003). The development of obesity and metabolic syndrome is due to several factors mainly dietary unbalance and unhealthy lifestyle, including a high consumption for the food with a high glycemic index and lack of physical activity.

We conducted our study to assess the influence of a bad snacking with inactivity on the metabolic syndrome in a Tunisian civil air navigating population.

MATERIALS AND METHODS

Study Population

This study was conducted over a period of three years (between September 2011 and September 2014) at the Aviation medical expertise center (CEMEDA); it derived from a going on prospective study. The study focused on three groups of male subjects aged 25-65 years, and practicing the same function (flight crew in civil aviation):

- P1 is composed of 35 patients with metabolic syndrome only. The average age are 47, 86 ± 27,54 years.
- P2 is composed of 38 patients with metabolic syndrome and obesity. The average age are 47,11±33,18 years.
- P3 is composed of 48 patients obese only. The average age are 39,19 ± 31,94 years.

The criteria were based on BMI and FID criteria of metabolic syndrome:

*BMI> 30kg/m^2

*The FID criteria of metabolic syndrome (FID, 2006):

Central obesity (waist circumference> 94 cm in male)

Plus two of the following four factors:

- high triglycerides ≥ 150 mg/dL (1.7 mmol/L), or specific treatment for this lipid abnormality
- Fasting plasma glucose ≥ 100 mg/dL (5.6 mmol/L), or previously diagnosed type 2 diabetes. If above 5.6 mmol/L or 100 mg/dL, OGTT is strongly recommended but is not necessary to define presence of the syndrome.
- Raised blood pressure: systolic BP ≥ 130 or diastolic BP ≥ 85 mm Hg, or treatment of previously diagnosed hypertension
- Reduced HDL cholesterol : < 40 mg/dL (1.03 mmol/L) in male, or specific treatment for this lipid abnormality

The selection of the three groups was based on the medical records which include BMI, waist circumference and biological analyzes that define the various criteria of metabolic syndrome.

Methods

We collected firstly general information from each subject by a pre established questionnaire, including (age, sex, marital status, personal and family history,). Then we focused on the lifestyle of the patient, which includes several elements (site, 2015). In this study, we focused mainly on physical activity, inactivity and type of snacks, because of their influence on the health of our population.

Statistical Analysis

At first our data was captured using the Excel version 2007 software. Statistical analysis was performed using SPSS Version 15 software.

Comparing two averages was made by Student's test.

The comparison was made of the percentage by the chi-square test of Pearson and if not valid, by the Fisher exact two-tailed test. The level of significance was accepted $p < 5\%$.

RESULTS

From Table No. 1, P1 and P2 population have almost the same average age, respectively, 47, 86 ± 9,855 years vs. 47, 11 ± 10,182 years, with a non-significant difference. As against the average age for the P3 population is equal to 39,19 ± 9,589 years, with a significant difference between P2 and P3 (p= 0,001), and between P1 and P3 (p= 0,0001). So P3 is a younger population average ages that P1 and P2.

The last two P2 and P3 populations are obese with a BMI>30kg/m2, respectively 32,61 ± 3,548 vs. 31,87± 2,124 kg/m^2, by against P1 is overweight with a BMI<

Table 1. The average age, BMI and waist circumference of the three populations

	Population N°1	Population N°2	Population N°3
Average age (years)	47,86 ± 9,855	47,11± 10,182	39,19 ± 9,589
Level of Significance	DNS* between P1 and P2	DS** between P2 and P3 (p = 0,001)	DS between P1and P3 (p= 0,0001)
Average BMI (kg/m^2)	27,55 ± 1,954	32,61 ± 3,548	31,87± 2,124
Level of Significance	DS between P1 and P2 (p = 0,0001)	DS between P2 and P3 (p = 0,0001)	DS between P1 and P3 (p = 0,0001)
Average Waist circumference	100,19 ± 5,574 cm	108,82 ± 11,334 cm	104,49 ± 12,918 cm
Level of Significance	DS between P1 and P2 (p = 0,0001)	DS between P2 and P3 (p = 0,028)	DS between P1 and P3 (p = 0,013)

P1: people with metabolic syndrome only
P2: people with metabolic syndrome and obesity
P3: people obese without metabolic syndrome
*DNS = no significant difference, **DS = significant difference

Table 2. The health status of the three populations by function

function	Population N°1	Population N°2	Population N°3
Captain	62,9%	57,9%	37,5%
Airline pilot	37,1%	42,1%	62,5%

P1: people with metabolic syndrome only
P2: people with metabolic syndrome and obesity
P3: people obese without metabolic syndrome
$X^2 = 6,2$; $p = 0,45$

Table 3. The time spent watching TV or computer between the three populations

		Mean	SD	p
Time in minutes spent watching TV	P 1	114.86	64.46	DNS between P1 and P2 (p= 0.13)
	P 2	151.18	100.25	DS between P2 and P3 (p=0.009)
	P3	100.66	61.96	DNS between P1 and P3 (p=1.000)
Minute time spent at the computer	P 1	84.85	57.51	DNS between P1 and P2 (p=1.000)
	P 2	85.28	60.04	DNS between P2 and P3 (p=0.33)
	P 3	107.5	71.25	DNS between P1 and P3 (p=0.34)

P1: people with metabolic syndrome only
P2: people with metabolic syndrome and obesity
P3: people obese without metabolic syndrome

30kg/m^2, is equal to 27,55 ± 1,954 kg/m^2, The difference is significant between the three populations (p = 0.0001).

The three populations (P1, P2 and P3) have circumference greater size values of IDF (> 94 cm), respectively 100,19 ± 5,574 vs. 108,82 ± 11,334 vs. 104,49 ± 12,918 cm. With a significant difference between P1 and P2 (p= 0,0001), between P2 and P3 (p=0,028) and between P1 and P3 (p= 0,013).

The results of the first survey showed that the percentage of people who practices captain function is greater in P1 than P2; the latter has a greater percentage than P3, respectively 62.9% vs. 57. 9% vs. 37.5%, with a non-significant difference (p= 0,45).

Physical activity

The percentage of people who do not practice physical activity is higher among people obese and with metabolic syndrome (P2) than in the two population P3 (people obese) and P1 (people with metabolic syndrome only), respectively 52, 6% vs. 33, 3 % vs. 28, 6% (the difference are not significant p = 0.07). Energy expenditure of the

Table 4. The comparison of the duration, frequency and intensity (type), of physical activity between the three populations

	P 1	P 2	P3	level of significance
Zero minutes / week	28 ,6%	52.6%	33, 3%	X_1^2 = 5.2 (P = 0.07)
< 150 ' / week	40 %	26.3%	43,8%	X_1^2 = 2.9 (P = 0.23)
≥ 150 ' / week	35.3%	21.1%	22,9%	X_1^2 = 2.3 (P = 0.32)
Endurance activity	60 %	34.2%	47,9%	X2 = 4,88 (P = 0.08)
Strength activity	14.3%	13.2%	18,8%	NS
Physical activity < 3 times per week	48.6%	86.8%	56,3%	X2 = 13,4 (P = 0.001)
Physical activity ≥ 3 times per week	51.4%	13.2%	43,8%	X2 =13,4 (P = 0.001)

P1: people with metabolic syndrome only
P2: people with metabolic syndrome and obesity
P3: people obese without metabolic syndrome

Table 5. The habit snacking while watching TV

	P 1	P 2	P3	p
snacking while watching TV or computer	45,7%	60,5%	64,6%	0,45
Nibbling on fatty foods	31,4%	28,9%	50,0%	0,45
Nibbling simple carbohydrate	22.9%	42.1%	50,0%	0.04
Nibbling foods high in simple carbohydrates and fats	11,4%	15,8%	33,3%	0,03
Nibbling fresh fruit	17.1%	15.8%	18,8%	0.45

P1: people with metabolic syndrome only
P2: people with metabolic syndrome and obesity
P3: people obese without metabolic syndrome

three populations is limited by an extremely sedentary work (steering). But, the difference between the three population are that P1 practice more physical activity than P2 and P3, for this P1 are not obese. When the duration of physical activity is greater than or equal 150'/week, we have noted no significant difference between the three populations P1, P2 and P3 respectively, 35,3% vs. 21,1% vs. 22,9% (p =0.32).

The difference in the intensity of physical activity is also no significant between the three populations, P1, P2 and P3. In fact, P3 practices a more strength activity than P1 and P2, respectively 18.8% vs. 14.3% vs. 13.2%. But the differences are not significant (see Table No. 3).

However, the difference in the frequency of physical activity is significant in the three populations. P1 practice greater than or equal to 3 times per week physical activity, more than P3 and P2, respectively 51.4% vs. 43,8% vs. 13.2% (p= 0.001) (see Table No. 1).

Inactivity

The two populations P1 and P3 show almost equally the same time seated to watch TV (less than 2 hours / day) with a non-significant difference (see Table No. 4). But P2 show more than 2 hours / day to watch TV, respectively 114.86 ± 64.46 vs. 100.66 ±61.96 vs. 151.18 ±61.96 minutes. There's no significant difference between P1 and P2 (p=0.13), P1 and P3 (p=1.000), but the difference is significant between P2 and P3 (p=0.009). The three populations spend less than 2 hours / day in a sitting position when using the computer. P3 use more computer than P2 or P1, respectively 107.5 ±71.25 vs. 85.28± 60.04 vs. 84.85± 57.51; with a non-significant difference (P> 0.05), (see Table No. 4). But the three populations use computer at the same time when they watches TV. So, we can deduct that the three populations spend more than 2 hours / day in sitting position when using the computer and watching TV.

In addition, the three populations P1, P2 and P3 use the car as the unique and only means of transport, respectively 94.3% vs. 97.4 % vs. 100 % 5p= 0.25). We note here very low energy expenditure for the three populations for a day, almost equal to the expense of resting metabolism. Mainly the time spent in time zone is very important (time of flight), thus reinforcing the sitting position, therefore increasing the inactivity.

Snacking habits in both groups

we find that the P3 nibbles in sitting position (In front of the TV or computer) food rich in fatty more than P2 or P1, respectively 50,0% vs. 28,9% vs. 31,4%, with no

significant difference (p= 0.45). The difference is significant when snacking is based on foods rich in simple carbohydrates or foods combined with fat and simple carbohydrates. P3 nibbles carbohydrates with high glycemic index (sugar and sweets) including candies, soft drinks, artificial juices, beer, sugar in coffee and tea ..., more than P2 or P1, respectively 50,0% vs. 42,1% vs. 22,9%, with significant difference (p= 0.04).

Also, P3 nibbles more foods rich in simple carbohydrate and fat, cookies, cakes, ice cream, chocolate ...more than P2 or P1 respectively 33,3% vs. 15,8% vs. 11,4%, with significant difference (p= 0.03). But, the three populations nibble less fresh fruit than food rich in simple carbohydrates and fat, with no significantly different (p=0.45).

DISCUSSION

The epidemic of obesity (OMS, 2003) and the development of metabolic disorders are related in a major part to an unhealthy lifestyle, including not only alcohol consumption, smoking, physical inactivity…, but also the modification of diet in a quantitative and or qualitative way. Indeed the increase in caloric intake, primarily an excess of fats and sweets, associated to physical inactivity (OMS, 2004; Sabrina, 2008), causes an imbalance between intake and expenditure (Healy et al., 2007). Caloric intake is provided by food, but the caloric expenditure of the human body is provided by four parameters: basal metabolism, postprandial thermo genesis, thermoregulation and physical activity or muscle exercise (Michael, 2008) (30% of total energy expenditure). According to Rigaud and Melchior in 1992 (Obesity, 2003), the first three parameters vary depending on the body of individuals, but the physical exertion varies according to the will and effort provided by the person (Escalon H. and al., 2009). Indeed, it can range from 15-20% at a sedentary person to more than 50 % in a very active subject (study of Saris 1996) (Livingstone, 2003).

In our study, despite P1 she is not obese (overweight), but it presents the criteria of metabolic syndrome. For against P2 and P3 both are obese, but P3 is metabolically healthy, by against P2 present the criteria of metabolic syndrome. The common point between these three populations is the waist circumference which is greater than 94 cm (presence of visceral fat), see table N°1. Indeed, several studies have discussed the contradictory relationship between body weight and metabolic disturbances (Emmanual et al, 2009). Indeed, there are metabolically obese normal-weight (MONW) individuals (Ruderman et al., 1998), who are frequently not detected because of a falsely reassuring body weight, and, in contrast, there is a metabolically healthy, but obese, people (MHO) (Sims, 2001; Esser et al., 2009). In our study, we detected three different populations: the metabolically sick population overweight (having the criteria of the metabolic syndrome) (MONW), metabolically healthy obese population (MHO), and the obese metabolically unhealthy population. The prevalence of this population (MONW) can be estimated between 5 and 10% according to studies (Beck, 2009; Beck et al., 2008). This population is characterized by a relative excess of visceral adipose tissue and insulin resistance, and has a risk factors for the development of type 2 diabetes and cardiovascular disease. However, these MONW subjects may not receive adequate prevention programs and treatment due to body weight normal or barely increased, falsely reassuring. As against the prevalence of the population (MHO) is estimated at least 20% (Esser, 2009; Esser et al. 2009). Nevertheless this population is free of all metabolic disturbances, even if obesity is extreme.

Several studies have shown that the prevalence of metabolic syndrome (MS) increases with age, in parallel with that of obesity (Azizi et al. 2003; Cameron et al., 2007). Similarly Balkau (Balkau et al., 2003) demonstrated in the French population increased prevalence MS with age: 5.6% among 30- 39 years, 10% for 50-59 years and 17.5% among 60-64 years. We find the same results in our study, that more we advance in age, more the prevalence of MS increases. Also, in our study, we find that prevalence of MS is correlated with the function. The more the job is stressful and requires responsibility, the more the prevalence of MS increases (see table N°2). This article aims to present the impact of some of the parameters (sedentary lifestyle, physical activity and snacking) contributing to the healthy lifestyle on these three types of different populations.

According to our study, we found that there was no significant difference between the three populations in energy expenditure concerning the time spent sitting to watch TV, use the computer, (see table N°3). Also, the difference is no significant in the practice of physical activity between the three populations. P1 may be sedentary, but active. Indeed, it has a greater than 150 minute's weekly physical activity at a frequency of 3 times a week than P2 and P3 (see table N°4). Moreover, P1 has frequently low daily energy expenditure but maintained over time (besides sports) shopping on foot, bringing children from school on foot, their leisure time is spent in gardening, raising some animals and do-it-yourself. All these activities were cited by a large number of people from the P1 population , but were not qualified as a physical activity, this is coherent with the results of the study led by Russell R. Pate (Russel et al., 2008) recording for a day, a low physical activity spread over a more or less long time (13 hours/day), generates a high cost of energy expenditure, while another person who

practices physical activity (moderate or force) in a regular but short time (1 hour/day) low cost of energy expenditure. The study of Healy and al in 2007 (Healy et al., 2007) showed that low physical activity is associated with a normal glucose value, but the glucose intolerance was observed during sedentarity (2 h after ingestion of glucose orally). Also according to the study of Hu 2003 (Hu et al., 2003), which showed that people who spend more than 2 hours per day sitting in front of the TV or in their offices each have a risk of respectively 23% and 5% to be obese and 14% and 7% have a high risk of T2DM. However, the act of practicing low physical activity (standing, walking, and doing household chores) for 2 h / day leads to a 9% reduction in obesity and 12% of type 2 diabetes (T2DM). This can explain why P1 have lower BMI than P2 or P3, so is not obese population.

Having regard to the foregoing, a relevant question is required: why P1 population are not obese, but have metabolic syndrome compared to the P3 population, which no have metabolic syndrome, despite being obese and it is as much sedentary as P2 (population obese and with metabolic syndrome)?

Regular physical activity can't however be sufficient to make energy balance negative. In fact, the benefits of exercise can be neutralized within minutes by eating food rich in fat (Bellisle, 1999). Snacks are based only on foods with high glycemic index or fatty foods, were observed in P3, than P2 or P1 ($p=0.04$ and $p= 0.03$). It is obvious that foods with a high glycemic index will cause a blood sugar imbalance and that the long -term consumption of sugars is associated with an increased risk of type 2 diabetes and cardiovascular diseases. Indeed, in the American journal of clinical nutrition, researchers have shown (study conducted between 1997 and 2010) the correlation between the amount of food that rapidly releases sugar with a high glycemic index and the development of type 2 diabetes. They found that the more diet is rich in foods with a high glycemic index, greater the risk of having type 2 diabetes (Willett et al., 2002). Also, studies in animals nourished with a high fat diet all become obese (Bray et al., 1998; Bray et al., 2004; Hill et al., 2000). The experiments carried out on humans have shown that high energy and fat intake is strongly and positively associated with the prevalence of overweight (Goldstein, 1992). This can explain why P2 and P3 are obese (BMI> 30kg/m^2), but P1 are not obese. Indeed, if we compare the three populations P1, P2 and P3 when snacking qualitatively in sedentary position, we find that no significant difference between the three population (see table N°5). However a high consumption of vegetables and fruit has a beneficial effect on the health of humans. Available data indicate that people who consume more fruit and vegetables often have a lower prevalence of risk factors for cardiovascular disease (Bellisle, 1999), hypertension, obesity and T2DM (Bazzano et al., 2003). Fruits are rich in vitamins, minerals and antioxidants, they play an important role in protecting our body (Willcox, 2004; Wojcik et al., 2004), and their consumption is associated with a low prevalence of certain cancers (He et al., 2007; Soerjomataram et al., 2010) and other chronic diseases (Harding et al., 2008). Finally and according to the World Health Organization (WHO), an adequate intake of fruits and vegetables would save 2.7 million lives a year. Thus P3 who have no metabolic syndrome nibbles fresh fruit than P1 or P2, but the difference is no significantly. The three groups have low regular physical activity, only P1 have a frequency for physical activity (greater than 3 times per week) than P2 and P3. And have the less percentage for snaking in front TV or computer than P2 and P3. Therefore P1 have a BMI <30 kg / m^2, but the waist size is greater than 94 cm. This type of practice (activity and snacking) conducted by P1 can save obesity (BMI), but not visceral obesity. Healthy lifestyle associated to balanced diet is fundamental for the effective protection of the crew health. Indeed, eviction of tobacco and alcohol, consumption of five fruits and vegetables per day and practicing physical activity for 30 minutes a day, can increase life hope of 14 years. That's way prevention (education, sensitization) is fundamental to a good life quality but, the effectiveness of this prevention depends tightly on awareness and individual will.

CONCLUSION

Obesity and metabolic syndrome does not stop increasing from one year to another. The growth of this epidemic is due in a major part to unhealthy lifestyle. In this study P1 has a BMI <30 kg / m^2, this population has a higher energy expenditure to the other two populations (P2 and P3) in frequency. Moreover, it nibbles less food in sedentary position (front of the TV or computer); mainly it nibbles fewer foods that are high in simple carbohydrates or in fat and simple carbohydrates, than P2 and P3. Thus, P1 is classified as non-obese populations. But this is a population with the criteria of the metabolic syndrome. Indeed, P1 and P2 are older than P3 and have a function of captain, that requires more vigilance of responsibility and a lot of stress mainly than P3 (based on the increase in the number of years of service in this task). This may be one of the causes of the presence of the metabolic syndrome. To establish a right conclusion; we still have to compare the other parameters that affect the lifestyle of these three populations, namely, consumption of alcohol and tobacco, as well, that the dietary imbalance.

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