ACTA SCIENTIFIC NUTRITIONAL HEALTH (ISSN:2582-1423)

Volume 4 Issue 10 October 2020

Research Article

Quality of Diet and Diagnosis of Nutritional and Metabolic Status in Inhabitants of a Rural Community in Mexico with High Intake of Wild and Cultivated Mushrooms

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Received: July 29, 2020

Published: September 30, 2020

Abstract

Objective: The prevalence of metabolic diseases in rural communities has been associated with the increase of hypercaloric diets, and the reduction in regional food consumption. The quality of diet and the frequency of mushroom consumption in inhabitants of a rural community in Mexico, as well as their nutritional and metabolic status, were investigated.

Design: Cross-sectional study in adults during July-August-2019.

Setting: It was performed in the rural community of Yuvila, Santa Catarina Ixtepeji, Oaxaca, Mexico.

Participants: 49 adult volunteers aged 18 to 72 signed an informed consent after explaining their participation in the study.

Intervention: A 24-hour reminder was applied, weight, height, percentage of total fat, waist and hip circumference, waist/hip index, blood pressure, glucose levels, triglycerides (TG) and total cholesterol (TC) were taken in capillary blood.

Results: There was a high consumption of macronutrients (> 100% adequacy: energy, proteins, carbohydrates, sugar and fats), and low consumption of vitamins and minerals (< 60% adequacy: B6, B5, B9, B12, K and Zn). We found an oscillation in the consumption of 8 wild mushrooms ranging from 4% to 96% of their intake. A combined prevalence of overweight and obesity of 79.6% was observed, 27% of the participants presented glucose levels ≥ 110 mg/dl 60% with TG ≥ 150 mg/dl and 30% with CT ≥ 200 mg/dl.

Conclusion: There is a decrease in the consumption of local foods and an increase in the intake of carbohydrates and fats that are causing metabolic diseases in rural communities.

Keywords: Rural Community; Obesity; Mushrooms; Macronutrients; Triglycerides; Cholesterol; Glucose

Introduction

In recent decades, globalization, loss of biodiversity, preference for industrialized foods rather than traditional ethnic foods, as well as the migration from the countryside to the city have led to a drastic change in lifestyle, causing a lethal effect in the health conditions of the population, which is associated with the increase in morbidity and mortality due to chronic diseases [1]. Unhealthy eating plays a significant role in the risk of developing chronic

health conditions such as cardiovascular disease, obesity, diabetes and hypertension [2]. In this sense, the modernization of the diet in Mexico is related to the abandonment of rich and wise national food traditions in favor of the adoption of a western model of consumption rich in industrialized foods with high costs in health, economy and ecology [3]. In this transition, it has been added to the traditional Mexican diet based mainly on corn, beans and other natural foods, high energy density foods, especially low-priced industrialized soft drinks and flour, which could explain the increase in overweight and obesity in adults from high-marginal populations [4]. Metabolic diseases such as obesity, type 2 diabetes mellitus, dyslipidemias, hypertension and cardiovascular diseases are increasing alarmingly worldwide. This prevalence is reaching rural communities where the consumption of native foods should protect people's health. The National Mid-Way Health and Nutrition Survey (ENSANUT MC) 2016 [5], indicates that obesity in urban areas is 75% and in rural communities it is 45%, while in 2012, they were of 75% and 33% respectively. In the specific case of Oaxaca state, in 2012, the combined prevalence of overweight and obesity in men was 59.4% and in women 69.2%. However, there is no evidence of contrast between urban and rural areas. In relation to the prevalence of arterial hypertension and diabetes by prior diagnosis, the state of Oaxaca was below the national average (15.9% and 7%, respectively) [6].

Edible wild mushrooms and other non-timber forest products are a relevant element in the food and income of several million households worldwide. So, governments and institutions have begun to value their importance within rural communities because of their contribution to food self-sufficiency and obtaining income [7]. In the state of Oaxaca, edible mushrooms have been valued in indigenous communities for generations, with extensive traditional knowledge and have been part of their economy based on exchange and barter [8].

In 2017, in the northern Sierra of Oaxaca, a different consumption was observed for each species of mushrooms. For example: *Pleurotus* sp. had the highest perceived abundance, *Cortinarius* sp. (*Malacii* section) had the highest traditional importance, identifying only *Tricholoma magnivelare* as a medicinal species [9]. Edible wild mushrooms have unique nutritional properties and these vary due to factor such as the species, the development of the sporoma, the region of the world where they grow, time of year, type of soil, among others and even the analytical method used to calculate its nutritional value [10].

Objective of the Study

The objective of this work was to know the quality of diet and the frequency of consumption of edible mushrooms, as well as the nutritional and metabolic status of the adult population of the community of Yuvila, Santa Catarina Ixtepeji, Oaxaca, Mexico.

Materials and Methods

Study area

The town of Yuvila, Santa Catarina Ixtepeji, is located in the region of the northern highlands of Oaxaca and belongs to the Distric of Ixtlan de Juarez. It is located at coordinates 17º 16' north latitude and 96º 34' west longitude, at an altitude of 1920 meters above sea level. The municipality has an area of 209.52 km^2 and represents 0.21% of the total area of the Oaxaca state [11]. For the town of Yuvila the population in 2010 was 320 inhabitants, 175 women and 145 men [12].

Recruitment of volunteers

The population of Yuvila has 198 adults (18 to 72 years old). Two sensitization workshops were held, with themes of healthy eating, and through them, adults between 20 and 72 years old were invited to participate in the study. 49 volunteers participated. The exclusion criteria were: 1) people under 18 and over 72 years; 2) pregnant women; 3) people with pacemakers (due to the use of bio-impedance) and 3) people prescribed with some modification of food intake. To begin with the nutritional assessment and detection of metabolic parameters, participants approved their participation through and informed consent form. The study complied with the guidelines established I the Declaration of Helsinki and the Committee of Ethics in Sciences of the "Colegio de Posgraduados, Campus Puebla, Mexico" (CP0011).

Evaluation of the quality of diet and frequency of mushroom consumption

To know the quality of the diet, a 24-hour reminder was made, through a validated format. To calculate the percentage of adequacy of energy consumption, macronutrients and micronutrients, the guide "Dietary reference intake" was used [13]. The recommendations of the Spanish Atherosclerosis Society were used to calculate total, monounsaturated (MUFA), polyunsaturated (PUFA), saturated (SAT) and cholesterol fats. The energy was adjusted for sex, age, weight and height, according to the formula of the estimated energy requirement (EER), the protein calculation was 0.8g protein/kg body weight; carbohydrate consumption was 45 - 65% in

relation to EER; fiber was estimated at 14 g/1000 kcal; total fats were calculated from 30 - 35% based on EER; saturated fats < 10% of total fat; monounsaturated fats were < 7% based on total fats; and cholesterol was 200 mg/day. Retinol (vitamin A) was 625 µg/day for men and 500 µg/day for women; thiamine (vitamin B1) was 1 mg/day for men and 0.9 mg/day for women; riboflavin (vitamin B2) of 1.1 mg/day for men and 0.9 mg/day for women; niacin (vitamin B3) of 12 mg/day for men and 11 mg/day for women; pyridoxine (vitamin B6) was adjusted for age and sex (1.1 mg/day for men and women over 50 years); cobalamin (vitamin B12) was 2 µg/day; calcium was 1000 mg/day for > 18 years and < 50 years and 1200 mg/day for > 51 years; iron for men was 6 mg/day and for women of 19 to 50 years was 8.1 mg/day and > 51 years was 5 mg/day; magnesium was 350 mg/day for men and 265 mg/day for women; sodium for men aged 18 to 50 years was 1.5 g/day, > 50 years and <70 years was 1.2 g/day, and for women it was 2.3 g/day; selenium was 45 µg/day for men and 55 µg/day for women; zinc was 9.4 mg/day for men and 6.8 mg/day for women. The percentage of adequacy was compared with the daily average nutrient intake in relation to the dietary reference intakes [13]. To know the consumption of edible mushrooms, we ask about the most consumed wild and cultivated mushroom and their culinary preparation. The frequency of consumption was: never or < 1 time per month, 1 - 3 times per month, 1 - 2 times per week, 3 - 4 times per week, 5 - 6 times per week and daily. The Nutrikal Vo 2016 software for data analysis was used (Consifo, S.C., México).

Assessment of nutritional status

The participants were presented with a fast from 10 to 12 hrs. The weight and percentage of body fat was estimated using and OMRON HBF-514C brand scale (0.1 kg precision) (Omron Healthcare, INC, Illinois, U.S.A.). The reference values for body fat percentages 14 were the following: a) Slim: men < 8.0%, women < 15.0%; b) Optimal: men 8.1 - 15.9%, women 15.1 - 20.9%; c) Slightly overweight: men 16.0 - 20.9%, women 21.0 - 25.9%; d) Overweight: men 21.0 - 24.9%, women 26.0 - 31.9%; and e) Obese: men ≥ 25.0%, women ≥ 32.0%. The height was taken with a stadiometer of the brand BAME 420 (0.1 cm precision). The nutritional status assessment was performed using the Body Mass Index (BMI). Valid data were considered as all those height values between 1.3 to 2.0m and the BMI values between 10 and 58 kg/m^2. Data outside these size ranges, BMI, as well as cases of pregnant women, were excluded from the analysis. The classification used to categorize BMI was that of WHO: malnutrition (< 18.5 kg/m^2), normal (18.5 to 24.9 kg/m^2), overweight (25.0 - 29.9 kg/m^2), obesity grade I (30.0 - 34.9 kg/m^2), obesity grade II (35.0 - 39.9 kg/m^2), obesity grade III (> 40.0 kg/m^2). A 2-meter Lufkin executive thin line anthropometric tape was used for waist and hip circumference, which is validated by ISAK (The International Society for the Advancement of Kinanthropometry) (Lufkin Industries, Inc, Texas, U.S.). The abdominal perimeter was classified according to the International Diabetes Federation (IDF). With the measurements obtained, the waist-to-hip index (ICC) indicators were determined. Blood pressure was taken with and OMRON HEM-7130 Baumanometer (Omron Healthcare, INC. Illinois, U.S.A.).

The biochemical parameters that were evaluated were: glucose, triglycerides (TG) and total cholesterol (TC) using and ACCUTREND Plus Roche (Roche Diagnostics Ltd., Switzerland). ACCUTREND brand glucose, TG and TC test strips, ACCU-CHEK brand lancets and an ACCU-CHEK softclix puncture device were used. The measurement was performed on the index finger of the patient's left hand. Altered clinical and metabolic parameters were defined as follows: TC ≥ 200 mg/dl, glucose ≥ 100 mg/dl, TG ≥ 150 mg/dl, systolic blood pressure ≥ 130 mmHg, diastolic blood pressure ≥ 85 mmHg and obesity abdominal in men ≥ 90 cm and women ≥ 80 cm.

Analysis results

Statistical analyzes were performed using the SPSS software version 15.0 (SPSS Inc., Chicago, IL, USA). The comparison between two groups was analyzed by the t-Student test. A statistically significant value was considered when $p < 0.05$.

Results and Discussion

Evaluation of diet quality and frequency of mushrooms consumption

The median percentage of adequacy of energy and nutrient consumption is shown in table 1. Proteins, carbohydrates, fiber, sugar, SAT, MUFA, PUFA, cholesterol, thiamine and iron were above 100% of the established requirements for the age and sex of the participants. The rest of the vitamins and minerals were below the established requirements, being folate and pantothenic acid those that presented less than 25% of the recommended intake per day.

The wild and cultivated edible mushrooms with the highest consumption are shown in table 2. The mushrooms most consumed by the community were firstly the *Amanita caesarea* (hongo rojo) with 94%, followed by *Suillus luteus* (hongo de manteca) with 44%, *Lactarius volemus* (hongo de leche) with 40%, *Laccaria amethystina* (hongo de pajarito) with 28%, and *Tricholoma magnivelare* (hongo blanco) with 26%.

Nutrient	IR[a]	Intake [b]p 50	% Adequacy [b]p 50	CI[c] 95%
Energy (kcal)	1,972.5	1,992.0	101.0	96.4 - 120.8
Proteins (g)	50.3	62.6	137.0	122.6 - 168.1
Carbohydrates (g)	267.9	310.3	114.5	102.3 - 122.2
Fiber (g)	27.6	31.6	104.5	90.3 - 117.2
Sugar (g)	25	30	120	110.4 - 173.7
Total fat (g)	71.2	56.8	80.2	78.4 - 120.7
SAT (g)	< 7.1	10.0	143.3	136.5 - 209.2
MUFA (g)	12.5	16.9	146.6	124.2 - 170.3
PUFA (g)	< 4.9	8.0	154.1	158.6 - 255.7
Cholesterol (mg)	< 200	238.0	119.0	105.9 - 171.2
Retinol (µg/day)	562.5	322.0	64.4	70.3 - 109.7
Thiamine, B1 (mg/day)	0.95	1.06	113.3	101.6 - 127.2
Riboflavin, B2 (mg/day)	1.0	0.72	80	75.2 - 106.6
Niacin, B3 (mg/day)	11.5	6.8	61.8	60.9 - 104.8
Pantothenic acid, B5 (mg/day)	5	1.2	24	21.5 - 46.6
Pyridoxine, B6 (mg/day)	1.26	0.46	40.9	40.7 - 61.7
Folate, B9 (µg/day)	320	73.3	22.9	29.3 - 47.7
Cobalamin B12 (µg/day)	2.0	0.84	42.0	44.8 - 107.3
Calcium (mg/day)	1100	1052	95.5	89.4 - 116.3
Iron (mg/day)	6.9	9.2	146.3	133.4 - 186.8
Potassium (g/day)	4.7	1.38	29.38	28.91 - 36.83
Magnesium (mg/day)	307.5	179.0	66.0	60.2 - 82.5
Sodium (g/day)	2.2	2.04	92.1	87.6 - 126.6
Phosphorus (mg/day)	580	372	64.1	61.9 - 106.3
Selenium (µg/day)	50	39	73.3	67.6 - 91.9
Zinc (mg/day)	8.1	3.4	47.9	39.5 - 60.3

Table 1: Median percentage of adequacy of daily consumption of energy and nutrients in adults of the community of Yuvila, Oaxaca.

[a]IR: International Recommendation Average; [b]p: Percentile Value; [c]CI: Confidence Interval; SAT: Saturated Fats; MUFA: Monounsaturated Fats; PUFA: Polyunsaturated Fats.

Wild edible mushrooms			
Common name	**Species**	**Number of people**	**%**
Hongo rojo	*Amanita caesarea* (Scop.) Pers.	47	94
Hongo blanco	*Tricholoma magnivelare* (Peck) Redhead	13	26
Hongo de leche	*Lactarius volemus* (Fr.) Fr.	20	40
Hongo de manteca	*Suillus luteus* (L.) Roussel	22	44
Hongo amarillo	*Cantharellus cibarius* (Fr.)	15	30
Hongo espinita	*Hydnum repandum* L.	3	6
Hongo de pajarito	*Laccaria amethystina* Cooke	17	28
Nanacate	*Boletus edulis* Bull.	2	4
Edible mushrooms grown			
Setas	*Pleurotus ostreatus* (Jacq.) P. Kumm.	20	40
Champiñones	*Agaricus bisporus* (J.E. Lange) Imbach	30	60
Huitlacoche	*Ustilago maydis* (DC.) Corda	4	8

Table 2: Consumption of wild and cultivated edible mushrooms registered in the community of Yuvila, Oaxaca.

Wild edible mushrooms grow during the rainy season, between the months of June and August of each year. These mushrooms are consumed only during the season and are found in forested areas, usually away from the community. In general, only the families that practice harvesting take advantage of wild edible mushrooms for self-consumption or for income generation, through their sale in the community or other markets. Although the entire population stated that they consume this type of mushrooms, their frequency of consumption varied as follows: 4% consume them 1 to 3 times per month, 34% 1 - 2 times per week, 58% 3 to 4 times per week, 2% 5 to 6 times per week and only 2% consume them daily. A high consumption for wild edible mushrooms was considered when their intake was equal or greater than 3 times per week. Therefore, 62% of the participants in the study had a high consumption of wild edible mushrooms, which indicated that more than half of the population maintains this level in the rainy season (June-August). On the other hand, the consumption of edible mushrooms cultivated was lower due to their low accessibility, such as *Ustilago maydis* (DC) Corda, known as "huitlacoche", *Agaricus bisporus* (J.E. Lange) Imbach, know as "champiñón" and *Pleurotus ostreatus* (Jacq.) P. Kumm., known commercially as "setas". 16% indicated that they never consume them, 66% mentioned consuming them 1 to 3 times per month, 10% consume them 1 to 2 times per week and 8% 3 to 4 times per week. There was no consumption of 5 to 6 times per week or a daily consumption of the edible mushrooms grown. Despite the infrequency, 84% indicated consuming mushrooms grown when it is not the season for harvesting wild mushrooms.

Assessment of nutritional and metabolic status

Of the 49 participants, 7 were men (14.3%) and 42 were women (85.7%). The minimum age of the participants was 20 years and the maximum was 72 years. Table 3 shows the assessment of nutritional status, based on anthropometric measurements and biochemical parameters.

Of the 49 participants, only 20.4% had normal weight, while 79.6% of the participants had a combined prevalence of overweight and obesity (51.1% were overweight, 22.4% were obese type I and 6.1% were obese type II). In Latin America, waist circumference cut points are lacking, for this reason we take the cut points in Asians of 90 cm for men and 80 cm for women, according to the recommendation of the IDF [14]. On the other hand, the increase in the waist/hip index (WHI) is related to a higher content of visceral fat to the detriment of peripheral fat, therefore, greater cardiovascular risk. Men with WHI ≥ 1.0 and women ≥ 0.85 have a higher cardiovascular risk. In this study, the average waist circumference for women was 89.2 ± 10.0 cm and for men 89.9 ± 7.2, the hip perimeter was 99.3 ± 9.2 cm for women and 95.7 ± 7.5 cm for men, and the WHI was 0.90 ± 0.07 for women and 0.94 ± 0.06 cm for men. Therefore, women have the highest cardiovascular risk. In relation to the percentage of fat, the average was 39.4%, being above the optimum for both men and women. Glucose, cholesterol and blood pressure data were found in normal ranges, while triglycerides are above 150 mg/dl.

Variable	Total (n = 49)	Women (n = 42)	Men (n = 7)
Age (years)	45.8 ± 14.6	45.8 ± 14.3	40.7 ± 16.3
Body mass index (BMI)	28.3 ± 4.0	28.6 ± 4.0	26.4 ± 4.0
Overweight	27.8 ± 1.5	27.8 ± 1.5	27.8 ± 2.0
Obesity type I	31.7 ± 1.7	31.8 ± 1.7	30.5 ± 0
Obesity type II	37.1 ± 2.5	37.1 ± 2.5	-
Waist circumference (cm)	89.3 ± 9.6	89.2 ± 10.0	89.9 ± 7.2
Hip circumference (cm)	98.8 ± 9.0	99.3 ± 9.2	95.7 ± 7.5
Waist/hip index (WHI)	0.91 ± 0.07	0.90 ± 0.07	0.94 ± 0.06
Body fat (%)	39.4 ± 8.4	41.5 ± 5.6	26.9 ± 11.5
Glucose (mg/dl)	89.8 ± 42.7	91.3 ± 44.6	81.0 ± 30.3
Triglycerides (TG, mg/dl)	205.8 ± 104.5	215.0 ± 108.3	151.0 ± 56.2
Total cholesterol (TC, mg/dl)	184.1 ± 25.3	181.9 ± 25.3	196.9 ± 23.1
Systolic blood pressure (mm Hg)	116.8 ± 15.3	116.3 ± 16.1	119.7 ± 10.0
Diastolic blood pressure (mm Hg)	74.3 ± 9.7	74.1 ± 10.3	77.3 ± 4.2

Table 3: Anthropometric and metabolic measurements of the participants

Data are shown on average ± standard deviation (SD).

Table 4 shows the number of participants who have altered metabolic parameters and than exceed healthy limits. Table 5 shows the number of participants who have a precious diagnosis with pharmacological treatment of type 2 diabetes mellitus, hypertension, hypertriglyceridemia and hypercholesterolemia. It can ben seen that 74.0% of participants have abdominal obesity (diagnosed by the waist circumference), 60% hypertriglyceridemia of which only 14% have a previous diagnosis of hypertriglyceridemia with pharmacological treatment, 27% have impaired glucose levels, of which 12.5% have a previous medical diagnosis with type 2 diabetes mellitus. In relation to TC, 30% of participants have cholesterol levels ≥ 200 mg/dl corresponding to 15 participants, of which only 1 of them has a previous diagnosis of hypercholesterolemia with pharmacological treatment and is not controlled. The prevalence of hypercholesterolemia was above the national average (28%) according to the ENSANUT MC 2016 [5].

Variable (IDF)	Media ± SD	n	%
Abdominal obesity			
Men ≥ 90 cm	94.50 ± 4.20	4	8
Women ≥ 80 cm	92.94 ± 7.80	33	66
Body fat (%)			
Men	31.7 ± 8.95	5	10
Women	41.83 ± 8.29	41	82
Hypertriglyceridemia			
Triglycerides ≥ 150 mg/dl	279.20 ± 93.99	30	60
Fasting impaired glucose			
DM2 o fasting glucose ≥ 100 mg/dl	137.46 ± 51.98	13	27
Blood pressure			
Systolic pressure ≥ 130 mmHg	143.71 ± 11.11	7	14
Diastolic pressure ≥ 85 mmHg	96.25 ± 10.04	4	8
Hypercholesterolemia			
Cholesterol ≥ 200 mm/dl	213.73 ± 18.41	15	30

Table 4: Prevalence of altered metabolic parameters of the participants of Yuvila, Oaxaca.

Previously diagnosed disease	N*	N controlled	Mean ± SD
Diabetes mellitus type 2 (mg/dl)	6	0	153.5 ± 73.8
Hypertension SP/DP (mmHg)	5	4	131.4 / 87.0 ± 25.2/18.1
Hypertriglyceridemia (mg/dl)	7	0	242.0 ± 111.3
Hypercholesterolemia (mg/dl)	4	3	187.8 ± 24.5

Table 5: Number of participants with previously diagnosed disease controlled with pharmacological treatment

*All participants with a previous diagnosis of the disease receive treatment at their health center in the community. SP: Systolic pressure; DS: Diastolic pressure.

Discussion

Evaluation of diet quality and frequency of mushrooms consumption

Oaxaca is one of the states with the highest percentage of rural population (22%) being above the national average [15]. Regarding the nutritional situation of the state of Oaxaca and quality of diet in rural communities, there is little information about it. The paradox between the prevalence of metabolic diseases and malnutrition is in the quality and quantity of nutrients in the population's diet. When there is an imbalance between macronutrients and micronutrients, one could speak of a low quality of diet. And when talking about poor diet quality and high energy intake, it can negatively affect body weight and increase the prevalence of chronic diseases such as cardiovascular diseases and diabetes mellitus [16]. Regarding the quality of the diet in the rural community of Yuvila, Oaxaca, the results show a clear difference between the intake of macronutrients and micronutrients. The consumption of micronutrients such as vitamins B6, B12, B9, B5 and zinc showed a low percentage of adequacy (< 60%), while above 100% was the consumption of energy, proteins, carbohydrates, fiber, sugar, SAT, PUFA, MUFA and cholesterol. Micronutrient deficiency is a problem in developing countries. Worldwide, around two billion people are deficient in micronutrients due to the consumption of low-quality foods that lack diversity. The most common micronutrient deficien-

cies experienced in developing countries are iron, iodine, zinc and vitamin A [17,18]. Micronutrient deficiency is related to several health consequences such as stunted growth and slow development [17]. In this study, zinc only covered 47.9% of the recommended intake and vitamin A only 64.4%, showing a similar behavior reported for developing countries [17,18]. However, both in Mexico and Oaxaca, more through studies are needed to know the intake of micronutrients in rural communities and their relationship with the abandonment of traditional diets. By presenting low intake of micronutrients and high intake of macronutrients, it is observed that participants consume high portions of nutritionally inadequate foods, which are foods containing high amounts of fats, carbohydrates, cholesterol and sugars, while providing low amounts of vitamins A, B2, B3, B5, B6, B9, B12, potassium, magnesium, phosphorus, selenium and zinc. These results indicate that the diversity that people give to their diet is poor. Part of the solution could be to identify food sources in rural areas and disseminate information through workshops. In addition, food gardens both domestically and at the community level have the ability to close the nutrition gaps and contribute to improving the nutritional status of the most vulnerable groups [19].

In Mexico, more than 300 species of edible wild mushrooms are known, which have been used as food and traditional medicine since pre-Hispanic times and incorporated into the diet of various ethnic groups [20]. One of the states of the Mexican Republic with the highest biodiversity of edible mushrooms is the state of Oaxaca, mainly in communities of the northern Sierra of the state. In relation to mushroom intake, the entire study population reported consuming them with a different frequency. Because previous studies have shown that the consumption of 8 ounces of mushrooms 3 times per week helps to reduce the total intake of energy and fat, as well as improving the quality of diet [21], a high consumption of mushrooms was considered greater than 3 times per week, and a low consumption of mushrooms when it was less than 2 times per week. Of the 50 participants, 100% indicated eating wild mushrooms in the rainy season (June-August). Of this 100%, 62% of the participants indicated consuming wild mushrooms more than 3 times per week during the harvest season. In relation to the cultivated mushrooms, 16% do not consume them and 84% indicated to consume cultivated mushrooms when it is not the rainy season (Table 2). The mushrooms most consumed by the community were firstly the mushrooms *Amanita caesarea* (hongo rojo) with 94%, followed by *Suillus luteus* (hongo de manteca) with 44%, *Lactarius volemus* (hongo de leche) with 40%, *Laccaria amethystina* (hongo de pajarito) with 28% and *Tricholoma magnivelare* (hongo blanco) with 26%. These data coincide with the study by Jiménez., *et al.* in 2013 [22], in which reported that the most commercialized wild edible mushrooms in Oaxaca were *Amanita caesarea*, *Cantharellus cibarius*, *Hydnum repandum*, followed by *Tricholoma magnivelare*, *Lactarius volemus* and *Hypomyces lactifluorum* (Schwein.) Tul. and C. Tul.

Nutritional and metabolic status of the population

A combined prevalence of overweight and obesity of 79.6% was found, above the national average which was 72.5%, according to data from the ENSANUT MC 2016 [5]. These data coincide with a study conducted on "nahuas" Indians in the state of Veracruz, Mexico, where 80.6% were overweight and obese [23]. Being alarming data the suffering of this condition in rural communities. Regarding the prevalence of altered metabolic parameters in the community of Yuvila, it was found that abdominal obesity had a higher prevalence having 74%, followed by hypertriglyceridemia with 60%, hypercholesterolemia with 30% and hyperglycemia with 27%. In addition, a prevalence of type 2 diabetes mellitus of 12.2% was found, being above the national average (9.4%) according to ENSANUT MC 20106 [5], which indicated that the highest prevalence was found in the southern region, mainly in rural areas. In relation to the TC, 8.1% of the participants have a previous medical diagnosis of hypercholesterolemia with pharmacology treatment, however 30% of the participants presented levels above 200 mg/dl of TC (hypercholesterolemia), being above the national average (28%) according to ENSANUT MC 2016 [5]. The data indicate that the increase in cases with dyslipidemia is increasing rapidly. Other studies carried out in Mexico, such as the one conducted to rightholders of the ISSSTE clinic in Chilpancingo, Guerrero, Mexico [24]. They found that abdominal obesity was the most prevalent factor in the entire population (61.8%) followed by hypertriglyceridemia (56.5%). In another study of patients from both rural and urban communities of a second level hospital in Merida, Yucatan, Mexico [23], the highest prevalence was abdominal obesity with 59.8% being more frequent in women than in men, in addition to another parameter with greater frequency was hypertriglyceridemia with 57.8% and thirdly hypertriglyceridemia with 48%. As mentioned earlier, abdominal obesity is the main trigger for other metabolic disorders. Several studies show that intra-abdominal fat, measured by abdominal circumference, is independently associated with each one of the metabolic criteria analyzed in this study and sug-

gests that it may have a central role in the pathogenesis of metabolic syndrome. Currently, society is experiencing major changes in the global distribution of food and its bioavailability. These changes also involve modification in the patterns of physical activity and combined with the high intake of energy dense foods, rich in carbohydrates, SAT and sugars, increase the predisposition to suffer metabolic disorders such as hypertension, glucose intolerance, dyslipidemia and obesity [25].

Conclusion

The diet quality of Yuvila's community is poor, because there is a high intake of macronutrients such as carbohydrates, proteins, fats sugars and cholesterol and low intake of vitamins and minerals. This indicates that adults in that community have a diet high in energy and poor in diversity. The latter is alarming contemplating that the communities of the northern Sierra of Oaxaca, Mexico have a high biodiversity of natural resources. However the diversification of traditional diets rich in local foods has been decreasing. Although there is a high intake of wild edible mushrooms during the rainy season, it decreases over the course of the year. With regard to nutritional status, the rural community of Yuvila has high rates of metabolic diseases such as obesity and overweight reflected in a high percentage of body fat in most participants, triglycerides and cholesterol. In this sense, it is a priority to carry out nutritional counseling and intervention studies to promote the consumption of natural foods typical of the region, including edible mushrooms within a healthy eating pattern. More studies are needed in rural communities to determine the quality of the diet, as well as the consumption of its natural resources and its association with the nutritional status of the population and the loss of traditional diets rich in endemic foods in these areas.

Acknowledgements

We thank to Dr. Magda Judith Mateo García in charge of the Community Health Center at Yuvila Santa Catarina Ixtepeji, Oaxaca, Mexico, for providing facilities to carry out this study.

Funding

Research work supported by the National Council of Science and Technology (CONACYT; www.conacyt.mx) in Mexico, through the Research Projects FORDECYT-273647 and Catedras 2014 and 105.

Ethics Approval and Consent to Participate

All participants in this study approved and signed the consent to participate and ethical policy.

Conflict of Interest

We declare that we have no conflict of interest.

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