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Impact of diet on cardiometabolic risk in patients with obstructive sleep apnea

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ABSTRACT

BACKGROUND. Obstructive sleep apnea (OSA) is a serious condition associated with increased morbidity and mortality from cardiovascular disease (CVD). It has been found that OSA and obesity commonly coexist. The American Academy of Sleep Medicine recommends diet-induced weight loss and exercise as lifestyle treatment options for OA. Epidemiological studies show that sleep apnea leads to increased risk factors for cardiovascular disease, including hypertension, obesity, and metabolic syndrome.

SUBJECTS AND METHODS. The present study aims to analyze the therapeutic efficacy of nutritional intervention in a sample of 53 male patients (mean age of 59.0 ± 9.0 years) with OSAS (obstructive sleep apnea syndrome) followed for 14 months. The present study aims to refine preventive and therapeutic dietary intervention to reduce cardio-metabolic risks in patients with OSA.

RESULTS. The data obtained shows a highly significant reduction in risk factors for cardio-metabolic diseases in the population of 53 Italian men (mean age 59.0 ± 9.0 years). Specifically, the average levels of the HOMA-IR value, insulin-resistance index, has been reduced by 50%, equally considerable are the reduction in the average levels of total cholesterol, triglycerides, BMI, systolic and diastolic blood pressure, fasting blood glucose, and fasting insulinemia.

CONCLUSIONS. The present study offers clear evidence of the therapeutic and preventive efficacy of diet in significantly reducing cardio-metabolic risk levels in OSAS patients.

KEYWORDS

MEDITERRANEAN DIET
CARDIOVASCULAR RISK
OSAS
PUBLIC HEALTH

INTRODUCTION

Obstructive sleep apnea (OSA) is one of the most important causes of chronic sleep fragmentation and sleep deficiency[1]. The OSA syndrome, referred to as OSAS (Obstructive Sleep Apnea Syndrome), has acquired considerable importance from an epidemiological point of view due to its increasing prevalence in the adult population[2-4]. OSA causes intermittent nocturnal hypoxemia and causes excessive daytime sleepiness with a relative increase in risks related to work activities and mood[5]. Obesity is the strongest risk factor for obstructive sleep apnea, and it is essentially the only reversible. OAS and obesity share common substrates, pathological processes, and comorbidities. Emerging data increasingly support a relationship between the two diseases and their effects on the development and progression of other pathological states[6-8]. Numerous studies have shown that sleep disorders, including chronic sleep deprivation and sleep fragmentation due to various environmental and biological factors, lead to mood disorders, anxiety disorders, poor cognition, lack of memory and decreased performance in academia and in the workplace[9].

OSAS, CARDIOVASCULAR RISK AND METABOLIC SYNDROME

OSAS is an important risk factor for major cardiovascular diseases, including arterial hypertension, ischemic heart disease, heart failure, rhythm/conduction disorders, and stroke[10]. Important risk factors for OSA include obesity, craniofacial or oropharyngeal anatomical abnormalities, male sex, and smoking[11]. During sleep, there is a reduction in the tone of the dilating muscles involved in maintaining airway patency. Central obesity, particularly the increase in visceral fat, has a direct impact on the origin of OAS in the relative narrowing of the airway lumen and increases the likelihood of obstruction[12]. The mechanisms governing the correlation between OSA and cardiovascular disease are still being studied, but the correlation between the two is established; in fact, the National Commission on Sleep Disorders Research has estimated that sleep apnea is likely to be responsible for 38,000 cardiovascular deaths per year, with $42 million spent on related hospitalizations[13]. Among other mechanisms, the role of disorders in clotting factors, acute endothelial damage, platelet activation and increased systemic inflammation are considered relevant in the pathogenesis of cardiovascular diseases[1]. Obesity, hypertension, dyslipidemia, and hyperglycemia are prevalent in obstructive sleep apnea syndrome[1]. Metabolic syndrome, however, is defined by visceral fat obesity plus at least two of these factors[1]. Some studies show that regardless of visceral fat obesity, OSAS has been associated with hypertension, dyslipidemia, and hyperglycemia (Figure 1). It is possible that OSAS can also predispose non-obese patients to the development of metabolic syndrome[17,18].

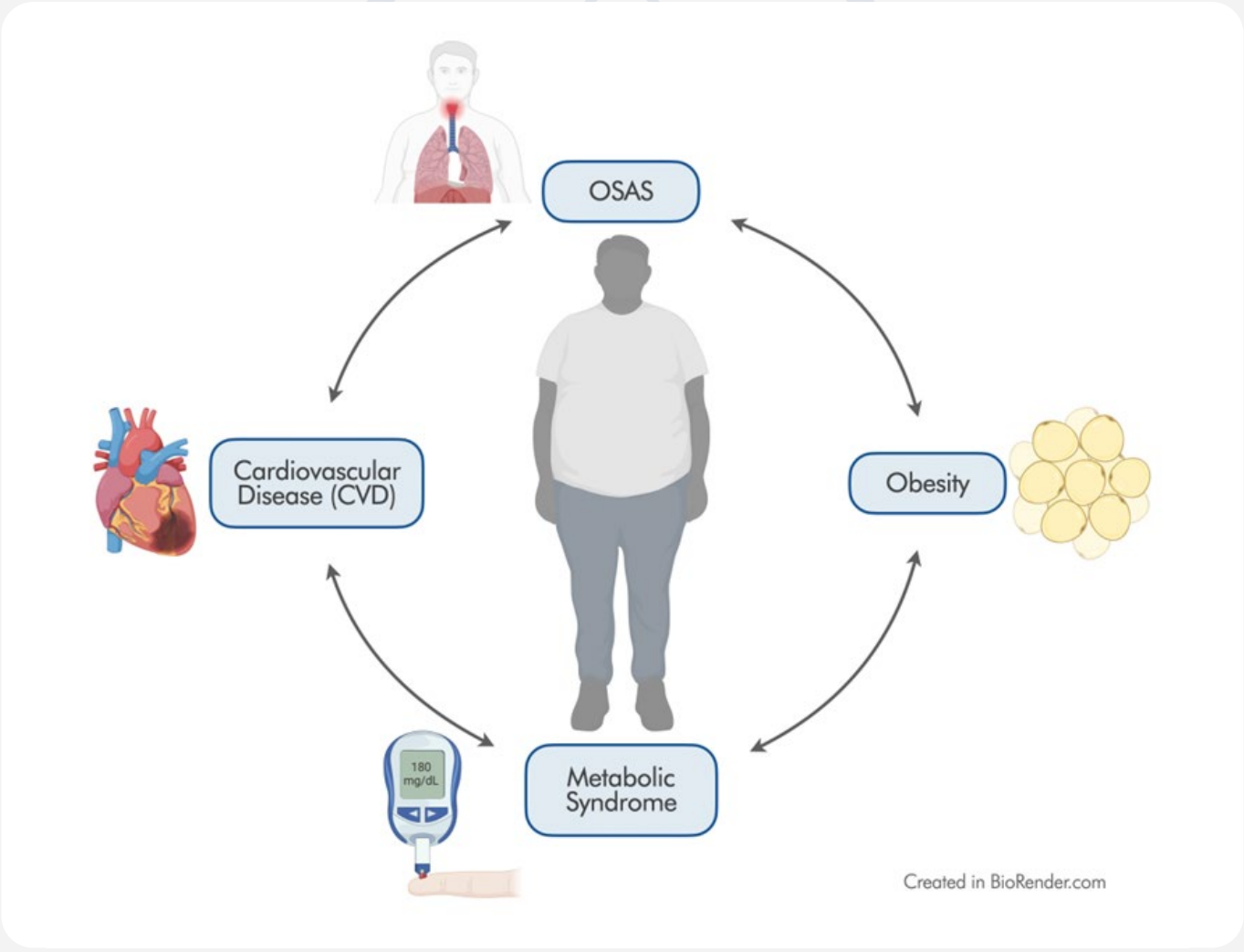

Figure 1. Correlation between OSAS, obesity, metabolic syndrome, and cardiovascular disease.

SUBJECTS AND METHODS

Subjects

This study was conducted in a population of 53 Italian men (mean age 59.0 ± 9.0 years) with OSAS, who voluntarily underwent dietary evaluation and haematological analyses (total cholesterol, triglycerides, fasting glucose, fasting insulin), blood pressure measurement and measurement of anthropometric and re-checked parameters at a distance of 14 months. The following are the mean values for the sample studied in the first half (Table 1).

Biochemical Exams

Blood samples were taken between 08:00 and 09:00 after an overnight fast and analyzed. Plasma lipid concentrations (triglycerides, total cholesterol, fasting glucose, fasting insulin). The calculation of the HOMA-IR (Homeostasis Model Assessment) index based on a mathematical homeostatic model by which insulin sensitivity is calculated is made by a comparison between the plasma glucose concentration and the fasting insulin level using the following formula:

(Fasting blood glucose x fasting insulinemia) / 405, with blood glucose expressed in mg/dL

Blood pressure

Blood pressure is the pressure exerted by the blood, pumped by the heart, on the wall of the arteries that distribute the blood itself in the body. Blood pressure, systolic pressure (SBP) or diastolic pressure (DBP) parameters have been the subject of numerous studies, some of which establish an association between the increase in these parameters and mortality, particularly at middle ages[19]. According to the World Health Organization (WHO), at least 1 in 5 adults in the world suffers from hypertension, and this factor is the cause of about half of the deaths from heart attack and ischemic stroke[20]. Blood pressure was detected by an experienced operator using an aneroid sphygmomanometer (non-invasive method) according to guidelines provided by the World Health Organization (WHO).

Anthropometric data

Anthropometric measurements were made in the morning and on an empty stomach. Body weight and height were measured by means of a scale with a calibrated altimeter model (Gima Astra 27310). From the ratio of weight to height, the Body Mass Index (BMI) was calculated, expressed in kg/m^2.

Table 1. Statistical description of the parameters in the population sample.

				95% Confidence Interval								
Descriptives	**N**	**Mean**	**SE**	**Lower**	**Upper**	**Median**	**Mode**	**SD**	**Variance**	**Range**	**Minimum**	**Maximum**
Age (years)	53	52.36	1.180	49.99	54.73	52	50.00 [a]	8.59	73.77	33	35	68
BMI (kg/m2)	53	33.89	0.508	32.87	34.91	33.0	30.00	3.70	13.68	16.0	27.0	43.0
SBP (mmHg)	53	128.92	1.650	125.61	132.24	130	120.00	12.01	144.34	50	100	150
DBP (mmHg)	53	75.38	1.042	73.29	77.47	75	70.00 [a]	7.59	57.55	30	65	95
Tot. Cholesterol (mg/dl)	53	223.38	2.677	218.00	228.75	224	200.00	19.49	379.93	120	170	290
Triglycerides (mg/dl)	53	160.23	2.920	154.37	166.09	159	155.00	21.26	452.02	134	116	250
Fasting glucose (mg/dl)	53	116.62	2.474	111.66	121.59	124	124.00 [a]	18.01	324.51	72	77	149
Fasting Insulin (mIU/ml)	53	7.40	0.663	6.07	8.73	5	5.00	4.83	23.32	22	3	25
HOMA-IR	53	1.53	0.201	1.13	1.93	1	1.00	1.46	2.14	7	0	7

Note. The CI of the mean assumes sample means follow a t-distribution with N - 1 degrees of freedom.
[a]More than one mode exists; only the first is reported

Nutritional Intervention

- The assessment of the nutritional status was carried out in the light of the anamnestic and pathological picture of the individual subjects. Everyone was prescribed a personalized Mediterranean diet based on these common indications:
- Exclusive use of extra virgin olive oil for cooking and seasoning,
- Increased consumption of vegetables, fresh vegetables
- Replacement of refined flour products with whole products with a lower glycemic index
- Predilection of vegetable and lean proteins: legumes, fish, lean cheeses, white meats
- Reduction of total consumption of processed meat and industrial products
- Restriction of butter, cream, fast food, sweets, pastries and sugary drinks
- Limiting salt consumption
- Drink at least 1.5/2 liters of oligomineral water
- In alcohol drinkers, a moderate consumption of red wine.

The instructions were provided through pamphlets, including recommendations for the Mediterranean diet, a pyramid of the Mediterranean diet, shopping tips, and recipes. The nutrient and micronutrient values of the diet have been reported below and calculated using dietary software Winfood PRO© 3.26.1 (Table 2).

Table 2. Average composition of the diet.

Nutrient	U.M.	Nutrient	U.M.	Nutrient	U.M.
Calories 1481	Kcal	Magnesium 228	mg	Methionine 1546	mg
Proteins 79	g	Copper 1	mg	Isoleucine 2791	mg
Lipids 42	g	Selenium 46	mcg	Leucine 4597	mg
Glycides available 207	g	C4:0-C10:0 0,3	g	Tyrosine 1963	mg
Amid 95	g	C12:0 Lauric 0,5	g	Phenylalanine 2557	mg
Oligosaccharides 67	g	C14:0 Miristic 0,40	g	Tryptophan 646	mg
Total fiber 22	g	C16:0 Palmitic 4,77	g	Polyalcohols 0.0	mg
Cholesterol 152	mg	C18:0 Stearic 1,48	g	Unsaturated fatty acids 29	g
Saturated fatty acids 7	g	C20:0 Arachidic 0,19	g	Animal proteins 49	g
Polyunsaturated fatty acids 7.2	g	C22:0 Beenic 0,0	g	Vegetable Proteins 22	g
Monounsaturated fatty acids 22	g	C14:1 ac. Myristoleic 0,4	g	Chlorine 0	mg
Calcium 423	mg	C16:1 ac. Palmitoleic 0.56	g	Chromium 0.02	mcg
Sodium 521	mg	C18:1 Oleic 19.73	g	Fluoride 41	mg
Potassium 3590	mg	C20:1 Eicosaenoic 0.18	g	Iodine 134	mcg
Phosphorus 1041	mg	C22:1 Erucic 0.10	g	Manganese 2.4	mg
Iron11	mg	C18:2 Linoleic 3.8	g	Molybdenum 3.6	mcg
Zinc 12	mg	C18:3 Linolenic 0.44	g	Nickel 0	mg
Folic Acid 396	mcg	C20:4 Arachidonic 0.15	g	Beta-carotene 1961	mg
Niacin 22	mg	C20:5 EPA 0.30	g	Alpha-tocopherol 0.86	mg
Riboflavin 1	mg	C22:6 DHA 0.61	g	Vitamin K 74	mcg
Thiamine 0	mg	Phytic acid 0.24	g	Vitamin B5 2,3	mg
Vitamin 'A' 827	mcg	Lysine 4640	mg	Vitamin B8 - Biotin 7	mcg
Vitamin 'B6' 2	mg	Histidine 1998	mg	Vitamin B12 7.3	mcg
Vitamin 'C' 219	mg	Arginine 3616	mg	H-Orac 6187	Umol
Vitamin 'D' 6	mcg	Aspartic acid 5741	mg	L-Orac 208	Umol
Vitamin 'E' 11	mg	Threonine 2639	mg	Total-Orac 6342	Umol
Oxalic acid 118	mg	Serine 2488	mg	Total Polyphenols 810	mg
Cellulose 2	g	Glutamic acid 9710	mg		
Purines 74	mg	Proline 2518	mg		
Water (food content) 1074	g	Glycine 2694	mg		
Edible part 1162	g	Alanine 3262	mg		
Insoluble fiber 13	g	Cystine 731	mg		
Soluble fiber 5	g	Valine 3167	mg		

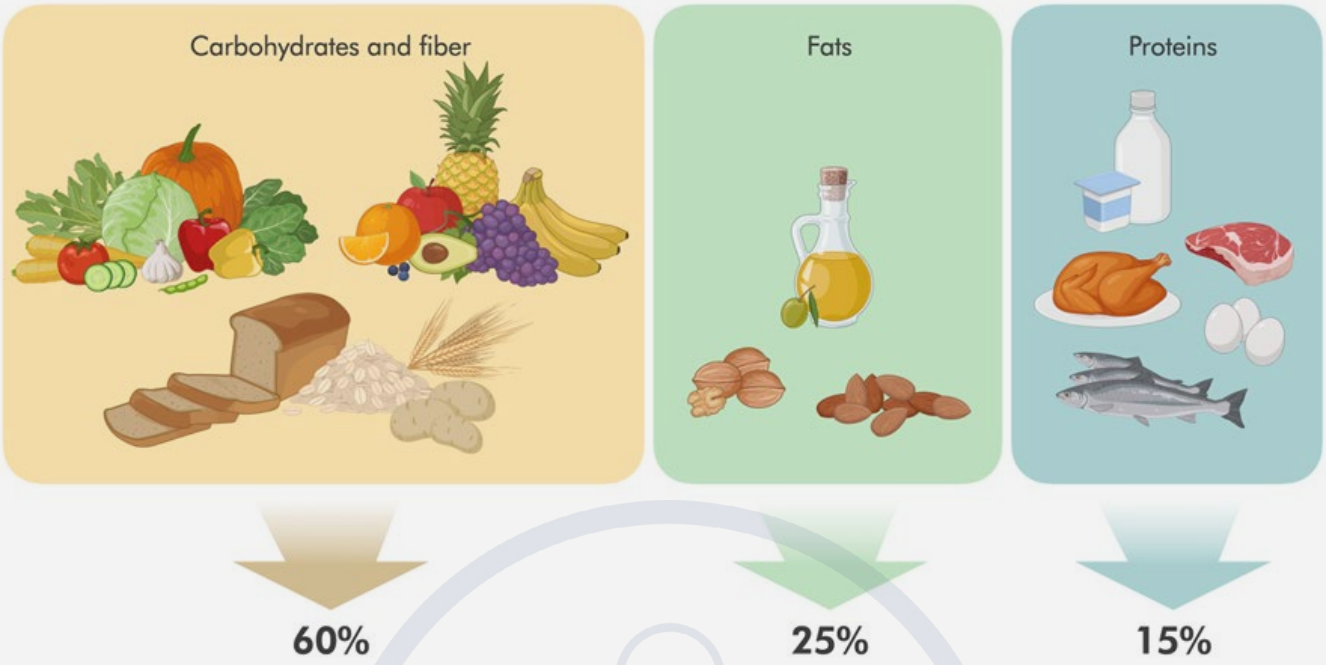

Figure 2. Composition in % of macronutrients of the prescribed diet, realized with BioRender.com

From the point of view of nutrients, the prescribed diet is characterized by 60% carbohydrates with a particular indication of preferring the complex carbohydrates contained in products made with wholemeal flours (bread and pasta), tubers (potatoes), and above all seasonal vegetables and vegetables, and seasonal fruits with a low glycemic index (Figure 2). The food day was divided into five meals of which: breakfast, snack, lunch, snack. The dietary prescription was adapted according to the clinical and physiological conditions of the individual subject.

Data analysis

The statistical analysis of the data collected by calculating the Pearson r correlation coefficient was performed. The analysis showed a significant positive correlation between total cholesterol levels and fasting blood glucose levels, and a positive correlation between BMI levels and fasting insulin levels; there is a significant correlation between BMI and age, between fasting blood glucose and age, a positive correspondence between high triglyceride levels and high levels of total cholesterol, and as is expected high levels of fasting insulin are related to an increase in the HOMA-IR index (Table 3).

Table 3. Correlation matrix of parameters in the studied population.

Correlation Matrix										
		Age (years)	**BMI (kg/m2)**	**SBP (mmHg)**	**DBP (mmHg)**	**Tot. Cholesterol**	**Trigly-cerides (mg/dl)**	**Fasting glucose (mg/dl)**	**HOMA-IR (mg/dl)**	**Fasting Insulin (mIU/ml)**
Age (years)	Pearson's r	—								
	df	—								
	p-value	—								
BMI (kg/m2)	Pearson's r	**0.308***	—							
	df	51	—							
	p-value	0.025	—							
SBP (mmHg)	Pearson's r	0.191	0.133	—						
	df	51	51	—						
	p-value	0.170	0.342	—						
DBP (mmHg)	Pearson's r	-0,089	0.221	0.249	—					
	df	51	51	51	—					
	p-value	0.525	0.112	0.072	—					
Tot. Cholesterol (mg/dl)	Pearson's r	0.090	-0.227	-0.086	-0.244	—				
	df	51	51	51	51	—				
	p-value	0.523	0.102	0.539	0.079	—				
Triglycerides (mg/dl)	Pearson's r	0.019	0.017	-0.118	-0.166	**0.343***	—			
	df	51	51	51	51	51	—			
	p-value	0.892	0.903	0.400	0.234	0.012	—			
Fasting glucose (mg/dl)	Pearson's r	**0.291***	-0.202	0.043	-0.214	**0.536*****	0.104	—		
	df	51	51	51	51	51	51	—		
	p-value	0.034	0.148	0.761	0.123	<.001	0.459	—		
HOMA-IR	Pearson's r	0.205	0.303*	-0.047	0.129	0.246	0.161	0.088	—	
	df	51	51	51	51	51	51	51	—	
	p-value	0.141	0.028	0.739	0.357	0.076	0.249	0.531	—	
Fasting Insulin (mIU/ml)	Pearson's r	0.099	**0.281***	-0.149	0.153	0.143	0.082	-0.111	**0.939*****	—
	df	51	51	51	51	51	51	51	51	—
	p-value	0.481	0.041	0.288	0.273	0.308	0.560	0.429	<.001	—

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

The coupled *t*-test was used to evaluate the results obtained with the Mediterranean diet over 14 months: this test is used when the same group of people is subjected twice to the same survey, which allows you to know if the average has changed between the first and second surveys (Table 4).

Table 4. Coupled t-test to assess the difference of the factors analyzed after 14 months of diet..

Paired Samples *t*-test							
			statistic	**df**	***p***	**Mean difference**	**SE difference**
BMI (kg/m²)	After 14 months, BMI (kg/m²)	Student's *t*	9.98	52.0	<.001	2.623	0.263
SBP (mmHg)	After 14 months, SBP (mmHg)	Student's *t*	11.01	52.0	<.001	10.698	0.972
DBP (mmHg)	After 14 months, DBP (mmHg)	Student's *t*	3.49	52.0	<.001	2.755	0.790
Tot. Cholesterol (mg/dl)	After 14 months, Tot. Cholesterol (mg/dl)	Student's *t*	14.04	52.0	<.001	18.491	1.317
Triglycerides (mg/dl)	After 14 months, Triglycerides (mg/dl)	Student's *t*	12.95	52.0	<.001	27.151	2.097
Fasting glucose (mg/dl)	After 14 months, Fasting glucose (mg/dl)	Student's *t*	12.97	52.0	<.001	18.943	1.461
Fasting Insulin (mIU/ml)	After 14 months, Fasting Insulin (mIU/ml)	Student's *t*	6.25	52.0	<.001	2.585	0.413
HOMA-IR	After 14 months, HOMA-IR	Student's *t*	5.17	52.0	<.001	0.792	0.153

Note. $H_{a\ \mu Measure\ 1 - Measure\ 2} > 0$

Comparisons were made of the mean levels of cardio-metabolic risk factors considered in the present study before the dietary route and after 14 months (Figure 3). The statistical analysis shows that in the total population:

- Average BMI levels (kg/m2) decreased by 8.0%
- Mean levels of systolic blood pressure (mmHg) were reduced by 8.0%
- Mean diastolic blood pressure (mmHg) levels were reduced by 2.0%
- Average total cholesterol levels (mg/dl) were reduced by 8.0%
- Average blood triglyceride levels (mg/dl) decreased by 16.0%
- Mean fasting blood glucose levels (mg/dl) decreased by 16.0%
- Mean fasting insulin levels (mIU/ml) decreased by 28.0%
- Medical levels of HOMA-IR decreased by 50.0% (Figure 4)

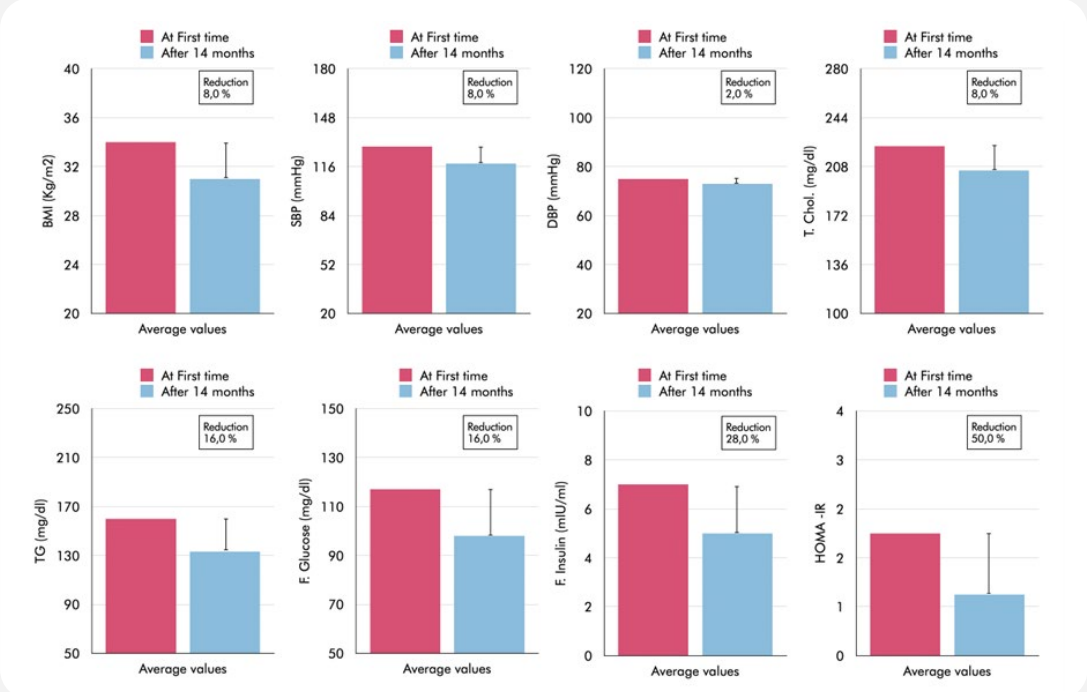

Figure 3. Comparison analysis of mean levels of risk factors before and after nutritional intervention.

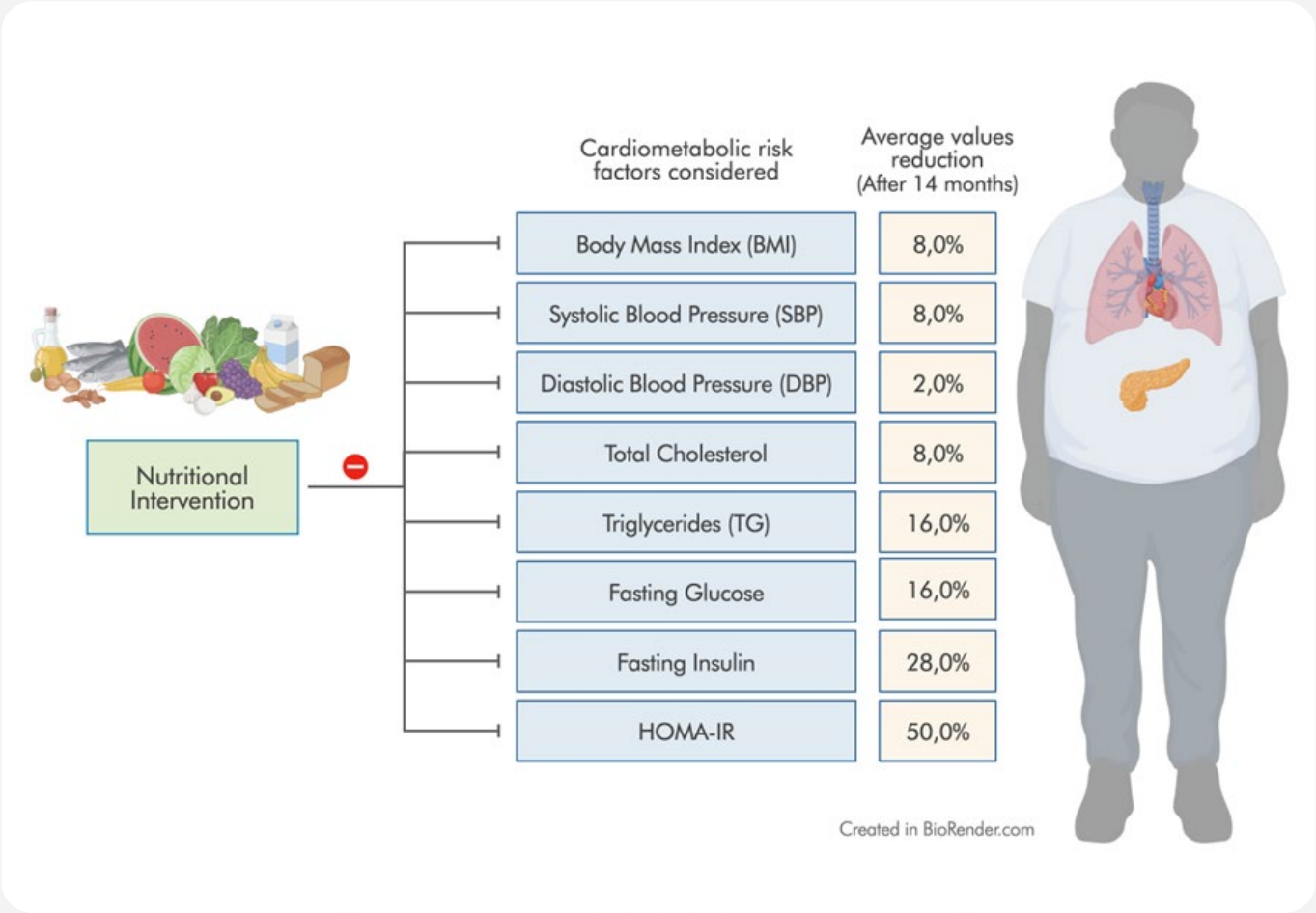

Figure 4. Impact of nutritional intervention on the reduction of the average percentage levels of cardio-metabolic risk factors considered in 14 months.

DISCUSSION

The data obtained shows a highly significant reduction in risk factors for cardio-metabolic diseases in the population of 53 Italian men (mean age 59.0 ± 9.0 years). Specifically, the average levels of the HOMA-IR value, insulin-resistance index, has been reduced by 50%, equally considerable are the reduction in the average levels of total cholesterol, triglycerides, BMI, systolic and diastolic blood pressure, fasting blood glucose, and fasting insulinemia. From the point of view of OSAS, all subjects reported an improvement in sleep quality and a reduction in symptoms related to obstructive sleep apnea. Please note that the results are obtained in a relatively short period of 14 months by nutritional intervention alone, without taking medication. It is understood that the Mediterranean Diet acts synergistically on all the risk factors taken into account, which have already been extensively studied in numerous studies.

CONCLUSIONS

The present study offers clear evidence of the therapeutic and preventive efficacy of nutritional intervention in significantly reducing cardio-metabolic risk levels in OSAS patients. The results obtained lay the foundation for future public health and preventive medicine actions in order to control and reduce the risk of OSA-related complications and consequently to the reduction of public spending and greater sustainability of health systems.

Conflict of Interest

The author declares that they have no conflicts of interest. The article is not under evaluation anywhere, and it is not submitted elsewhere.

Policy on Ethics

The author declares that informed consent has been obtained from the subjects who have adhered to the following observational study in complete freedom.

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