Effect of Dietary Intervention on Metabolic Syndrome Risk Factors among Adults

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ABSTRACT

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Syndrome X is distinguished by the co-occurrence of determinants that are unquestionably linked to an increase in the chance of experiencing chronic illnesses like adult-onset diabetes and coronary artery disease. Addressing modifiable lifestyle factors, including dietary habits, is essential in preventing and managing metabolic syndrome (MetS). This study investigated the evaluating the effectiveness of dietary interventions on MetS risk factors among a sample of adults. The research involved a six-month dietary intervention program conducted on fifty adults aged from 20 to 60 years targeting high-risk individuals with MetS. An individualized balanced diet was tailored, and anthropometric assessments biochemical analyses, and routine medical examinations were conducted. Most of the studied sample were Class 3 (high-risk) obesity with mean Body Mass Index (BMI) (40.1 ± 6.7), an increase in Total cholesterol (TC), fasting blood sugar (FBG), triglycerides (TG), and Low-density lipoprotein-cholesterol (LDL-c) levels and decrease in High-density lipoprotein-cholesterol (HDL-c) levels. The intervention program resulted in considerable alterations in MetS and its criteria among participants. There was a notable reduction in factors such as FBG, TC, LDL-c, and TG, accompanied by elevated HDL-c levels. ***In conclusion,*** *dietary intervention can improve MetS and associated risk factors in adults.*

Keywords: Metabolic Syndrome, Dietary Intervention, Metabolic Risk Factors, Adults.

INTRODUCTION

The International Diabetes Federation has developed a description of the criteria of MetS including having a waist circumference of more than 94 and 80 centimeters for males and women respectively, as well as the presence of more than two or equal of the subsequent circu-mstances: FBG levels above 100 milligrams per deciliter (mg/dl) or confirmed diabetes, levels of HDL-c for men 40 mg/dl and 50 mg/dl for females, or drug to cure low HDL-c, 150 mg/dl of blood TG or medication therapy for high TG and Blood pressure greater than 130/85 millimeters of mercury (mmHg) or hypertension (HTN) medication **(Alberti *et al.*, 2009)**

In comparison with individuals without MetS a total of 8,494 deaths were noted during 16.71 years of follow-up through a pros-pective cohort study conducted by the National Health and Nutrition Examination Survey involving 36,414 adults **(Li *et al.*, 2023).**

Among obese Egyptian college students, the prevalence of metabolic syndrome was 24.37 % in a study involving eight hundred obese participants with (BMI >30Kg/m2) their ages ranged from 18 to 24 years old from October 6th, Cairo and Misr University for Science and Technology univ-ersities conducted from April 2011 to April 2013 (**Ahmed *et al.*, 2014),** While a study by **Mahrous *et al.*,** illustrated that the prevalence of insulin resistance syndrome was 16.7% among 455 of 18–25 years old Students of Menoufia University and it was more common among female students.

Restricting calories can lead to weight loss and an improvement in peripheral lipid profile and cytokine, which could potentially reduce coronary artery disease (**Montefusco *et al.*, 2021**).

As evidenced by recent research, modifiable lifestyle factors particularly eating beha-viors correlate with both the prevalence and prevention of dysmetabolic syndrome (**Fahed *et al.*, 2022).**

AIM OF THE STUDY

This survey's purpose is to investigate and assess the impact of specific dietary changes on the risk factors correlated with Syndrome X in a sample of adults. The ultimate goal is to provide evidence-based strategies for the management and prevention of Mets, contributing to improved public health outcomes.

METHODOLOGY

Fifty persons between the ages of 20 and 60 participated in this trial, which focused on high-risk MetS patients. An individualized balanced diet was tailored for the six months. The Scientific Research Ethics Committee, in GOTTI, accepted the search by a Review and Approval Certificate (RAC). The study will be conducted through the year when the (IN 000149) Ethics Committee number was valid.

Subjects exposed at the onset of intervention and the end to:

1- **Anthropometric assessment:** It was conducted (Height, hip, weight, BMI, and waist measurements). Quetelet Index was computed by dividing the weight of an individual in kilograms by the square of their height in meters. **(Jelliffe, 1966).** BMI was used according to **(WHO, 2000).** Hip and Waist circumference **(Dalton *et al.*, 2003).**

2- **Biochemical analysis:** Serum lipid profile (TG, total, HDL-c, and LDL-c cholesterol) and fasting blood sugar were made according to the method described by **(Raba and Mottola 1995; Kumari and Kanwar 2012; Lopes-Virella *et al.*, 1977; Martin *et al.*, 2013; Fossati and Prencipe 1982).**

3- **Routine Medical examination**: Blood pressure: While sitting with the right hand, the arm supported at heart level, and the feet flat on the floor, the systolic and diastolic blood pressures were taken **(Owusu *et al.*, 2015).**

4- **Dietary assessment:** 24-hour recall was conducted. The recalls were used to calculate the intake of food types as well as energy and nutrients. The Egyptian food composition tables were used to calculate the consumption of energy and nutrients.

National Nutrition Institute, 2006). By comparing the calorie and nutrient intake with **Raymond and, Morrow's (2022)** recommended dietary allowances (RDA) the adequacy of the diet was evaluated.

The criteria for exclusion:

- Gravid or nursing mothers
- Whom is on a restrictive diet
- People who suffer from serious diseases such as cancer, liver or heart problems, or are unable to engage in physical activity

Statistical Analysis:

Version twenty-one of the Statistical Package for the Social Sciences (SPSS) was used to analyze the data. Percentages and mean ±SD of the results were reported. Compare the means (paired-samples T-test) was used to assess the outcomes. Significant statistically were taken into consideration at $P < 0.05$. (**Snidecor and Cokhran 1967)**

OUTCOMES

Table one shows that the examined group was morbidly obese before intervention with BMI (40.1 ± 6.7) and a significant decrease to obesity class Π with BMI (35.1 ± 5.6).

Table (2) demonstrates the highly significant decline in FBG, TC, and LDL-c with a highly considerable increase in HDL-c cholesterol.

Table three and Figure one shows how many metabolic syndrome criteria there are before intervention all intervention samples had criteria of MetS however after intervention (28%) became had less than 3 factors only.

Table (4) shows a highly significant improvement in dietary intake decrease in Kcal, protein, fat, and Carbohydrate, and a non-significant increase in fiber.

Table (5) shows that there is a high reduction in sodium consumption and a strong rise in calcium, magnesium, and potassium consumption.

Table (6) shows that there is a highly significant increase in intake of vitamins A, C, B1, and B2 after intervention.

DISCUSSION

After Six months of dietary intervention with an individualized balanced diet, there was a noticeable lowering in every anthropometric parameter as well as clinical parameters (table 1) and this was associated with improvement in all laboratory parameters with a very notable decline in FBG, LDL-c and TC as well as a significant elevation in HDL-c (table 2). This reduced the percentage of patients with metabolic syndrome by 28 % **(**table 3 and Fig. 1**).** This is comparable with the **Van Namen *et al.,* (2019)** study in which lifestyle intervention led to a 39 % lowering in the spread of MetS**.**

As regards macronutrient analysis for 24-hour recall, there was a highly significant improvement in dietary intake decrease in Kcal, Protein, fat, and carbohydrate, and a significant increase in fiber (table 4). Also (table 1) showed that participants were morbidly obese before intervention with a BMI (of 40.1 ± 6.7) and a significant decrease to obesity class Π with a BMI (of 35.1 ± 5.6) the findings of **Chao *et al.,* (2021)** are in agreement with These results as they reported in Certain scientific research and meta-analyses have demonstrated that low low-caloric regimen compared to a higher calorie diet consistently resulted in more short-lived (<6 months) weight loss, with the decreasing of this benefit over longer periods (>12 months). Proceed in progress dietary commitment, which is substantial to both long-short run weight losses, may arise from increased attempts to find metabolic and behavioral characteristics in dieters.

Also, there was a considerable decrease in sodium consumption and a notable rise in calcium, magnesium, and potassium consumption (table 5). These results agree with those of **Filippini *et al.,* (2021)** who discovered an almost linear association between a reduction in SBP as well as DBP and sodium consumption across the whole range of sodium intake from dietary sources. Also, these findings in linear with a systematic review conducted by **Gonçalves, and Abreu (2020)** that suggested that the risk of CVD is correlated with a reduced sodium-to-potassium ratio and rise in potassium levels.

The outcomes of **Piuri *et al.*, (2021)** agree with the results as they reported that following a proper dietary pattern which includes the right intake of magnesium can improve Mets, by lowering hypertension, high blood glucose, and hypertriglyceridemia. This occurs, through the positive impact on the structure of the gut microbiome and the B1 and D vitamin metabolism as well as modification of gene regulation and protein expression profile and protein signature.

Additionally, the outcomes are consistent with **Woo *et al.*, (2020)** which demonstrated that the incident risk of MetS and each component was inversely correlated with dietary calcium consumption, even intake from vegetables. The inverse asso-ciation was more distinguished through individuals with two components of MetS at baseline**.**

Also, there was a highly significant decrease in iron and zinc consumption but they were still within RDA (table 5). These results may be inverse with **Zhu *et al.*, (2018)** who reported that there was a positive correlation between insulin resistance syndrome and its criteria in adult people and dietary iron consumption. But maybe agree with these findings if we take into consideration that their consumption level is still within RDA.

The results are consistent with **Ding *et al.*, (2022)** who found a negative correlation between the consumption of zinc from dietary sources and Dysmetabolic syndrome in a meta-analysis of observational studies.

As mentioned in (table 6), There is a considerable rise in vitamin C, B1, and B2. **Liu and Park, (2022)** discovered that a low dietary ascorbic acid ingestion may raise the chance of developing syndrome X and associated metabolic charact-eristics, particularly high blood sugar. To improve glycemic control, adults should be advised in a setting of therapy to ingest 100 mg of vitamin C daily through their diet. This may illustrate that the studied sample had insufficient V.C. consumption before inter-vention and took an acceptable range after this.

In addition, the results go in parallel with **Ponce *et al.*, (2019)** who concluded that orange juice with a diet that is balanced resulted in improvement in MetS features, especially insulin and insulin resistance.

The findings are in harmony with **Wong *and others*., (2020); and Dludla *etc*., (2022)** who observed that it has been supposed that Anti-inflammatory and antioxidant advantages are positive consequences of ascorbate intake. They also findings highlighted the significance of vitamin C intake for metabolic syndrome patients via supplementations, drinks, and foods to preserve its level of concentration in the bloodstream and maybe reverse MetS

Also, our results go in parallel with **Ashor *et al*., (2019)** who reported that **the** pathophysiology of cardiac dise-ase may be impacted and altered by increased ascorbic acid intake from food, particularly from vegetables and fruits due to the physiological functions of vitamin C including epigenomics regu-lation, antioxidant activity, and collagen formation

The findings of **Wu *et al*., (2020)** are in agreement with the results as they reported that Increased consumption of vitamins B1 and B2 has been linked to a lower incidence of metabolic syndrome.

The results are consistent with **Nguyen and Kim (2022)** as they reported that Adults with comorbidities showed a subs-tantial 7% reduction in syndrome X when their daily B1 intake was doubled.

CONCLUSION:

In conclusion, **t**his study demonstrates the significant improvements in metabolic risk factors after the dietary inter-vention with a significant amelioration in dietary intake, including a decrease in calories, protein, fat, and Carbohydrates and a non-significant increase in fiber. Also, there is an obvious decline in sodium consumption and a notable rise in intake of calcium, magnesium, and pota-ssium consumption. While there is a highly significant rise in A, C, Thiamine, and B2 vitamins. According to these results, adults' risk of developing metabolic syndrome may be effectively decreased by dietary interventions.

RECOMMENDATIONS:

Consuming a healthy, balanced diet to maintain a healthy weight, physical activity, and optimal sleep. Decrease salt consumption as follows: Choose the lowest content packaged products of sodium, Pick fresh poultry and vegetables instead of packaged ones. And use condiments, spices, and vinegar to add flavor to foods instead of salt, increase consumption of fresh vegetables and fruits, increase consumption of dairy products specially fermented products, increase consumption of water instead of soft drinks, and use healthy oils to decrease the consumption of saturated fatty acids

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Table (1): anthropometric and clinical data before and after the intervention.

Anthropometric and clinical data		Pre N= 50 Mean ± SD	Post N= 50 Mean ± SD	P value
Anthropometric data	Age (yrs.)	42.9±9.4	42.9 ± 9.4	
	Weight (Kg)	108.1 ± 20.4	94.8 ± 17.6	0.000
	Height (Cm)	164.1 ± 7.2	164.1 ± 7.2	-
	BMI (kg/m^2)	40.1 ± 6.7	35.1 ± 5.6	0.000
	Waist (Cm)	115.2 ± 13.8	105.3 ± 12.5	0.000
	Hip (Cm)	123.8 ± 14.1	116.1 ± 13.0	0.000
	Waist to Hip ratio (Cm)	0.93 ± 0.08	0.91 ± 0.09	0.002
	Waist to Height ratio (Cm)	0.70 ± 0.07	0.64 ± 0.06	0.000
Clinical data	Systolic BP (mm Hg)	141.4 ± 25.2	127.8 ± 10.8	0.000
	Diastolic BP (mm Hg)	92.0 ± 12.8	85.0 ± 6.3	0.000

The results are significant when the P value ≤0.05

Table (2): Descriptive Statistics for and laboratory parameters before and after the intervention

	Cut off points	Pre N= 50	Post N= 50	P value
		Mean ± SD	Mean ± SD	
FBG (mg/dl)	< 100	113.7 ± 36.8	95.9 ± 12.6	0.011
TC (mg/dl)	< 200	226.0 ± 74.9	176.0 ± 43.3	0.000
TG (mg/dl)	< 150	169.9 ± 63.2	123.0 ± 46.7	0.000
HDL-c (mg/dl)	> 40	39.2 ± 6.5	43.6 ± 11.7	0.029
LDL-c (mg/dl)	< 100	119.8 ± 43.2	92.1 ± 27.8	0.000

FBG = fasting blood glucose TC = total cholesterol TG= triglyceride
HDL-c = high-density lipoprotein-cholesterol The results are significant when the P value ≤0.05
LDL-c= Low-density lipoprotein-cholesterol

Table (3): distribution of Risk factors before and after the intervention

Risk factors	Pre N= 50		Post N= 50	
	No	%	No	%
1 factor	-	-	4	8.0
2 factors	-	-	10	20.0
3 factors	8	16.0	22	44.0
4 factors	36	72.0	12	24.0
5 factors	6	12.0	2	4.0

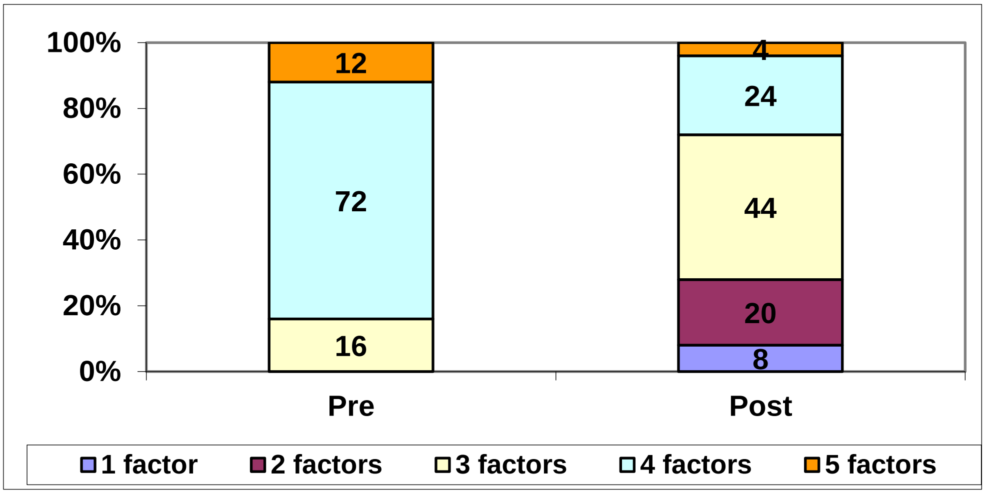

Fig. (1): distribution of Risk factors before and after the intervention

Table (4): dietary intake from energy, fiber, and macronutrient

Macronutrients	RDA range	Pre		Post		P value
		Mean ±SD	% of RDA	Mean ±SD	% of RDA	
Calories (Kcal)	1500 – 2500	2921.7 ±942.4	146 %	1627.6 ±383.7	81.4 %	0.000
Fiber (g)	21 – 35	10.4 ± 3.8	37.14 %	18 ± 2.0	64.3 %	0.010
Protein(g)	56.25 – 93.8	104.4 ± 33.1	139.2%	79.0 ± 22.3	105.3%	0.000
Fat (g)	50 – 83.3	102.5 ± 48.2	153.8%	46.3 ± 23.9	69.5%	0.000
Carbohydrate (g)	206.25-343.8	394.6 ± 122.4	143.5%	215.6 ± 42.4	78.4%	0.000

Source of RDA: Raymond and Morrow 2022. The results are significant when the P value ≤0.05

Table (5): Dietary intake from minerals before and after the intervention

Micronutrients	RDA range	Pre		Post		P value
		Mean ± SD	% of RDA	Mean ± SD	% of RDA	
Sodium (mg)	1300 – 1500	4164.0 ± 1894.9	297.4 %	1707.2 ± 616.2	121.9 %	0.000
Potassium (mg)	4700 – 4700	2432.3 ± 969.2	51.8 %	2816.2 ± 603.9	59.9 %	0.030
Calcium (mg)	1000 – 1200	550.9 ± 256.0	50 %	860.0 ± 464.2	78.2 %	0.006
Phosphorus (mg)	700 – 700	1017.2 ± 268.7	145.3%	1060.0 ± 401.5	161.4 %	0.655
Magnesium (mg)	310 – 420	146.7 ± 66.8	40.2 %	203.9 ± 77.3	55.9 %	0.011
Iron (mg)	8 – 18	16.7 ± 5.1	128.5%	12.8 ± 3.7	98.5 %	0.002
Zinc (mg)	8 – 11	12.4 ± 3.6	130.5%	9.5 ± 3.2	100 %	0.001

Source of RDA: Raymond and Morrow 2022. The results are significant when the P value ≤0.05

Table (6): Dietary intake from vitamins before and after the intervention

Micronutrients	RDA range	Pre		Post		P value
		Mean ± SD	% of RDA	Mean ± SD	% of RDA	
Vitamin A (µg RE)	700 – 900	213.8 ± 103.3	26.7 %	527.4 ± 251.0	65.9 %	0.004
Vitamin C (mg)	75 – 90	35.6 ± 16.8	43.2 %	110.3 ± 48.1	133.7 %	0.000
Vitamin B1(mg)	1.1 – 1.2	0.8 ± 0.4	69.6 %	1.0 ± 0.3	87.0 %	0.030
Vitamin B2 (mg)	1.1– 1.3	0.8 ± 0.4	66.7 %	1.2 ± 0.5	100%	0.005

Source of RDA: Raymond and Morrow 2022. RE= Retinol Equivalent
The results are significant when the P value ≤0.05

تأثير التدخل الغذائي على عوامل خطر الإصابة بمتلازمة الأيض بين البالغين

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2. بقسم التغذية الإكلينيكية بالمعهد القومى للتغذية
3. الهيئة العامة للمستشفيات والمعاهد التعليمية

الملخص العربي

تتميز المتلازمة الآيضية بالتواجد المشترك لعوامل الخطر التي ترتبط بلا شك بزيادة خطر الإصابة بأمراض مزمنة مثل مرض السكري من النوع الثانى وأمراض القلب والأوعية الدموية. تعد معالجة عوامل نمط الحياة ، بما في ذلك العادات الغذائية، أمرًا ضروريًا للتحكم والوقاية من متلازمة التمثيل الغذائي . ركزت هذه الدراسة على تقييم تأثير التدخلات الغذائية على عوامل خطر الإصابة بالمتلازمة الأيضية بين عينة من البالغين. ***المواد والطرق:*** *تضمن البحث برنامج تدخل غذائي مدته ستة أشهر تم إجراؤه على خمسين شخصًا بالغًا تتراوح أعمارهم بين 20 إلى 60 عامًا إستهدف الأفراد المعرضين لخطر الإصابة بالمتلازمة الآيضية. تم تصميم نظام غذائي فردي متوازن، وتم إجراء تقييمات القياسات الجسمانية، والتحليلات البيوكيميائية، والفحوصات الطبية الروتينية.* ***النتائج:*** *معظم العينة المدروسة كانت تعاني من السمنة المفرطة مع متوسط مؤشر كتلة الجسم (40.1 ± 6.7)، وزيادة في نسبة الجلوكوز في الدم أثناء الصيام ، الكوليسترول الكلي ، الدهون الثلاثية وكوليسترول البروتين الدهني منخفض الكثافة وانخفاض مستويات كوليسترول البروتين الدهني عالي الكثافة. أدى برنامج التدخل إلى تحسينات كبيرة في عوامل الخطر ميتس بين المشاركين. كان هناك انخفاض ملحوظ في عوامل مثل السكر الصائم ، الكوليسترول الكلى ، كوليسترول البروتين الدهني منخفض الكثافة ، والدهون الثلاثية، مصحوبًا بزيادة في مستويات كوليسترول البروتين الدهني عالي الكثافة* ***الملخص:*** *هناك تأثير للتدخل الغذائي على عوامل خطر المتلازمة الأيضية لدى البالغين ويمكن أن يحسن المتلازمة الأيضية ومخاطرها .*

الكلمات المفتاحية: *متلازمة التمثيل الغذائي، التدخل الغذائي، عوامل خطر الأيض، البالغين.*