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Impacts of Extra Virgin Olive Oil Consumption on Glycemic Control in Patients with Metabolic Syndrome

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ABSTRACT

The purpose of this study was to observe the impacts of extra virgin olive oil on glycemic control in patients with metabolic syndrome (MetS). A total number of 70 patients of both genders with MetS were selected with the age varying from 35 to 55 years. Among them, 35 patients who had consumed 25 ml of extra virgin olive oil daily for 12 weeks were included in the study group (Group B). Another 35 patients who did not consume extra virgin olive oil were enrolled as control group (Group A) for comparison. Levels of fasting blood glucose (FBG) and glycosylated hemoglobin (HbA_1c) were measured in both control and study groups at baseline and after 12 weeks. EVOO consumption group showed a statistically significant decrease fasting blood glucose (p =.003) and glycosylated hemoglobin (p <0.001) in comparison to control group who did not consume extra virgin olive oil. Regular consumption of extra virgin olive oil improves glycemic status in patients with metabolic syndrome.

Keywords: Metabolic syndrome (MetS), Extra virgin olive oil, Oil consumption, and Glycemic status.

INTRODUCTION:

Metabolic syndrome (MetS) is a group of risk factors that are related to cardiovascular diseases (CVD), diabetes mellitus and stroke. These risk factors are related to each other, co-occurring and the underlying causes and features are similar. The component of metabolic syndrome includes mainly hyperglycemia, hypertension, dyslipidemia & central obesity. Patients with metabolic syndrome are twice as likely to develop cardiovascular diseases (CVD) and five times as likely to develop type 2 diabetes (Alberti *et al.,* 2009; Aryal and Wasti, 2015). Different international organizations and experts' groups have tried to define metabolic syndrome in a little different ways (Chiva-Blanch and Badimon, 2017).

According to the National Cholesterol Education Program-Adult Treatment Panel III (NCEP - ATP III) criteria, metabolic syndrome is diagnosed when any three or more of the following five features are present; abdominal obesity can measured by waist circumference (≥ 102 cm in men and ≥ 88 cm in women), hypertriglyceridemia (≥150 mg /dl), low HDL cholesterol (< 40 mg /dl in men and < 50 mg /dl

in women), high blood pressure (>130/85 mm of Hg), high fasting glucose > 110 mg/dl (Parikh and Mohan, 2012).

The prevalence of metabolic syndrome is increasing very fast in both developed and developing countries globally (Cornier *et al.,* 2008). According to IDF, the number of people affected by metabolic syndrome among adults in the worlds is 20-25%. In Bangladesh, the prevalence of MetS is around 30.7% (Candido *et al.,* 2017). The number of cardiovascular patients is much higher in South Asia region. The underlying factors behind the high prevalence of MetS in South Asians region are, increasing trend of urbanization, sedentary life style, physical inactivity and unhealthy dietary pattern. These factors influence glucose intolerance, dyslipidemia and abdominal obesity (Misra *et al.,* 2004; Moran & Vedanthan, 2013). Extra virgin olive oil (EVOO) is the very high grade of unrefined edible oil and its associated with a decreased risk of cardiovascular diseases, dyslipidemia, type 2 diabetes mellitus, hypertension and obesity (Lopez-Miranda *et al.,* 2010). It is extracted by the first pressing of the olive fruit (*Olea europaea*) and belongs to Oleaceae family (Wijayanthie *et al.,* 2019). About 6000 years ago, extra virgin olive oil originated in ancient Persia, Mesopotamia or Egypt and then spread to the Greek and Roman Empire (Meldrum, 2021).

Currently the largest producers of olive oil are the Spain, Italy and Greece (Romani *et al.,* 2019). EVOO chemical composition depends on many factors like as olive variety, maturation grade of fruit at the time of harvesting and methods of harvesting olive oil. It consists of major and minor components. Major components are high degree of fatty acid that represents 98-99% of the total weight of EVOO particularly monounsaturated fatty acid (MUFA) such as oleic acid much higher (55-83%) then the other acid (3-21%) including's the linoleic acid, palmitic or stearic acid. Minor components are small in amount about 2% of total weight of oil (Ghanbari *et al.,* 2012; Ruin-Dominguez *et al.,* 2013). Minor components are two types, one is non-polar and other is polar part. Minor Polar part again subdivided among these: secoiridoids (oleuropein, oleocanthal), phenolics (hydroxytyrosol), phenolic acid (gallic acid), flavonoids (luteolin) and ligans (Romani *et al.,* 2019).

MATERIALS AND METHODS:

Study place

The study was conducted at outdoor of Dhaka Medical College Hospital, Dhaka from July 2021 to July 2022.

Ethical approval of the study protocol

The study protocol was approved by Research Review Committee and Ethical Review Committee of Dhaka Medical College, Dhaka.

Inclusion criteria

The inclusion criteria were diagnosed metabolic syndrome patients according to modified National Cholesterol Education Program-Adult Treatment Panel III (NCEP-ATP III) criteria age 35-55 years of the both genders.

Exclusion criteria

The exclusion criteria were regular insulin therapy, oral steroids, endocrine disorders, autoimmune diseases, malignancy, history of the liver, renal, heart diseases, smoking, alcohol intake, pregnant & lactating mother & patients who were known allergic to the extra virgin olive oil.

Study population and design

A prospective interventional study was conducted in the department of physiology at the Dhaka Medical College, Dhaka. Total number of 70 patients of both genders with MetS was selected with the age vary from 35 to 55 years. Among them, 35 patients who had consumed 25 ml extra virgin olive oil daily for 12 weeks were included in the study group (Group B). Another 35 patient who did not consume extra virgin olive oil, were enrolled as control group (Group A) for comparison. 25 ml extra virgin olive oil (Olitalia) was measured by supplied measuring cup. A person can consume 1 liter of extra virgin olive oil for 40 days. Each patient in the study group was given a total of 2 liters of 200 ml extra virgin olive oil for 12 weeks. A regular telephonic contact and periodic visit was taken to supply extra virgin olive oil and to ensure compliance with intervention. Empty bottles of extra virgin olive oil and the amount of oil left in the bottle were checked to understand that the patient was consuming the oil regularly. The participants were instructed to use extra virgin olive oil in their daily cooking instead of other oils.

Statistical analysis

All parameters are expressed as mean ± SD (standard deviation). Paired and Unpaired student's 't' test were performed to compare quantitative data between study and control groups. Chi Square test was performed to compare qualitative data between study and control groups. *P* value < 0.05 was accepted as level of significance. Statistical analysis was performed by using a computer based statistical program SPSS (Statistical package for social science) version 23.0.

RESULTS:

Total 70 patients with the metabolic syndrome were enrolled for this study. Among them of 68 patients completed this study. 2 subjects from the study group were excluded due to personal region. In the study group, there were 23 female and 10 male patients with mean age 45.33 ± 7.41 and in the control group; there were 20 female and 15 male patients with mean age 47.71 ± 10.92. No statistical differences were observed at baseline characteristics between these two groups. But after 12 weeks consumption of extra virgin olive oil, the study group showed a statistically significant decrease in FBG (p <0.05) HbA_1c (p <0.001) levels in comparison to their baseline values.

Table 1: General Characteristics of the patients in control and study groups (n=68).

	Control	Study	*p*-value
Age	47.71±10.92	45.33±7.41	0.462
Gender			
Male	15(40%)	10(30.3%)	
Female	20(60%)	23(69.7%)	0.699

Mean (±SD) age of the patients in control group was found 47.71±10.92 years that of 45.33±7.41 in study group and the difference was not statistically significant (p>.05). Similarly no statistically significant association was found between study and control group in gender of the patients (p>0.05).

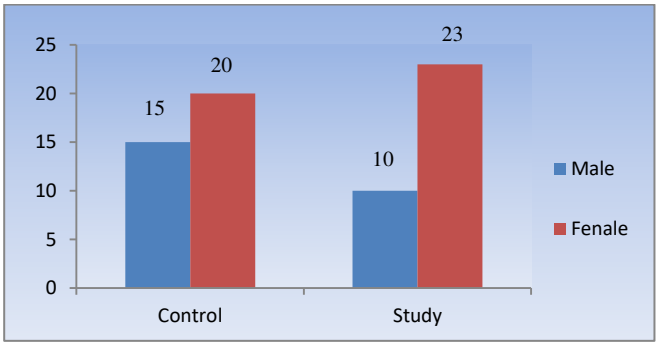

Fig. 1: Comparison of gender in control and study groups (n=68).

Table 2: Fasting blood glucose (FBG) levels in control and study groups (n=68).

	FBG (mmol/L) Group A-Control group	Group B - Study group	
	At baseline	**At baseline**	***p* value**
At baseline	7.6±1.2 (6.2-11.6)	8.46±2.40 (6.20-17.3)	0.08[b]
After 12 weeks	7.7±1.2 (6.4-12.0)	6.88±1.04 (5.7-12.7)	<0.001[b*]
***p* value**	0.096[a]	0.003[a]	

Results are expressed as mean ± SD. a= Paired t test was performed for comparison within groups and b = unpaired t test was performed to compare between groups.

The test of significance was calculated and p <005 as accepted level of significant. n = total number of the patients. * =significant

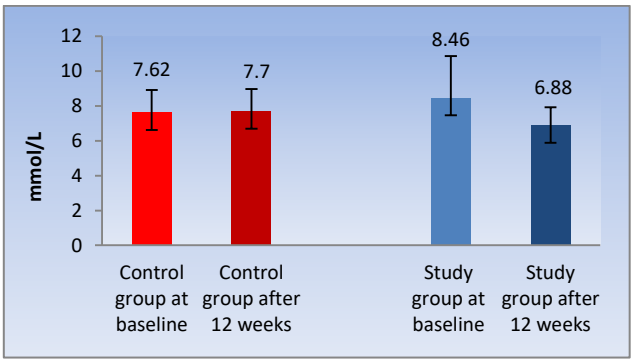

Fig. 2: Mean fasting blood glucose in control and study groups (n=68).

n = total number of patients

Mean fasting blood glucose of control group at baseline

Mean fasting blood glucose of control group after 12 weeks

Mean fasting blood glucose of study group at baseline

Mean fasting blood glucose of study group after 12 weeks

Table 3: Glycosylated hemoglobin (HbA_1c) levels in control and study groups (n=68).

	HbA_1c% Group A-Control group	**Group B - Study group**	
	At baseline	**At baseline**	***p* value**
At baseline	7.1±0.9 (6.1-10.2)	7.6±1.6 (6.0-12.0)	0.120[b]
After 12 weeks	7.1±0.8 (6.0-10.2)	6.56±0.6 (5.8-10.6)	<0.001[b*]
***p* value**	0.110[a]	<0.001[a*]	

Results are expressed as mean ± SD. a= Paired t test was performed for comparison within groups and b = unpaired t test was performed to compare between groups. The test of significance was calculated and p <0.05 was accepted level of significant. n = total number of patients. * =significant

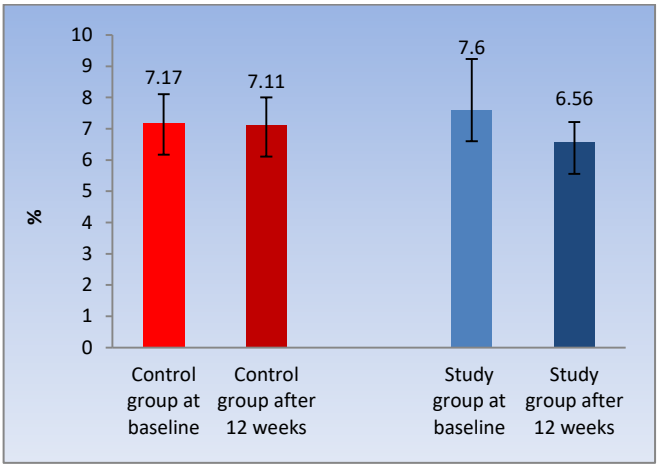

Fig. 3: Mean glycosylated hemoglobin in control and study groups (n=68).

n = total number of patients

Mean glycosylated hemoglobin of control group at baseline

Mean glycosylated hemoglobin of control group after 12 weeks

Mean glycosylated hemoglobin of study group at baseline

Mean glycosylated hemoglobin of study group after 12 weeks

DISCUSSION:

The principal finding of the present study is that the consumption of extra virgin olive oil improves glycemic status in the patients with metabolic syndrome (MetS). Now-a-days, changing in the life style and unhealthy dietary pattern was significantly associated with metabolic syndrome. In recent years, natural food products have been more popular in the preventing metabolic syndrome and its complication. One of the natural ingredients is extra virgin olive oil; rich in monounsaturated fatty acid (MUFA) and phenolic oleocanthal compound have several health benefits. Patients were recruited for this study from the Department of Endocrinology, Dhaka Medical College. And after patient selection each patient was explained in detail about the purpose and benefits of this study. The normal lifestyle of the patients remains unchanged during the course of study. In present study, the mean fasting blood glucose (p=0.003) and HbA_1c (p <0.001) were found significantly lower in patients with MetS (study group) after consumption of extra virgin olive oil in the comparison to that of their base line value. Again, after 12 weeks, fasting blood glucose and HbA_1c were found significantly (p <0.001) lower in study group in comparison to that of the control group. Oleuropein, the main phenolic compound of the extra virgin olive oil has favorable effects on blood glucose and glucose tolerance by decreasing oxidative stress and increasing peripheral uptake of the glucose. It decreases the digestion and absorption of starch and also inhibits the pancreatic amylase activity (Khalili *et al.,* 2017). Oxidative stress leads to β-cell dysfunction and ultimately develops diabetes. Oxidative stress also liable for dipeptidyl-peptidase -4(DPP-4) activation which causes inhibit of insulin secretion. Extra virgin olive oil decreases the dipeptidyl-peptidase (DPP-4) activity and increase insulin secretion. Extra virgin olive oil stimulates the intestinal cell to release endogenous incretin such as glucagon like peptide 1 and gastric inhibitory peptide from distal small intestine. These glucagon like peptide 1 and gastric inhibitory peptide binds with the receptors in endocrine portions of pancreas that eliciting the secretion of insulin and reduce blood glucose levels (Violi *et al.,* 2015). Glucagon like peptide 1 (GLP1) promote the proliferation of pancreatic β cell and also reduce the pancreatic β-cell apoptosis. Others phenolic compound like tyrosil, caffeic acid, luteolin causes inhibit the endoplasmic reticulumn induced beta cell apoptosis, enhanced the

glucose stimulated the insulin secretion and glucose sensitivity (Marrano *et al.,* 2021). Almost similar results have been observed in the studies of different researchers of the different countries (Paniagua *et al.,* 2014; Santangelo *et al.,* 2016). Santangelo *et al.* (2016) suggested that daily input of high polyphenol rich extra virgin olive oil significantly reduced fasting blood glucose and glycosylated hemoglobin level. It also decreased the ALT, AST, LDL cholesterol and increase HDL-cholesterol levels in the plasma. They selected of 11 over weight type 2 diabetes mellitus patients. They do not take insulin and who consumed HP- EVOO 25 ml/day for 8 weeks. The first 4 weeks were the wash-out period. And after the end of study significantly reduced fasting blood glucose and glycosylated hemoglobin level have been found.

On the contrary, Patti *et al.* (2020) had performed an interventional study to observe the impacts of extra virgin olive oil consumption in metabolic syndrome patients. They had selected 23 patients. The patients were asked to consume 4 large spoon (which corresponded to 32g) extra virgin olive oil rich in high oleocanthal concentration daily during their main meals such as lunch and dinner for 2 month. During the study period no other type of oil was allowed. And they were also advised to maintain their normal life style as followed before intervention. But at the end of the study, no significant difference were observed in fasting blood glucose and HbA_1c levels after consumption of the extra virgin olive oil. There are a few limitations of this study. First, the study population is small and then, the study was conducted in a selected hospital. So, we recommend large sample size from different areas of the country to establish the beneficial effect of extra virgin olive oil on metabolic syndrome.

CONCLUSION AND RECOMMENDATIONS:

After analyzing the results of the study, it can be concluded that FBG and HbA_1c were significantly decreased in study group after 12 weeks of consumption of extra virgin olive oil in comparison to their baseline value and control group. So, regular consumption of extra virgin olive oil may improve glycemic status in patients with metabolic syndrome. Therefore, regular intake of extra virgin olive oil can be an alternative choice for management of metabolic syndrome. We recommend the assessment of HOMA-IR and level of oxidative stress to confirm the mechanism of action of the extra virgin olive oil to improve insulin sensitivity and reduce insulin resistance.

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CONFLICTS OF INTEREST:

The authors declare that there is no conflict of interest.

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