ECRONICON OPEN ACCESS

EC ENDOCRINOLOGY AND METABOLIC RESEARCH

Research Article

The Influence of XY Curcumin on Body Weight, Body Mass Index, and Waist Circumference in Persons with Metabolic Syndrome

Senada Selmanovic[1], Azijada Beganlic[1]*, Albina Softic[2], Zejneba Pasic[3], Elvisa Omerovic[1] and Brekalo-Lazarevic S[4]

[1]Public Health- Educational institution Dom zdravlja Dr. M. Sehovic Tuzla-Department of Family Medicine, Family Medicine Teaching Center, Bosnia and Herzegovina

[2]Hausarztpraxis R. Pürckhauer and Kollegen, Sontheim an der Brenz, Bosnia and Herzegovina

[3]Department of Neurology, University Clinical Center Tuzla, Bosnia and Herzegovina

[4]Public Health- Educational institution Dom zdravlja Dr. M. Sehovic Tuzla-Department of Occupational Medicine, Bosnia and Herzegovina

***Corresponding Author:** Azijada Beganlic, Public Health- Educational institution Dom zdravlja Dr. M. Sehovic Tuzla-Department of Family Medicine, Family Medicine Teaching Center, Bosnia and Herzegovina.

Received: August 16, 2017; **Published:** October 11, 2017

Abstract

About 20 to 30 percent of the adult population in the world has a set of risk factors known as metabolic syndrome (MetS). Abdominal or central obesity, atherogenic dyslipidemia (elevated triglyceride level, decreased HDL-cholesterol level, elevated LDL-cholesterol level), impaired glucose tolerance and insulin resistance (IR) are major risk factors for MetS development.

Considering a great role which inflammation has in most chronic diseases, anti-inflammatory agents such as curcumin, should be partly used to prevent disease because not all people should be taking such medication-only those who are in the risk of inflammatory diseases and whose bodies can safely handle such treatments.

Aim: to determine the effects of curcumin on body weight (BW), body mass index (BMI) and waist circumference (WC) in MetS.

Subjects and Methods: A prospective cohort study was conducted at 100 subjects with MetS in Tuzla Canton. 50 participants with MetS and prediabetes (PD) and 50 participants with MetS and diabetes mellitus Type 2 (DM T2), in the age of 35 - 70 years. In total, there were 65 women and 35 men. The MetS features are set by the International Diabetes Federation (IDF) criteria from 2005. The study of curcumin influence on BW, BMI WC, was performed using the single-factor Analysis of variance (ANOVE) repeat measurements. Statistical significance was interpreted using "p" value. If the value of this parameter is less than 0.05, the statistical significance of the observed parameter is verified.

Results: The female persons were significantly represented than the male once (65:35), which is consistent with the fact that women suffer from metabolic disorders more than men. The largest number of subjects (29%) were in the age group 66 - 70 years. The use of curcumin, continuously for one year at a dose of 400 mg/day, statistically significantly reduced BW, BMI and WC in subjects with MetS and PD, as well as at the subjects with MetS and DM T2.

Conclusion: Curcumin together with nonpharmacological and pharmacological measures can improve the control of essential anthropometric parameters in MetS and prevent or delay the onset and complications of DM T2.

Keywords: *Metabolic Syndrome; Curcumin; Diabetes; BMI; The Waist Circumference*

Introduction

Metabolic syndrome

20 - 30% of the population in middle and older age suffers from the MetS [1]. Its prevalence is increasing worldwide, which is linked with overweight and sedentary lifestyle. Metabolic syndrome (MetS) is a set of metabolic disorders that increase the risk of DM T2, cardiovascular diseases, stroke, fatty liver, certain malignant and some other diseases. MetS carries five times higher risk for DM T2 [2]. In MetS´s pathogenesis, insulin resistance (IR) is indicated as a common etiologic factor for each MetS component [3]. World Health Organisation (WHO) published the first criteria for MetS in 1998 [4]. According to WHO criteria, MetS is a set of metabolic risk factors: insulin resistance (IR), arterial hypertension (AH), central obesity and dyslipidemia. This definition has shown a limitation in clinical use due to the impossibility of measuring insulin resistance. In 2001, NCEP ATP III published a simplified definition where all criteria were equally important [5]. According to this definition for MetS diagnosis, three of the following five criteria are required: waist circumfernce: for Men ≥ 102 cm, for Women ≥ 88 cm, triglyceride (TG) ≥ 1.7 mmol / L, HDL Cholesterol < 1.03 mmol / L for Men and < 1.3 Mmol/L for Women, systolic blood pressure (SBP) ≥ 130 mmHg, diastolic blood pressure (DBP) ≥ 85 mmHg and serum glucose in plasma (FG) at ≥ 6.1 mmol/L [6]. In 2003, the NCEP ATP III revised the criteria of glucose in plasma, lowering on ≥ 5.6 mmol/L while the other criteria were retained in the definition 2001 [7]. IDF proposed the latest consensus definition of MetS in April 2005 [8]. In this new definition, the central obesity is the main focus. To meet the criteria for MetS, the person must have a central obesity defined by WC, that is ethnically specific for Europeans: for men ≥ 94 cm and for women ≥ 80 cm with at least two or more of the following four criteria: TG ≥ 1.7 mmol/L, HDL-cholesterol for men < 1.03 mmol/L and for women < 1.29 mmol/L, SBP ≥ 130 mm Hg and DBP ≥ 85 mm Hg, patients use antihypertensive therapy, FG ≥ 5.6 mmol/L or DM T2 diagnosis. IDF and the American Heart Association/National Heart Association, Lung and Blood Institute (AHA / NHLBI) agreed that WC should not be a precondition for setting up a MetS diagnosis. Based on their consensus, WC is one of the five equal criteria in METS. The presence of any of three of the five risk factors is a METS diagnosis [9].

About 20 to 30 percent of the adult population in the world has a set of risk factors known as metabolic syndrome. In 2000, about 32% of American adults had metabolic syndrome [10]. In the last few years the number has incrised to 34% [11]. In the study, the European Global Profile of Cardiovascular Risk in Hypertensive (GOOD) patients examined the profile of cardiometabolic risk in adults with hypertension in European regions. The research has shown that the prevalence of metabolic syndrome is affected by 68% of Central European population, 52% of Mediterranean regions and 50% of Northwestern Europe [12].

Obesity

According to WHO data, obesity takes epidemic proportions and has become the leading public health problem in the end of the 20th century. Obesity is the cause of significant illness and increased mortality. The prevalence of obesity in western countries was estimated between 20% and 30% of the population [13,14].

Obesity was defined by the BMI, it represents the body weight ratio in kilograms (kg) and the body surface area in the square meter (m^2). According to the WHO criteria (1997) based on BMI, persons can be divided into four classes [15] (Table 1).

Classification (WHO, 1997)	Value of BMI (kg/m^2)
Malnutrition	< 18.5
Normal body weight	18.5 - 24.9
Overweight	25 - 29.9
Obesity	≥ 30.0

Table 1: *Classification of overweight and obesity in adults by WHO.*

Impaired Glucoregulation in MetS

Obesity, DM type 2, dyslipidemia and hypertension are the basic characteristics of metabolic disorder associated with MetS, which is associated with increased risk of premature death [16-18]. In MetS, one of the diagnostic criteria is the glucoregulation disorder. Today, diagnostic criteria for impaired glucose tolerance (IGT) and diabetes mellitus are used, according to the findings of American diabetes association (ADA) 2003, recommended by WHO [19] (Table 2). According to these criteria, the plasma glucose value at the people with

MetS may be: normal glucose regulation (NG) with plasma glucose at < 5.6 mmol/L; Impaired fasting glucose tolerance (IFG), with plasma glucose 5.6 - 6.9 mmol/L; Impaired glucose tolerance (IGT) when glucose is detected in a randomized case or 2 hours after test load- Oral Glucose Tolerance Test (OGTT) 7.8 - 11.0 mmol/L or as combined IFG and IGT and DM type 2 with plasma glucose values of ≥ 7.0 mmol/L or in a random finding or 2 hours after OGTT ≥ 11.1 mmol/L. The condition of IFG and/or IGT is termed as a prediabetes (PD). Both, PD and DM T2, require education, nonpharmacological and pharmacological treatment until reaching the metabolic target values. Nonpharmacological measures include diet adapted to the people with PD and diabetes limited calorie intake, physical activity of 150 minutes per week, reduction of stress and limited consumption of alcohol. Drugs recommended in pharmacological treatment of PD and DM T2 are oral anti-diabetic drugs. In the treatment of PD, metformin and inkretine are recommended as well, while in pharmacotherapy DM T2, all drug groups are recommended in both (monotherapy and in combined therapy) as well as insulin.

Plasma glucose values for IFG, IGT i DM			
	Fasting glucose (mmol/L) ADA (2003) ; WHO (2006)		**OGTT (mmol/L)**
NG	< 5.6 ; < 6.1		< 7.8
IFG	5.6 - 6.9 ; 6.1 - 6.9	and	< 7.8
IGT	< 5.6 ; < 6.1	and	7.8 - 11.0
IFG i IGT	5.6 - 6.9 ; 6.1 - 6.9	and	7.8 - 11.0
Diabetes mellitus (DM)	≥ 7.0	or	≥ 11.1

Table 2: *Diagnostic criteria for Impaired Glucose Tolerance and DM T2.*

Abbreviations: NG: Normal Blood Glucose; IFG: Impaired Fasting Glucose; IGT: Impaired Glucose Tolerance; DM: Diabetes Mellitus

Curcumin

Curcumin is the primary active ingredient of turmeric curcum (lat. Curcuma longa), it is in bright yellow color. Turmeric or Siamese tulip (Curcumalonga) is a plant from a ginger family. It was used as a spice and nutrition supplement, and it was first identified by Lampe and Milobedzka in 1910 [20]. This Indian spice is derived from the root of the curcum plant. Numerous therapeutic actions have been developed on a variety of diseases and conditions, such as skin, lung and digestive disorders, and used as a preparation for various pain, wounds and liver disorders. Its active ingredient is also attributed to pharmacological activities.

The mechanism of curcumin acting

Curcumin has been carefully studied for years and contains many potential health benefits. The effects of curcumin have been studied in western medicine systems for decades. Taking into account that inflammation plays a major role in most chronic diseases, useful of anti-inflammatory agents, such as curcumin, should be partly used to prevent disease because not all people should be taking such medication-only those who are in risk of inflammatory diseases and whose bodies can safely handle such treatments.

Inflammatory processes play an important role in the development of DM T2 [21]. A large number of different inflammatory cytokines and transcription factors (such as TNF and NF-κB) and various enzymes are involved in this process. Both, TNF and NF-κB activation are associated with insulin resistance [22]. Insulin resistance is a key factor in the emergence of MetS. In diabetes, curcumin can suppress blood glucose levels, increase the pancreatic beta-cell antioxidant status, and enhance PPAR-γ activation [23]. Curcumin promotes PPAR-γ gene expression and suppresses the expression of the low density lipoprotein receptor (LDL) receptor, which in turn reduces the level of intracellular cholesterol and thereby reduces the stimulatory effect of LDL-cholesterol on the liver, generated by the activation of the star cell [24]. Curcumin suppresses insulin-induced star-cell activation interrupting the insulin signal pathway and decreasing oxidative stress over the same PPAR-γ mechanisms [25]. Curcumin can adjust blood sugar levels at the people with diabetes as demonstrated in a

study of 40 years ago [26,27]. The mechanism by which curcumin improves this situation is likely to be its hypocholesterolemic effect, antioxidant capacity and body cleansing from free radicals. The anti-inflammatory activity of curcumin is based on the inhibition of leukotriene synthesis (inflammatory mediators) and the changes in prostaglandin production. It blocks the proliferation of lymphocytes and reduces actvity of natural killer cells. Antioxidant activity of curcumin is accomplished by neutralizing free radicals that damage cellular organisms by oxidizing their structures, leading to accelerated aging, atherosclerosis, cancer, rheumatoid arthritis, cataracts, Parkinson's and Alzheimer's disaeses. Curcumin may act to reduce cholesterol levels in the liver, as shown in animal studies [28]. Reduction of cholesterol levels was associated with LDL and VLDL fraction. Significantly reduced blood triglyceride and phospholipids were also present in diabetic rats when given curcumin. Numerous clinical trials which are still ongoing should provide an even better understanding of the mechanisms and therapeutic potentials of curcumin [29].

Aim

To determine therapeutic effects of XY Curcumin on BW, BMI, and WC in subjects with MetS.

Subjects and Methods

The Subjects

For this research, permission was granted from the Ethics Committee of the Public Health Insitution Dom zdravlja "Dr. Mustafa Šehović" with a polyclinic, as well as, the voluntary consent of the subjects who were involved in this study group. The survey was conducted on the selected group of subjects (100) in the period from 01.05.2013. until 30.04.2014.

Study design

A prospective cohort study was conducted on 100 subjects in the Tuzla Canton who had diagnosis of MetS, aged 35 to 70 years. The MetS features are set by the IDF criteria (2005). The therapeutic effects of the XY curcumin were monitored, which were taken by the subjects in the study group (N = 50). All of the subjects were treated with nonpharmacological and pharmacological therapy for disorders that were established on the basis of the full set of diagnostic IDF criteria (2005) during the study.

Including and excluding criteria

Including criteria were as follows: volunteering for inclusion in the study, age 35-70, diagnosis of MetS according to IDF criteria (2005), the subjects with MetS and DM T2 who use oral anti-diabetes drugs and whose disease lasts less than 10 years and who don´t have an allergy to curcumin. Excluding criteria were as follows: refusal of voluntary consent for inclusion in the study, the existence of serious mental or psychic disorders such as comorbidity, acute disease, acute premature conditions, bile stems, conditions immediately after surgery, acute bleeding, using anticoagulant therapy, DM T2 longer than 10 years as well as patients with DM T2 who are insulin users, and there is an allergy to curcumin.

Division of subjects

Based on the inclusion and exclusion criteria, the subjects (N = 100) were selected and divided into two groups of 50: group A (tested - using XY curcumin) and group B (control - not using XY curcumin). Within the groups we have subgroups of 25 subjects: subgroup A1 (subjects with METS and PD) and subgroup A2 (subjects with METS and DM T2). Randomization of the groups (A and B) was performed by age, sex, and randomization of the subgroup (A2) with DM type 2 even for the duration of the disease, and the type of oral antidiabetic, that between of the groups and subgroups there were no significant differences (Figure 1).

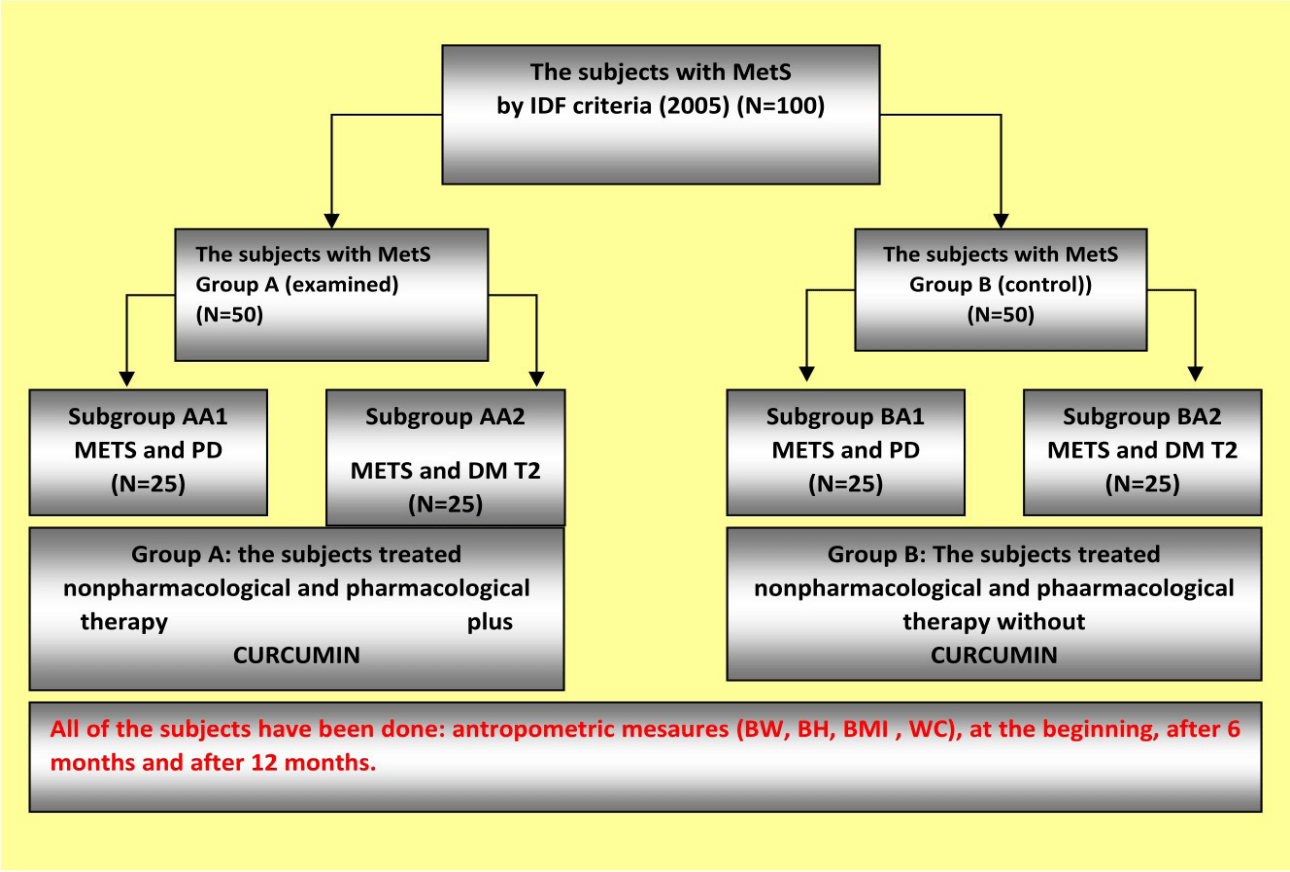

Figure 1: *Study design.*

The Treatment of subjects

One month prior to engagement in the study, the subjects were prepared for the study and clarified their purpose for the study. All subjects were treated with the nonpharmacological measures, which include: education about the condition of the disease and counseling on smoking hazards, because smoking is an important absolute risk factor for the development of coronary heart disease (CHD), peripheral thrombosis and for a major risk factor for stroke [30,31]; limited consumption of alcohol; limited intake of calories during the diet as well as benefits from every day physical activity in reducing obesity and reducing stress.

Both groups of patients were treated with (pharmacologically) standardized therapy for a condition and diagnosis based on the criteria of IDF (2005) with drugs that are known to be effective and reliable in leading metabolic parameters to target values. Metformin was used for treatment of hyperglycemia at a dose of 2000 mg/day, for treatment DM T2 metformin was used at a dose of 2000 mg/day in monotherapy and in combined therapy with the addition of sulfonylurea preparations of the second generation. In the treatment of essential hypertension, ACE inhibitors, ARB receptor blockers, metabolic neutral beta-blockers and metabolic-neutral diuretics. In the treatment of atherogenic dyslipidemia, statins and fibrates were also used. Acetylsalicylic acid at a dose of 100 mg/day dose was recommended for all subjects [32]. All Subjects in the study group (Group A) were recommended to take a dietary supplement, curcumin in

the pill shape at a dose of 400 mg/day during 12 months. The effects of treatment are followed by anthropometric measures.The control group didn´t recive a placebo. It is not a placebo controlled study. The subjects of this group have used pharmacological therapy for diabetes or prediabetes and the other comorbidity, and have also been on nonpharmacological therapy (change of life style).

Methods

Measurement of anthropometric parameters BW, body height (BH) and WC

BW was measured on the weighing scale. The subjects were measured barefooted and light dressed. The obtained values are automatically reduced by 0.9 kg, which would be accounted for by the remaining clothing of the examinee. The body height was measured with the metal strap calibrated correctly and fastened to the appropriate balance stand. Measurement of the subjects was done in the "Frankfurter´ Horizontals" (the top of the eyebrows in the line with the top of the ear).

In Bosnia and Herzegovina this the routinal procedure to measure individual BW and after that we calculated BMI for every patient.

Determination of BMI

The BMI was calculated from BW and BH of subjects by the following formula: BMI= TBW kg/BH m^2.

Measurement of WC

The volume of WC was measured in the area of the navel and the fifth lumbar vertebra with a meter band and the was expressed in centimeters (cm). The values were calculated according to IDF (2005) criteria: for men WC 94 cm and for women WC 80 cm.

Statistical methods

Collected data were entered into a specially crafted database on a personal computer and statistical processing was performed using the appropriate software support in the IBM SPSS Statistics 21 and they are presented in the work. The study of the effects of curcumin on BW, BMI and WC was performed using single-factor ANOVE repeated measurements. In practice, the application of this method requires that every subject (subject, observation unit) is measured under two or more different conditions, or on the same continuous scale on three or more time intervals, and also serves to compare respondents' answers to three or more different questions. And the answers must be measured on the same scale. For every of the four subgroups of subjects it was examined whether there was a statistically significant difference in the results obtained in relation to the mean values of the parameters, where statistical significance was interpreted using "p" value. If the value of this parameter is less than 0.05, the statistical significance of the observed parameter is verified.

In the multivariate test tables, results of various multivariate analysis of variance tests are obtained, where Wilks' Lambda Indicators (Wilks' Lambda) were used and associated probabilities in column "p" value. This indicator represents the quotient of the sum of squares of deviation (average value) within the group and the total deviation range and reaches the value between 0 and 1, where the nearest 1 indicates that the median values of the independent variables of the group do not differ widely, while the values close to 0 show that they differ. Wilks' lambda indicator with the criteria set forth herein was also used to determine statistically significant differences in all observed parameters.

Results of the Study

Distribution of subjects by sex

Based on the criteria set, a total of 100 subjects (N = 100) were selected, including 50 subjects with MetS and PD and 50 subjects with MetS and DM T2. In total, there were 65 women and 35 men. The women were significantly more in comparison to men, which is in line with the fact that women suffer from metabolic disorders more than men. The distribution of all subjects by gender is shown in table 3.

Sex	Number of subjects (N)	Number of subjects with characteristics of MetS and PD (N)	Number of subjects with characteristics of MetS and DMT2 (N)
Female	65	33	32
Male	35	17	18
Total	100	50	50

Table 3: *Distribution all of subjects by sex.*

Distribution of subjects by age

The age range of subjects in the study was 36 - 70 years. The largest number of subjects (29%) were in the age group 66 - 70 years. The age distribution of all subjects was presented in grades of 5-years (Table 4).

Age of subjects	Number of subjects (%)
36 - 40	2
41 - 45	2
46 - 50	9
51 - 55	19
56 - 60	18
61 - 65	21
66 - 70	29

Table 4: *Distribution all of subjects by age.*

The Influence of XY curcumin on anthropometric measurements

The Influence of XY curcumin on BW

All subjects in the study were measured BW three times: at the beginning, after 6 months and one year after the beginning of the study. Within the study, it was observed that the BW parameter behaved in group A subjects who used curcumin and its associated subgroups AA1 (subjects with MetS and PD) and AA2 (subjects with MetS and DM T2), and in control group B subjects who were not used curcumin and its associated subgroups BA1 (subjects with MetS and PD) and BA2 (subjects with MetS and DM T2). There was a statistically significant difference in the average BW measured at the beginning (BW1), after six months BW2) and after one year (BW3). The results obtained are shown in table 5. As shown in table 5, the middle value BW measured in subgroup AA1 with METS and PD, which used curcumin, was 83.16 kg at the beginning of the study, so that after one year the middle value of BW was 78.16 kg. In subgroup AA2 with MetS and DM T2, which used curcumin, at the beginning of the study the middle value of BW was 87.92 kg and in the end of the study it was 82.44 kg. Continuous drop in BW parameter is recorded. The Wilks 'Lambda lattice (Wilks' Lambda) obtained by multivariate variance analysis and the associated probability $p < 0.05$ confirms that BW values were statistically significant measured at three time intervals in group A subjects who used curcumin.

Body weight during the study (kg)					
Observation interval	Statistical parameters	Examined Group A (Use Curcumin)		Control group B (do not use Curcumin)	
		AA1 (MetS and PD)	AA2 (MetS and DM T2)	BA1 (MetS and PD)	BA2 (MetS and DM T2)
First measurement (start)	N	25	25	25	25
	Mean	83.16	87.92	89.60	90.96
	Std. deviation	12.56	14.57	11.66	15.19
Second measurement (in the middle)	N	25	25	25	25
	Mean	80.56	84.20	89.64	90.88
	Std. deviation	12.00	15.47	11.92	16.42
Third measurement (in the end)	N	25	25	25	25
	Mean	78.16	82.44	90.12	90.96
	Std. deviation	11.29	15.13	11.66	17.58
Wilks' Lambda†		.120*	.226*	.957	.998
p††		< 0.001	< 0.001*	.600	.979

Table 5: *The influence of Curcumin on BW.*

Wilks' Lambda † and its associated probability . P value†† represents the ratio of the squared deviation of the result from the middle value within the group and the total deviation range and it gets the value between 0 and 1, with the amount closer to 1 indicates that the middle values independently observed variables for the group do not differ much. The values near 0, show that they differ. Wilks' Lambda with the mentioned criteria used to determine statistically significant differences in the other subgroups within the study. Subgroups: AA1 (METS and PD); AA2 (METS and DM type 2); BA1 (METS and PD); BA2 (METS and DM type 2)

** The existence of statistically significant differences, with p <0 .05*

However, in control group who did not use curcumin, there was no significant change in BW average. In subgroup BA1 with MetS and PD, at the beginning of the study the average BW was 89.60 kg and in the end was 90.12 kg. In subgroup BA2, with MetS and DM T2 characteristics, the average BW at the beginning and in the end of the study was the same 90.96 kg, while after six months it was 90.88 kg. There was no statistically significant difference in the BW average variation within subgroups which did not use curcumin during the three observation intervals of measurement.

The influence of curcumin on BMI

The influence of curcumin on BMI was observed in subjects in Group A who used curcumin versus control group B who did not use this preparation. The table 6 shows how the using of curcumin has influented to BMI.

Body mass index (kg/m^2) during the study					
Observation interval	Statistical parameters	Examined group A (Use Curcumin)		Control group B (do not use Curcumin)	
		AA1 (MetS and PD)	AA2 (METS and DM T2)	BA1 (MetS and PD)	BA2 (MetS and DM T2)
First measurement (start)	N	25	25	25	25
	Mean	30.44	32.13	32.07	32.44
	Std. deviation	3.79	4.84	3.79	4.66
Second measurement (in the middle)	N	25	25	25	25
	Mean	29.45	30.78	32.08	32.40
	Std. deviation	3.30	5.00	3.57	5.18
Third measurement (in the end)	N	25	25	25	25
	Mean	28.58	30.14	32.27	32.41
	Std. deviation	3.13	4.62	3.74	5.58
Wilks' Lambda†		.106*	.258*	.951	.999
p††		< 0.001*	< 0.001*	.560	.985

Table 6: *The Influence of Curcumin on BMI.*

Treatment of measured of BMI using a single-factor analysis of repeated measurements of variance, showed statistically significant difference in the average values of this parameter in the group A that used curcumin, such as the associated subgroups AA1 and AA2. In the subgroup AA1 with the characteristics of MetS and PD, the average of BMI was initially 30.44 kg/m^2, and in the end of the study it was 28.58 kg/m^2. In the subgroup AA2 with MetS and DM T2 characteristics, the average of BMI at the beginning was 32.13 kg/m^2 and in the end of the study was 30.14 kg/m^2. Wilks' Lambda Indicator and Significance $p < 0.05$ shows that group middle BMI values are statistically different significantly at the beginning and in the end of the study in subjects who used curcumin.

BMI in control group B that did not use curcumin, such as the subgroups BA1 and BA2, did not change significantly during the study.

The influence of curcumin on WC

Measurement of WC in subjects is the fundamental diagnostic parameter in setting the MetS (IDF, 2005). The WC of group A patients who used curcumin and the associated subgroups AA1 (MetS and PD) and AA2 (subjects with MetS and DM T2 characteristics) were compared with WC of group B subjects who did not use curcumin and its associated Subgroup BA1 (subjects with characteristics of MetS and PD) and BA2 (subjects with characteristics MetS and DM T2). As the WC parameter changes during the study in the three recorded measurements, it is shown in table 7.

Waist circumference (cm) during of study					
Observation interval	**Statistical paremeters**	**Examined group A (use Curcumin)**		**Control group B (do not use Curcumina)**	
		AA1 (MetS and PD)	**AA2 (MetS and DM T2)**	**BA1 (MetS and PD)**	**BA2 (MetS and DM T2)**
First measurement (start)	N	25	25	25	25
	Mean	98.60	103.36	104.16	103.84
	Std. deviation	9.51	10.08	7.52	10.34
Second measurement (in the middle)	N	25	25	25	25
	Mean	95.56	98.44	103.16	103.60
	Std. deviation	9.25	10.13	7.76	12.23
Third measurement (in the end)	N	25	25	25	25
	Mean	92.52	95.48	103.08	103.32
	Std. deviation	8.67	10.86	7.44	13.32
Wilks' Lambda†		.128*	.324*	.805	.983
p††		< 0.001*	< 0.001*	.082	.820

Table 7: *The Influence of Curcumin on WC.*

In subgroup AA1 with MetS and PD characteristics, the average WC at the beginning of the study was 98.60 cm, after six months 95.56 cm, in the end of the study it was 92.52 cm. In the AA2 subgroup with MetS and DM T2 characteristics, the WC average was 103.36 cm, after six months 98.44 cm, while in the end this average was 95.48 cm. Wilks' lambda indicator and $p < 0.05$ in Group A using curcumin, or the associated subgroups AA1 and AA2, indicates a statistically significant difference between the measured WC at the beginning and the WC measured after 6 months and one year after the beginning of the study.

In the control group B that did not use curcumin, ie the subgroups BA1 and BA2, the WC did not change statistically significantly during the three measurements in the year.

Discussion

The study was conducted on 100 subjects with MetS in Tuzla Canton. Tuzla Canton is placed in North-Easteren part of Bosnia and Herzegovina (BiH). Because of the war, during the period of 1992 - 1995 at this part of Balkan, the population is in the very poor economic conditions and situation. There are so many obesitiy at the people because the food here is full of high satured fatty acids. There is lack of phisical activity, stress and sedentary life style.

The purpose of this study was to point out the therapeutic effects of XY curcumine on anthropometric measurements with MetS. The influence of DM T2 is enormus on global health care and the economy [33]. According to the WHO, there are 311 million people in the world living with diabetes. This number continues to grow, especially in developing countries and the poor countries of Asia and others. Because DM T2 is currently incurable, the usual approach to treatment is an attempt to control long-term use of antidiabetic drugs. Restricting the number of newly developed diabetes should be one of the key strategies to limit the effects of diabetes globally [34]. One of the alternative approaches to the prevention of development of DM T2 is to intervene within MetS before the disease develops completely. Interventional approach is important and it relies on timely identification of persons with prediabetes and preventive approach measures before a disease develop completely. The role of primary healthcare is irreplaceable in early detection and the creation of better control of the particular parameters of this metabolic complex. Obesity is a high risk factor for DM T2 [35], because 61% of patients with diabetes are obese and 80% are overweight [36].

Increasing BMI increases the risk of developing DM T2. The Finnish Diabetes Prevention Study (there were 522 middle-aged, overweight subjects with impaired glucose tolerance who were randomized to either a usual care control group or an intensive lifestyle intervention group) has shown that weight reduction (BW) after 1 and 3 years, weight reductions were 4.5 and 3.5 kg in the intervention group and 1.0 and 0.9 kg in the control group. The intensive lifestyle intervention produced long-term beneficial changes in diet, physical activity, and clinical and biochemical parameters and reduced diabetes risk [37]. In our study, all subjects who used XY curcumin at a dose of 400 mg/day during one year had statistically significant reductions in BW, BMI and WC. Statistical significance for BW, BMI and WC was $p < 0.0001$. Reduction of BW of 5 - 10% of the initial body weight, reduces the risk of developing a variety of diseases related to obesity [38]. Results similar to ours are also shown in the study of Chuengsamarna et al., where a group of subjects were treated with curcumin, at the last control after 9 months and later, showed a trend of weight loss, BMI and WC [39].

The study similar to ours, Di Pietra., *et al*. (2015) followed the potential role of curcumin to loss of BW, BMI, and WC within 30 days, in obese persons with MetS. The preliminary results of this study were shown the loss of BW 1.88-4.91%, decreasing of WC 2.36- 4.14%, and reduction of BMI 2.10 - 6.43% [40]. In our study the results were followed after 6 and 12 months. Decreasing of BW in the experimental group, in the subgroup with PD characteristics was from 3.12% after 6 months to 6.01% after 12 months using curcumin. In the subgroup with DMT2 characteristics, the loss of BW was from 4.23% after 6 months to 6.23 % after 12 months. Reduction of WC in the subgroup with PD characteristics was from 3.08% after 6 months to 6.17% after 12 months and in the subgroup with DMT2 characteristics WC was decreased for 4.76% after 6 months and for 7.62% after 12 months. According to the changes mentioned above, in the experimental group BMI was increased in the subgroup with PD for 3.25% after 6 months and 6.11% after 12 months. In the subgroup with DMT2, BMI was decreased for 4.20% after 6 months and for 6.19% after 12 months. The followed parameters had a statistically significant reduction related to the control group which did not use curcumin and has already been exposed to standard nonpharmacological and pharmacological measures.

Wilks´ Lambda indicator and pvalue < 0.05 show that group middle values BW, BMI and WC are statistically significant different at the beginning and in the and of the study in the subjects who used curcumin.

No similar examinations and studies of this kind have been done in BiH so this study is new for us.

Conclusion

Curcumin together with nonpharmacological and pharmacological measures can improve the control of essential anthropometric parameters in MetS and thus prevent or delay the onset and the complication of DM T2. The use of curcumin, continuously for one year at a dose of 400 mg/day, statistically significantly reduces the average BW, BMI and WC in subjects with MetS in the grade of PD and DMT2.

Bibliography

1. Zimmet P., *et al*. "Global and social implications of the diabetes epidemic". *Nature* 414.6865 (2001): 782-787.
2. Zimmet P and Alberti G. "The IDF definition why we need a global consensus". *Diabetes Voice* 51 (2006): 11-14.
3. Crepaldi G and Maggi S. "The metabolic sindrome: a historical context". *Diabetes Voice* 51 (2006): 8-10.
4. WHO Department of Non-comunicable Disease Surveillance. Definition, Diagnosis and Classification of Diabetes Mellitus and its Complication. Report of WHO Consultation. Geneva (1999).
5. "Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) (2001)". *Journal of the American Medical Association* 285.19 (2001): 2486-2497.
6. Ford ES. "Prevalence of the Metabolic Syndrome Defined by the International Diabetes Federation among Adults in the US". *Diabetes Care* 28.11 (2005): 2745-2749.
7. Dekker JM., *et al*. "Metabolic Syndrome and 10-year Cardiovascular Disease Risk in The Hoorn Study". *Circulation* 112.5 (2005): 666-673.
8. The IDF consensus worldwide definition of the metabolic syndrome (2005).
9. Alberti KG., *et al*. "Harmonizing the Metabolic Syndrome". *Circulation* 120.16 (2009): 1640-1645.
10. Ford ES., *et al*. "Prevalence and correlates of metabolic syndrome based on a harmonious definition among adults in the U.S". *Journal of Diabetes* 2.3 (2010): 180-193.
11. Mozumdar A and Liguori G. "Persistent increase in prevalence of metabolic syndrome among U.S. adults: NHANES III to NHANES 1999-2006". *Diabetes Care* 34.1 (2011): 216-219.
12. Farsang C., *et al*. "Inter-regional comparisons of the prevalence of cardiometabolic risk factors in patients with hypertension in Europe: the GOOD survey". *Journal of Human Hypertension* 23.5 (2009): 316-24.
13. Rosenbaun M., *et al*. "Medical progress: Obesity". *New England Journal of Medicine* 337 (1997): 396-407.
14. Kopelman PG. "Obesity as a medical problem". *Nature* 404.6778 (2000): 635-643.
15. World Health Organization. "Obesity: Preventing and Managing the Global Epidemic". WHO, Geneva (1997).
16. Reaven GM. "Role of insulin resistance in human disease". *Diabetes* 37.12 (1988): 1595-1607.
17. Čabrijan T and Čabrijan Ž. "Sindrom X -polimetabolički sindrom-sindrom inzulinske rezistencije". Lipidi. Glasilo odbora za lipide 8 (1998): 3-14.
18. Hanefeld M. "The Metabolic Syndrome: roots, myths and facts". In: Hanefed M, Leonhardt W (Harsg) The metabolic Syndrome. Jena-Stuttgard: Fischer (1997): 13-24.

19. World Health Organisation. "Definition and diagnosis of diabetes mellitus and intermediate hyperglycemia: report of WHO/IDF consultation". Geneva (2006).

20. Lampe V and Milobedzka J. "Studien über Curcumin". *Berichte der Deutschen Chemischen Gesellschaft* 46.2 (1913): 2235-2240.

21. Pillarisetti S and Saxena U. "Role of oxidative stress and inflammation in the origin of Type 2 diabetes--a paradigm shift". *Expert Opinion on Therapeutic Targets* 8.5 (2004): 401-408.

22. Moller DE and Berger JP. "Role of PPARs in the regulation of obesity-related insulin sensitivity and inflammation". *International Journal of Obesity and Related Metabolic Disorders* 27.3 (2003): S17-S21.

23. Nishiyama T., *et al*. "Curcuminoids and sesquiterpenoids in turmeric (Curcuma longa L.) Suppress an increase in blood glucose level in type 2 diabetic KK-Aγ mice". *Journal of Agricultural and Food Chemistry* 53.4 (2005): 959-963.

24. Yuasa K., *et al*. "Stevioside as a possible antiviral agent for hepatitis C virus infection. Digestive Disease Week (DDW). San Diego, CA. (2008): Abstract S1943.

25. Kang Q and Chen A. "Curcumin suppresses LDL receptor gene expression, leading to the inhibition of cholesterol/LDL-induced hepatic stellate cell activation". *British Journal of Pharmacology* 157.8 (2008): 1354-1367.

26. Srinivasan M. "Effect of curcumin on blood sugar as seen in diabetic subject". *Indian Journal of Medical Sciences* 26.4 (1972): 267-270.

27. Srinivasan K. "Plant foods in the menagment of diabetes mellitus: Spices as potential antidiabetic agents". *International Journal of Food Sciences and Nutrition* 56.6 (2005): 339-414.

28. Babu PS and Srinivasan K. "Influence of dietary curcumin and cholesterol on the progression of experimentally induced diabetes in an albino rat". *Molecular and Cellular Biochemistry* 152.1 (1997): 13-21.

29. Jurenka JS. "Anti-inflammatory Properties of Curcumin, a Major Constituent of Curcuma longa: A Review of Preclinical and Clinical Research". *Alternative Medicine Review* 14.2 (2009): 141-153.

30. Kannel WB. "Cigarette smoking and coronary heart disease". *Annals of Internal Medicine* 60 (1964): 1103-1106.

31. Hubert HB., *et al*. "Clinical characteristics and cigarette smoking in relation to prognosis of angina pectoris in Framingham". *American Journal of Epidemiology* 115.2 (1982): 231-242.

32. Chesney CM., *et al*. "Effects of niacin, warfarin, and antioxidant therapy on coagulation parameters in patients with peripheral arterial disease in Arterial Disease Multiple Intervention Trial (ADMIT)". *American Heart Journal* 140.4 (2000): 631-636.

33. Wilding JPH. "Obesity and nutritional factors in the pathogenesis of type 2 diabetes mellitus". U: Pickup JC, Williams G, ur. Textbook of Diabetes, 3. ed. Malden, Mass.: Blackwell Science (2003).

34. Hogan P., *et al*. "Economic costs of diabetes in the US in 2002". *Diabetes Care* 26.3 (2003): 917-932.

35. Ros R. "Atherosclerosis - An Inflammatory Disease". *The New England Journal of Medicine* 340.2 (1999): 115-126.

36. Colditz GA., *et al*. "Weight gain as a risk factor for clinical diabetes mellitus in women". *Annals of Internal Medicine* 122.7 (1995): 481-486.

37. Lindström J., *et al*. "The Finnish Diabetes Prevention Study (DPS): Lifestyle intervention and 3-year results on diet and physical activity". *Diabetes Care* 26.12 (2003): 3230-3236.

38. Van Gaal LF., *et al*. "The beneficial effects of modest weight loss on cardiovascular risk factors". *International Journal of Obesity* 21.1 (1997): S5-S9.

39. Chuengsamarn S., *et al*. "Curcumin Extract for Prevention of Type 2 Diabetes". *Diabetes Care* 35.11 (2012): 2121-2127.

40. Di Pierro F., *et al*. "Potential role of bioavailable curcumin in weight loss and omental adipose tissue decrease: preliminary data of a randomized, controlled trial in overweight people with metabolic syndrome. Preliminary study". *European Review for Medical and Pharmacological Sciences* 19.21 (2015): 4195-4202.

Volume 1 Issue 3 October 2017