Physical Exercise versus Natural Estrogen Supplement in Treatment of Metabolic Syndrome in Aged Female Rats

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ممارسة الرياضة البدنية مقابل هرمون الإستروجين الطبيعي المضاف في علاج متلازمة التمثيل الغذائي لدى إناث الفئران المسنة

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List of Abbreviations

ABP	**Arterial blood pressure**
AI	**Atherogenic index**
BMI	**Body mass index**
BW	**Body weight**
BWG	**Body weight gain**
C	**Control group**
Ch.	**Total cholesterol**
CVD	**Cardio-vascular diseases**
DBP	**Diastolic blood pressure**
ELISA	**Enzyme-linked immunosorbent assay**
ER	**Estrogen receptors**
FB	**Fibrinogen**
FBG	**Fasting blood glucose**
FBMI	**Final body mass index**
FBW	**Final changes in the body weight**
GLUT	**Glucose transporter**
HbA1c	**Glycated haemoglobin**
HDL-C	**High density lipoprotein cholesterol**
HOMA-IR	**Homeostasis model assessment of insulin resistance**
HRT	**Hormone replacement therapy**
IL	**Interleukins**
IPGTT	**Intraperitoneal glucose tolerance test**

IRS- 1	**Insulin receptor substrate-1**
IRS-2	**Insulin receptor substrate-2**
LDL-C	**Low density lipoprotein cholesterol**
LSD	**Least significant difference**
M	**Arithmatic Mean**
MAP	**Mean arterial blood pressure**
MS	**Metabolic syndrome**
MS	**Metabolic syndrome- untreated group**
MS_E	**Metabolic syndrome swim-exercised group**
MS_S	**Metabolic syndrome soybean-supplemented group**
PP	**Pulse pressure**
PPAR	**Peroxisome proliferator-activated receptors**
SBP	**Systolic blood pressure**
SBP	**systolic blood pressure**
SD	**Standard deviation**
SEM	**Standard error of the mean**
SHBG	**Steroid hormone binding globulin**
SPSS	**Statistical Program for Social Science**
SREBP	**Sterol regulatory element binding protein**
TG	**Triglycerides**
TNF	**Tumor necrosis factor**
VF	**Visceral fat**
WC	**Waist circumference**
WHO	**World Health Organization**

Introduction

Metabolic syndrome is a disease of unhealthy lifestyle. Imbalanced diet in the form of increased caloric intake and lack of physical activity are the main predisposing factors. Aging and menopause independently increase the incidence of metabolic syndrome as reported by ***Ford et al. (2002)*** *and* ***Janssen et al. (2008).***

World Health Organization (WHO) defined metabolic syndrome by the presence of diabetes mellitus or insulin resistance and two of the following characteristics: a high waist/hip ratio, a high concentration of triglycerides or a low concentration of HDL cholesterol, increased blood pressure, and urinary excretion of albumin, proinflammatory state and prothrombotic state (i.e. high levels of fibrinogen or plasminogen activator inhibitor-1) ***(Alberti and Zimmet, 1998).***

The Third report of the National Cholesterol Education Program ***(NCEP ATP III report, 2001 and 2002)*** emphasized the role of central obesity in the pathogenesis of metabolic syndrome and defined it by the presence of any 3 of the following: central obesity, increased waist circumference, hypertriglyceridaemia, Low HDL cholesterol, hypertension and fasting hyperglycemia.

Recently, several studies demonstrated increased prevalence of the metabolic syndrome among all age groups in Egypt reaching 39.7% among school students ***(Hasssan et al., 2011).*** The prevalence among prepubertal was quite higher than pubertal students and in girls more than boys with abnormal lipid profiles, obesity and insulin resistance ***(Hasssan et al., 2011)***.

Also in middle aged and elderly Egyptians, the prevalence of metabolic syndrome was potentially higher reaching almost 55 % based on the American Heart Association/Updated NCEP ATP III criteria with 48.2% of the population sample having moderate to high risk of developing cardiovascular disease ***(Abd Elaziz et al., 2014).***

Postmenopausal state was also reported to be associated with a 60% increased risk of the metabolic syndrome ***(Park et al., 2003).*** The risk of cardiovascular diseases attributed to the metabolic syndrome appeared to be especially high in women, and it was estimated that half of all cardiovascular events in women could be related to the metabolic syndrome ***(Wilson et al., 1999; Ogbera 2010).***

Based on the above cited data, a growing worldwide prevalence of metabolic syndrome is to be expected in the coming years making it necessary to throw more light on the etiology, treatment and prevention of this syndrome.

Therefore the present study was designed to investigate the ability of lifestyle intervention either by swim –exercise program or diet supplementation with soy bean flour to reverse or alleviate the criteria of metabolic syndrome. The conditions that predispose to metabolic syndrome in humans (namely aging, menopause and unhealthy diet) were simulated in the experimental animals, then the effects of the swim –exercise program and diet supplementation with soybean flour were evaluated on the different features of the metabolic syndrome.

Aim of the work

The present study aimed at evaluating the long term effects of implementing a swim- exercise program and soybean flour supplementation in diet on the various components of the metabolic syndrome in aged female rats.

Review of Literature

Metabolic Syndrome

Metabolic syndrome (MS) is defined as a collection of risk factors including elevated blood levels of fasting glucose, total cholesterol, LDL-cholesterol, triglycerides as well as increased arterial blood pressure and central adiposity. Metabolic syndrome was reported to be associated with increased risk for cardiovascular disease (CVD) and type 2 diabetes ***(Alberti et al., 2009).***

Although the global prevalence of the metabolic syndrome is difficult to estimate ***(Alberti et al., 2009)***, yet it shows simultaneous increase in populations around the world ***(Ervin, 2009***). Also, the prevalence of the individual components of the metabolic syndrome, as well as the syndrome as a whole, are highly variable among different ethnic populations ***(Cameron et al., 2004).***

The Metabolic syndrome is considered a worldwide problem affecting both developed and underdeveloped countries in a rapidly progressive way ***(Allal-Elasmi et al., 2010)***. Differences in genetic profile, eating habits, physical activity, age, gender, and lifestyle influence the prevalence of

metabolic syndrome and its components ***(Cameron et al., 2004).***In several studies, the incidences of metabolic syndrome among postmenopausal women were found to be increased in the world ***(Royer et al., 2007).***

The underlying mechanisms of metabolic syndrome are interwoven and difficult to delineate. However, it was suggested that obesity, improper dietary habits and sedentary life style are the roots of the metabolic syndrome ***(Grundy, 2008).***Excess accumulation of body fat and particularly in the viscera might trigger inflammation, insulin insensitivity, dyslipidemia, and hypertension ***(Bergman et al., 2006).***

Parulkar et al. (2001) reported that insulin resistance could lead to dyslipidemia that might be initiated by the resistance of adipocytes to the effects of insulin. The inability of insulin resistant fat cells to store the triglycerides could result in their hydrolysis and release of fatty acids, when being available, the increased hepatic synthesis of triglycerides and VLDL would occur. In addition, inflammatory markers decrease insulin sensitivity by causing dysfunction of insulin receptors substrate-1 (IRS- 1) and insulin receptors substrate-2 (IRS-2), decreasing glucose uptake and consequently increasing the dependence on lipid metabolism, thus creating a vicious circle***(Varman et al., 2004).*** Moreover, peroxidation of blood LDL-