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EFFECTS OF CURCUMA LONGA (TURMERIC) EXTRACT OR PHYSICAL ACTIVITY ON CERTAIN METABOLIC ASPECTS IN OBESE ADULT MALE ALBINO RATS

By

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ABSTRACT

Background: The prevalence and severity of obesity and associated co-morbidities such as type 2 diabetes mellitus (DM), coronary heart diseases, and hypertension are rapidly increasing across the world. Curcuma longa is one of the natural plant products that has many biological activities. Also, regular physical activity is a protective wall against occurrence of many diseases. **Objective:** Determination of the effects of curcuma longa (turmeric) extract or physical activity on certain metabolic aspects in obese adult male albino rats. **Materials and Methods:** Forty male albino rats were used in this study, and divided into four equal groups: Group I: served as a normal control non-obese group, group II: control obese group not exposed neither to turmeric extract nor physical activity, group III: obese group exposed to physical activity, and group IV: obese group exposed to turmeric extract. At the end of the experimental period, blood samples were collected for measuring blood glucose, glycosylated hemoglobin (HbA1c), C-peptide, total cholesterol, triglycerides (TG), low density lipoprotein–cholesterol (LDL-C), and high density lipoprotein–cholesterol (HDL-C). **Results:** High fat diet-induced obesity was associated with significant higher levels of blood glucose, HbA1c, C-peptide, cholesterol, TG and LDL-C, and with significant lower levels of HDL-C levels as compared with the control normal group. Administration of curcuma longa extract or physical activity in obese rats caused significant lower levels of blood glucose, C-peptide, cholesterol, TG, and LDL-C, significant higher level of HDL-C and insignificant changes in HbA1c as compared with the control obese group. On the other hand, administrated curcuma longa extract produced insignificant changes in blood glucose, HbA1c, C-peptide and cholesterol levels as compared to group of rats undergo physical activity, while changes in TG, LDL-C and HDL-C in both groups were significant. **Conclusion:** Curcuma longa extract or physical activity showed promise results for treatment of obesity and problems associated with obesity such as insulin resistance and type II diabetes by decreasing body weight, blood glucose, improvement of insulin receptors, lipid profile and dyslipidemia associated with obesity. However, physical activity showed more improvement in glycemic control and lipid profile than curcuma longa extract.

Key words: Obesity, Physical activity, Curcuma longa (turmeric), Dyslipidemia.

INTRODUCTION

Obesity is a chronic disease of multi-factorial origin, dependent on the complex interaction between genetic, environmental, and epigenetic factors **(Pereira-Lancha et al., 2012).** Obesity and overweight occur due to imbalance between calories consumed and calories utilized. Globally, the main reasons for overweight and obesity are excessive high-energy food intake, and physical inactivity due to the increasingly sedentary nature of many forms of work **(Chandrasekaran et al., 2012)**.

Obesity is one of the main public health problems in the world, being considered a disease which worries due to social, psychological and metabolic issues. It is linked to the development of co-morbidities that may even lead to death **(Pinheiro et al., 2004)**. Health consequences due to obesity fall into two broad categories:

1. Those attributable to the effects of increased fat mass such as osteoarthritis and obstructive sleep apnea, as the extra weight puts added stress on every part of individual's body **(Chandrasekaran et al., 2012)**.
2. Those due to the increased number of fat cells such as diabetes mellitus, cancer, cardiovascular disease and non-alcoholic fatty liver disease **(Bray, 2004)**. Increased fat also creates a proinflammatory state, and a prothrombotic state **(Shoelson et al., 2007)**.

During the last decade, an increase in the use of medicinal plants and herbal medicine has been observed all over the world **(Dhaliya et al., 2013)**. Curcuma longa Linn has been used in folk traditional medicine as a household remedy for a wide range of pathological conditions such as arthritis, diarrhea and cancer **(Micucci et al., 2013)**. Biological and pharmacological properties of curcuma longa has been shown to exert several biological actions such as anti-obesity, anti-atherosclerosis, anti-diabetes, anti-mutagenesis, anti-cancer, and anti-oxidation effects **(Orellana-Paucar et al., 2012 and Witkin & Li, 2013).**

Reduced daily physical activity in healthy young adults is associated with negative metabolic consequences such as decreased insulin sensitivity and increased abdominal fat **(Olsen et al., 2008).**

The present study was a trial to determine the effects of administration of curcuma longa extract or physical activity on certain metabolic aspects in obese adult male albino rats.

MATERIALS AND METHODS

ANIMALS: The present work was carried out on 40 adult male albino rats of local strain, ranging in weight between 100 – 150 gm. Rats were brought from (Nile Pharmaceuticals Company) and were kept in suitable cages (30 × 50 × 30 cm for every 5 rats) at room temperature with the natural light dark cycle. They were maintained on a balanced diet and green vegetables with free water supply and left to acclimatize to environment for two weeks prior to inclusion in the experiment. After acclimatization, 30 rats were exposed to special fat diet regimen for 3 months for induction of obesity.

Rats were divided into four equal groups as follows:

- Group I: Control normal group (not exposed neither to turmeric extract nor physical activity).
- Group II: Control obese group (not received neither turmeric extract nor undergo physical activity).
- Group III: Obese group underwent physical activity 5 days/week for 4 weeks.
- Group IV: Obese group received curcuma longa extract in a dose of 50 mg/kg/day for 4 weeks.

Curcuma longa extract preparation: Curcuma longa (turmeric) powder was purchased from a local market. Ten grams of fine-powdered turmeric were weighed and mixed with 100 ml of water, kept in a water bath at 60°C for two hours and filtered. This extract was diluted in water (1:10) and administered orally to rats by feeding tube **(Asadi et al., 2014)**. Rats received 50 mg/kg/day of curcuma longa extract for 4 weeks **(Sengupta et al., 2011)**.

Induction of obesity: The experimental diet (g/kg diet) was according to the formula of **Kim et al. (2005)**. It included the normal diet for control group (5% fat, carbohydrates 65%, proteins 20.3%, fiber 5%, salt mixture 3.7%, and vitamin mixture 1%). The obesity induced by high fat diet (HFD) contained fat 46%, carbohydrates 24%, proteins 20.3%, fibers 5%, salt mixture 3.7%, and vitamin mixture 1%). Normal and high fat diet constituents were purchased from El-Gomhoria Company, Cario, Egypt. HFD was preserved at 4 ?C until used.

Calculation of Body mass index: Rats were weighed and the naso-anal lengths were measured on a calibrated platform to calculate the body mass index [BMI = body weight / lengths^2 (kg/m^2)] **(Joan et al., 2006)**.

Physical activity program: Rats in group III were subjected to swimming in a swimming plastic barrel 50 cm diameter with a depth of 50 cm filled with tap water at 32±2 ?C. Rats were given the chance to stay in water on the 1st day for 10 min/day till reaching 60 min/day on the sixth day to be familiar and adapt with water. The exercise protocol was continued 5 days per week for 4 weeks **(Estadella et al., 2004)**.

Collection of blood samples: After calculating the body mass index, blood was collected (3 ml of blood for each) from the retro-orbital plexus **(Pauli et al., 2006)**.To obtain serum, the blood was collected into a glass centrifuge tube. It was rapidly set to centrifuge at 5000 r.p.m. for 10 minutes. Serum was sucked out into Eppendorf tubes and stored frozen at -20?C until required for determination of blood glucose level **(Burtis and Ashwood, 2011)**, glycosylated hemoglobin (HbA1c) level **(Nathan et al., 1984)**, serum C-peptide protein level **(Ashby and Frier, 1981),** and serum levels of TG **(Fossati and Prencipe, 1982)**, total cholesterol **(Allain et al., 1974)**, and LDL-C & HDL-C **(Lopez, 1977).**

Statistical analysis of data*:* Data management and analysis were performed using Statistical Package for Social Sciences (SPSS) version 21. All results were expressed as means ± standard deviations (SD). Statistical comparisons between different groups were done using one-way analysis of variance (ANOVA) followed by the Tukey–Kramer multiple comparison test to judge the difference between various groups. Significance was considered at P<0.05.

RESULTS

Effect of curcuma long extract or physical activity on body weight, length and body mass index (Fig. 1 and 2):

After the period of induction of obesity and before the treatment, there were significant high values of body weight (313.4±19.2 g), length (20.1±0.9 cm), and BMI (7.7±0.5 g/cm^2) of rats in control obese group (group II) as compared to control non obese group (group I) (130±5.6 g), (16.5±0.5 cm) and (4.8±0.1 g/cm^2) respectively. In comparison to control obese group (group II), body weight (379.1±18.6 g) and BMI (8.1±0.5 g/cm^2) showed significant low levels following physical activity (346.9±26.3 g) and (6.2±0.4 g/cm^2) respectively, and insignificant change in length (19.1±1.2 cm). In comparison to control obese group, body weight and BMI showed significant low level following curcuma longa extract administration (312.1±15.5 g) and (5.9±0.3 g/cm^2) respectively, but insignificant change in length (19.6.±0.7 cm) in group IV in comparison to group II (20.3 ± 0.8).

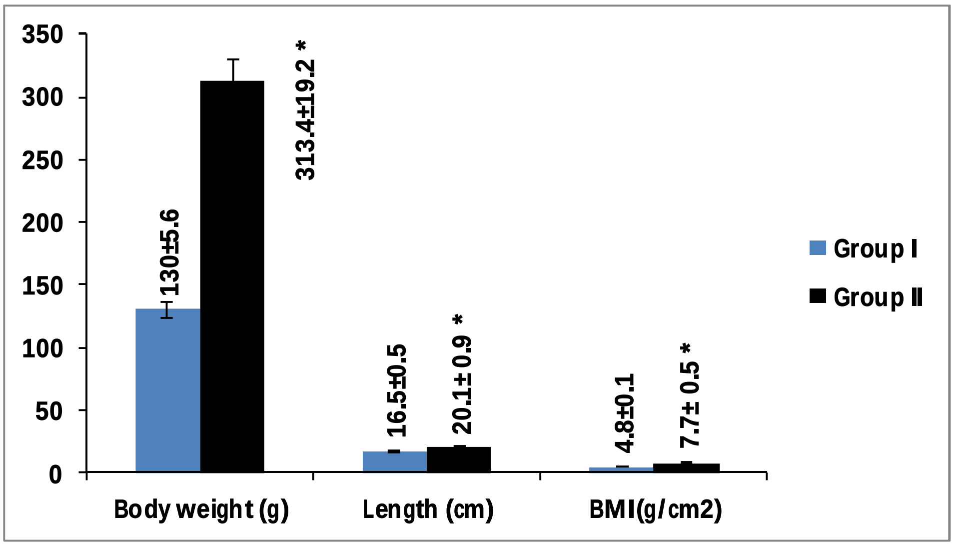

Figure (1): Mean ± SD of body weight, length and body mass index following induction of obesity.

*, significant as compared to control

Effect of curcuma long extract or physical activity on blood glucose level (mg/dl) and HbA1c (%):

High fat-diet in group II led to significant higher levels of blood glucose (163.1±32.9) as compared with group I (92.4±16.8). Physical activity in group III and curcuma longa administration led to significant decrease in blood glucose levels (93.1±22.2 and 113.1±16.3 respectively) as compared with group II (163.1±32.9). There were insignificant high values of blood glucose levels in group IV (113.1±16.3) as compared with group III (93.1±22.2)-(Fig. 3). High fat-diet in group II caused significant higher levels of HbA1c levels in group II (6.1±0.9) as compared with group I (4.8±0.7). Physical activity and administration of curcuma long caused insignificant change of HbA1c levels in group III (5.5±1.0) and group IV (5.9±0.8) respectively in comparison to group II (6.1±0.9). In addition, there were insignificant higher values of HbA1c levels in group IV (5.9±0.8) in comparison to groups III (5.5±1.0)- (Fig. 4).

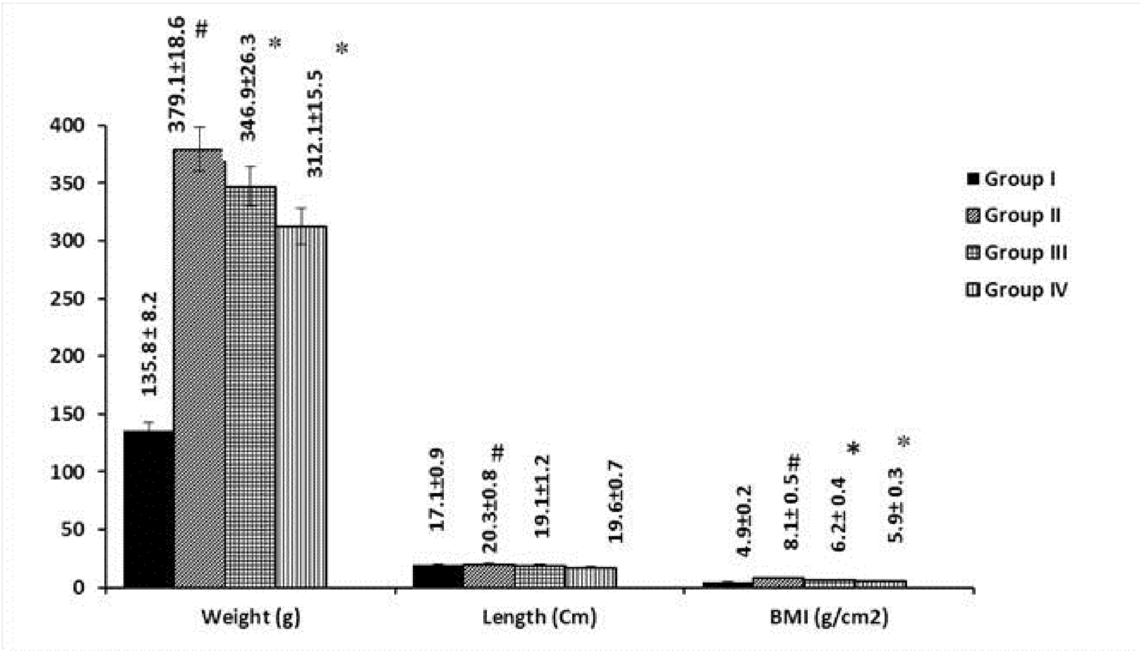

Figure (2): Mean ± SD of body weight, length and BMI in different studied groups at the end of the experiment.

significant compared with normal group, * significant compared with obese group.

Effect of curcuma long extract or physical activity on C-peptide level (pg/ ml) (Fig. 5):

C-peptide levels were significantly high in group II (87.3±3.2) in comparison to group I (38.2±3.4). A significant decrease in C-peptide levels occurred in groups III (82.1±2.9) and IV (83.2±2.8) in comparison to group II (87.3±3.2). There were insignificant high value of C-peptide levels in groups IV (83.2±2.8) in comparison to groups III (82.1±2.9).

Effect of curcuma long extract or physical activity on lipid profile (Fig. 6):

There were significant high levels of total cholesterol in groups II (79.5±4.7) in comparison to group I (56.3±3.6). Total cholesterol levels showed significant low levels in groups III (69.4±4.0) and IV (70.2±2.6) in comparison to group II (79.5±4.7). There were insignificant high values of total cholesterol level in groups IV (70.2±2.6) in comparison to groups III (69.4±4.0).

There were significant high levels of TG in groups II (87.3±3.0) in comparison to group I (57.1±3.2). There were significant lower levels of TG in groups III (63.3±5.0) and IV (74.0±5.6) in comparison to group II (87.3±3.0). There were significant high levels of TG in group IV (74.0±5.6) in comparison to group III (63.3±5.0).

There were significant high levels of LDL-C in group II (20.8±3.4) in comparison to group I (10.3±1.7). There were significant low levels of LDL-C in groups III (7.2±2.6) and IV (12.7±2.9) in comparison to group II (20.8±3.4). There were significant high levels of LDL-C in group IV (12.7±2.9) in comparison to group III (7.2±2.6).

There were significant low levels of serum HDL-C in groups II (31.2±1.7) in comparison to group I (34.5±1.9). There were significant high levels of HDL-C in group III (49.6±2.8) and group IV (42.7±2.9) in comparison to group II (31.2±1.7). There were significant low levels of HDL-C in group IV (42.7±2.9) in comparison to group III (49.6±2.8).

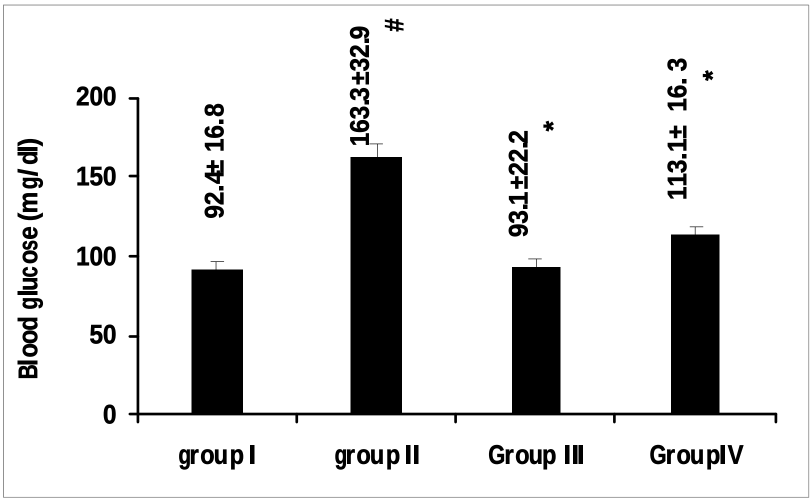

Figure (3): Mean ± SD of blood glucose levels in different studied groups at the end of the experiment.

significant compared with normal group. * significant compared with obese grou

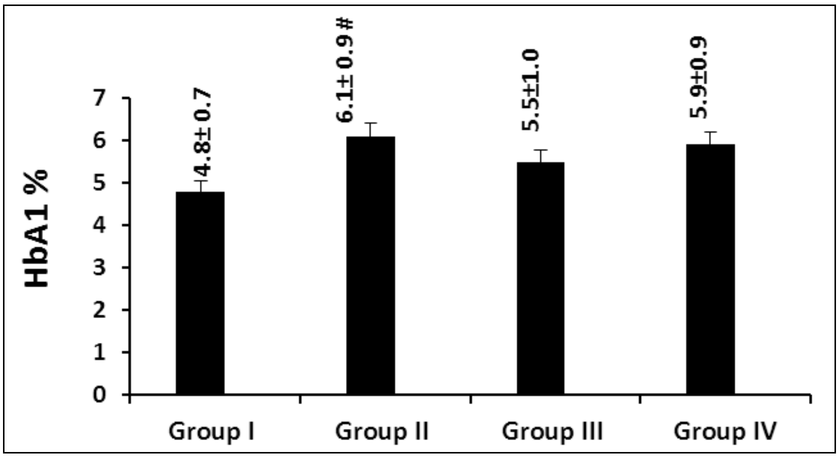

Figure (4): Mean ± SD of HbA1 levels in different studied groups at the end of the experiment.

significant compared with normal non obese group.

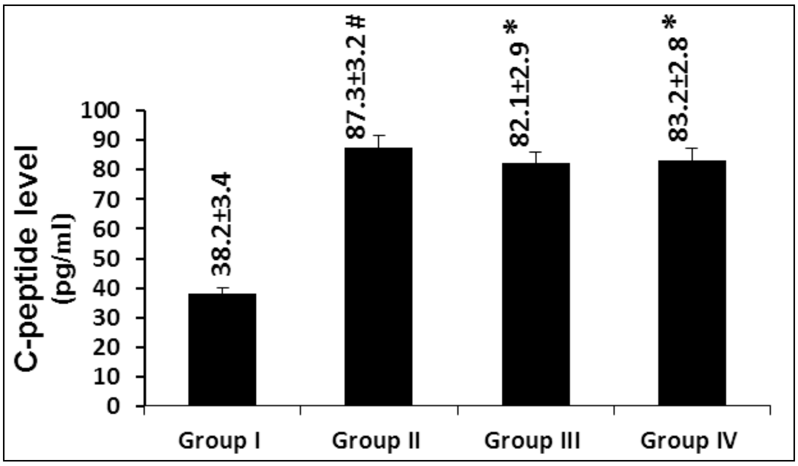

Figure (5): Mean ± SD of C-peptide levels in different studied groups at the end of the experiment**.**

significant compared with normal group. * significant compared with obese group

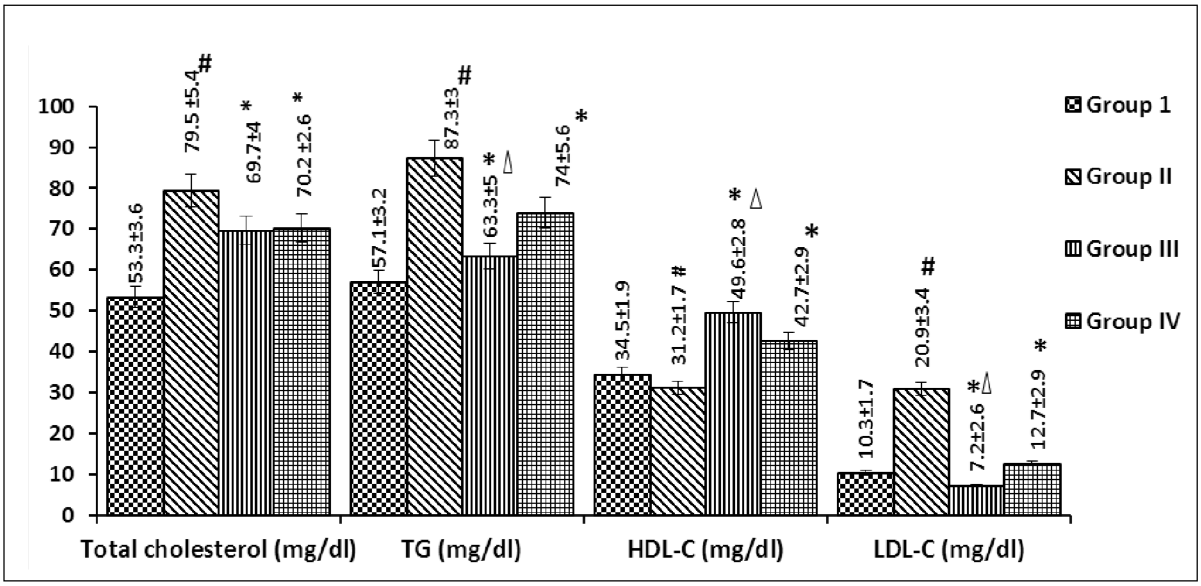

Figure (6): Mean ± SD of total cholesterol, TG (triglycerides), HDL-C and LDL-C levels in different studied groups at the end of the experiment**.** # significant compared with normal group.

* significant compared with obese group.

Δ significant compared with curcuma longa group.

DISCUSSION

Obesity has been considered an emerging health problem and a leading preventable cause of death worldwide **(Shehzad et al., 2011)**. It is one of the risk factors for many diseases prevalent in the world including type 2 diabetes, coronary heart diseases **(Philip, 2008)**, hypertension, obstructive sleep apnea, osteoarthritis of large and small joints and increased incidence of certain forms of cancer **(Zarghami et al., 2008)**.

The results of the present study revealed significant higher levels of blood glucose and C-peptide in control obese group (group II) as compared to control non obese group (group I). Obesity is associated with numerous metabolic abnormalities including insulin resistance and is considered one of the most important risk factors for type 2 diabetes **(Sindelka et al., 2002)**. Even moderate obesity dramatically increases the risk of diabetes **(Saltiel and Khan, 2001)**. In obese individuals, adipose tissue releases increased amounts of non-esterified fatty acids (NEFAs) **(Karpe et al., 2011)**, glycerol, hormones **(Kahn et al., 2006)**, pro-inflammatory cytokines **(Gregor and Hotamisligil, 2011)** and other factors that are involved in the development of insulin resistance which is accompanied by dysfunction of pancreatic islet β-cells resulting in failure to control blood glucose levels. Other studies suggested that insulin resistance is an adaptive secondary response to prevent further weight gain **(Gisela, 2005)**. **Muscelli et al. (2001)** found that fasting and steady-state plasma C-peptide levels were about three times higher in the obese compared to the non-obese group. C-peptide level was higher in subjects who particularly had abdominal obesity with increased waist hip ratio **(Kumar et al., 2005)**.

Administration of curcuma longa extract to obese rats significantly lower levels of blood glucose and C-peptide. These results were in consistence with a study has done by **Nwozo et al. (2009)**, **Olatunde et al. (2014)** and **Aizman et al. (2015)** who reported that administration of regular diet with powder rhizome of curcuma longa significantly decreases blood glucose level in the diabetic group compared with those diabetic fed on regular diet without powder rhizome of curcuma longa, while a little higher levels than in the control animals. Also, in intact rats receiving powder rhizome of curcuma longa blood glucose concentration was significantly lower than in the control group. Curcumin showed a better overall function of β-cells, with higher homeostasis model assessment of β-cell function (HOMA-β) and lower C-peptide level **(Chuengsamarn et al., 2012)**. Curcumin reduces many of the inflammatory signals known to be overactive in diabetes as cytokines, interleukin 6, interleukin 1 and TNFα and improves the action of disrupted insulin-response pathways in diabetes **(Shishodia et al., 2005)**.

One of the reasons for decreasing blood glucose after ingestion of turmeric may be a reduction of the absorption rate of carbohydrates in the gastrointestinal tract due to inhibition of the Na^+-glucose co-transporter **(Vallon et al., 2013)**. Also, reducing insulin resistance **(Xi et al., 2007)** and glycogenesis process **(Aizman et al., 2015)** may play an important role in maintaining the glucose concentration in plasma. Curcuma longa extract may contain biomolecules that can modify or stimulate insulin receptors, modify the structure of glucose transport protein 4 (GLUT 4) and may inhibit insulin antagonist within the body **(Igbakin and Oloyede, 2009)**.

The results of the present study showed significant lowering of blood glucose levels and C-peptide in physical activity group, as compared to control obese group, but insignificant difference between physical activity group and group of rats administrated curcuma longa extract. Frequent physical activity is associated with lower systemic inflammation, improved insulin sensitivity and reduced insulin resistance proved by lowering effect of regular physical activity on insulin and C-peptide levels **(Pischon et al., 2003)**. **Sohaily and his Co-workers (2012)** showed that regular exercise by non-athletic obese subjects significantly reduces glucose level and insulin resistance and bring about significant changes in weight loss, body fat percentage and body mass index. Increased insulin sensitivity may be due to decrease in glycogen concentrations **(Bloem & Chang, 2008)**.

The results of the present study revealed significant higher levels of HbA1c in control obese group as compared to control non obese group. These results were in agreement with that of **Shrestha et al. (2012)** and **Zago et al. (2013)** who found significant higher level of HbA1c and a positive association with glucose level and the TG/HDL-C ratio in diabetic and obese subjects.

Administration of curcuma longa extract to obese rats insignificantly lower HbA1c levels as compared to control obese group. Turmeric can reduce HbA1c level by reduction in hepatic glucose production and glycogen synthesis and stimulation of glucose uptake by increasing GLUT4, GLUT2 and GLUT3 gene expressions **(Ghorbani et al., 2014)**, increasing activation of adenosine mono-phosphate (AMP) kinase **(Kim et al., 2015)**, promoting peroxisome proliferator-activated receptor gamma ligand-binding activity **(Ghorbani et al., 2014),** suppressing hyperglycemia-induced inflammatory state **(Grynkiewicz and Slifirski, 2012)**, stimulation of insulin secretion from pancreatic tissues, improvement in pancreatic cell function **(Abdel Aziz et al., 2013)**, increasing phosphorylation of protein kinase B **(Campos, 2012)**, insulin receptor β and reduction of insulin resistance.

The current study showed insignificant lower levels of HbA1c in physical activity group as compared to control obese group and group of rats administrated curcuma longa extract. Physical activity improves glucose uptake in muscles, reflected by reduced need for insulin and lower HbA1c level **(Beraki et al., 2014)**. There were significant improvements in the mean HbA1c reading pre and post training in resistance and treadmill exercise groups **(Bweir et al., 2009)**. Also, **Tokmakidis et al. (2004)** found that HbA1c was significantly lower following 4 and 16 weeks of training compared to baseline.

The results of the present study revealed significant higher levels of serum TG, total cholesterol and LDL-C, but significant lower levels of serum HDL-C in control obese group as compared to control non obese group. High fat diet induced significant increase in the mRNA expression of PPAR-γ & C/EBPα, fatty acid synthase (FAS), acetyl-CoA carboxylase (ACC), adipocyte protein 2 (aP2), and lipoprotein lipase (LPL) in white adipose tissue compared with the normal diet-fed rats causing dyslipidemia **(Kim et al., 2016)**. **Masur et al. (2008)** observed marked elevation of serum NEFAs, cholesterol and TG in overweight individuals irrespective of the dietary intake of fat. The insulin resistance in adipose tissue results in increased activity of the hormone-sensitive lipase, which is probably sufficient to explain the increase in circulating NEFAs. The excess NEFAs are carried to the liver and converted to TG and cholesterol. Excess TG and cholesterol are released as very low density lipoprotein particles, leading to higher levels of both triacylglycerol and cholesterol.

Administration of curcuma longa extract to obese rats caused significant lower levels of serum total cholesterol, TG and LDL-C levels, but significant higher levels of HDL-C in the group of rats. **Nwozo et al. (2009)** found that there is a significant high levels of total cholesterol and triglycerides in diabetic rats not receiving curcuma longa extract compared to diabetics receiving curcuma longa extract or non-diabetic rats and, this implies that the curcuma longa extract exhibits hypolipidemic effect. Also, **Pashine et al. (2012)** showed decreased serum total cholesterol, TG and LDL-C in overweight hyperlipidemic subjects taking oral extract of curcuma longa compared to those on placebo treatment. **Asadi et al. (2014)** found that curcuma reduces cholesterol, TG and LDL-C and increases HDL-C in fructose-fed rats. Also, oral administration of the aqueous rhizome extract of curcuma longa to the diabetic rats significantly reduced the level of triglycerides, total cholesterol, and LDL-C and significantly increases the level of HDL-C **(Olatunde et al., 2014)**. The results suggest that aqueous extract of curcuma longa rhizome possesses potential therapeutic value in combating atherosclerosis. **Kim et al. (2016)** found that fermented curcuma longa suppressed body weight gain, reduced white adipose tissue weight TG, and cholesterol in high-fat diet-induced obese rats due to suppression of adipocyte differentiation and lipogenesis with a decrease in the mRNA expressions of FAS, ACC, aP2, and LPL. In addition, it increased lipolysis and β-oxidation by up-regulating the expression of lipases such as adipose triglyceride lipase, hormone-sensitive lipase, adiponectin, and AMP-activated protein kinase. The lowering effect of curcuma longa extract on lipid profile was considered to be related to the increased expression of LDL-C receptors **(Dou et al., 2008),** decreased cholesterol uptake in the intestines, increased conversion of cholesterol to bile acids in the liver and increased cholesterol fecal excretion **(Akram et al., 2010)**. Also, it may be due to an increase in the activity of hepatic cholesterol 7 alpha-hydoxylase thereby enhancing cholesterol catabolism **(Houston et al., 2009)** or due to changes in gene expression involved in cholesterol homeostasis **(Peschel et al., 2007 and Kim et al., 2011).**

The results of the current study showed that physical activity significantly lower levels of serum TG and LDL-C, but significant high levels of HDL-C as compared to control obese group and group of rats administrated curcuma longa extract. The levels of total cholesterol were significantly low in physical activity group than in control obese group, but insignificant difference of total cholesterol of physical activity group and group of rats administrated curcuma longa extract. Exercise especially prolonged exercise leads to increased insulin sensitivity, reduces insulin resistance and improves lipid profile in obese individuals and obesity-related diseases **(Bloem and Chang, 2008)**.

CONCLUSION

Curcuma longa extract or physical activity exerted anti-obesity effects and showed promise results for treatment of the problems associated with obesity such as insulin resistance and type II diabetes by decreasing body weight, blood glucose level, C-peptide level, total cholesterol, triglycerides, LDL-C and increasing HDL-C level however, physical activity showed more improvement in glycemic control and lipid profile than curcuma longa extract. Further studies should be done to evaluate the effect of other doses of curcuma longa extract with and without physical activity on obesity, diabetes mellitus and other metabolic disorders. Also, to evaluate the effect of different modes, intensities and durations of physical activity with and without administration of curcuma longa on metabolic changes associated with obesity.

REFERENCES

1. **Abdel Aziz MT, El-Asmar MF, Rezq AM, Mahfouz SM, Wassef MA, Fouad HH, Ahmed HH, and Taha FM (2013):** The effect of a novel curcumin derivative on pancreatic islet regeneration in experimental type-1 diabetes in rats (long term study). Diabetology & Metabolic Syndrome, 5(75): 1-14.
2. **Aizman RI, Koroshchenko GA, Gajdarova AP, Lukanina SN and Subotyalov MA (2015):** The Mechanisms of PLANT Rhizome Curcuma Longa Action on Carbohydrate Metabolism in Alloxan - Induced Diabetes Mellitus Rats. American Journal of Biomedical Research, 3: 1-5.
3. **Akram M, Ahmed A, Usmanghani K, Mohiuddin E and Asif M (2010):** Curcuma longa and curcumin: a review article. ROM J BIOL – Plant BIOL., 55(2): 65–70.
4. **Allain CC, Poon LS, Chan CS, Richmond W and Fu PC (1974):** Enzymatic determination of total serum cholesterol. Clin Chem., 20:470-475.
5. **Asadi S, Sohrabi M, Zarei S, Ghyasvand T, Rezaei FA and Goodarzi MT (2014):** Effects of Curcuma longa and Cinnamon aqueous extracts on Serum Carbohydrates and Lipids metabolism and oxidative status in high Fructose fed Rats. International Research Journal of Biological Sciences, 3: 78-82.
6. **Ashby JP and Frier BM (1981):** Circulating C-peptide: measurement and clinical application. Annals of Clinical Biochemistry, 18 (3): 125-130.
7. **Beraki A, Magnuson A, S?rnblad S, Aman J and Samuelsson U (2014):** Increase in physical activity is associated with lower HbA1c levels in children and adolescents with type 1 diabetes: results from a cross-sectional study based on the Swedish pediatric diabetes quality registry (SWEDIABKIDS). Diabetes Research and Clinical Practice, 105: 119-125.
8. **Bloem C and Chang A (2008):** Metabolism and endocrine. J Clin Endocrinol Metab., 93(2): 387-392.
9. **Bray GA (2004):** Medical consequences of obesity. J Clin Endo Metab., 89(6): 2583–2589..
10. **Burtis CA and Ashwood ER (2011):** Determination of blood glucose. In: Tietz text book of clinical chemistry. 5th ed. Pbl. WB Saunders. Co. London, Philadelphia, P. 796.
11. **Bweir S, Al-Jarrah M, Almalty AM, Maayah M, Smirnova IV, Novikova L and Stehno-Bittel L (2009):** Resistance exercise training lowers HbA1c more than aerobic training in adults with type 2 diabetes. Diabeto lMetab Syndr., 10: 1-27.
12. **Campos C (2012):** Chronic hyperglycemia and glucose toxicity: pathology and clinical sequelae. Postgrad Med., 124(6): 90–97.
13. **Chandrasekaran CV, Vijayalakshmi MA, Prakash K, Bansal VS, Meenakshi J and Amit A (2012):** Herbal Approach for Obesity Management. American Journal of Plant Sciences, 3: 1003-1014.
14. **Chuengsamarn S, Rattanamongkolgul S, Luechapudiporn R, Phisalaphong C and**

Jirawatnotai S (2012): Curcumin extract for prevention of type 2 diabetes. Diabetes Care, 35(11): 2121-2127.

15. **Dhaliya SA, Surya AS, Dawn VT, Betty C, Arun K and Sunil C (2013):** A review of hyperlipidemia and medicinal plants. Int J APS BMS., 2(4). 219-237.

16. **Dou X, Fan C, Wo L, Yan J, Qian Y and Wo X (2008):** Curcumin upregulates LDL receptor expression via the sterol regulatory element pathway in HepG2 cells. Planta Med., 74(11): 1374-1379.

17. **Estadella D, Oyama LM, Damaso AR, Ribeiro EB, Oller DO and Nascimento CM (2004):** Effect of palatable hyperlipidic diet on lipid metabolism of sedentary and exercise rats. Nutrition, l20 (2): 218-224.

18. **Fossati P and Prencipe L (1982):** Triglycerides determination after enzymatic hydrolysis. Clin Chem., 28: 2077-2080.

19. **Ghorbani Z, Hekmatdoost A and Mirmiran P (2014):** Anti-hyperglycemic and insulin sensitizer effects of turmeric and its principle constituent curcumin. Int J Endocrinol Metab., 12 (4): 18081.

20. **Gisela W (2005):** Insulin and Insulin Resistance. Clin Biochem Rev., 26(2): 19-39

21. **Gregor MF and Hotamisligil GS (2011):** Inflammatory mechanisms in obesity. Annual Review of Immunology, 29: 415–445.

22. **Grynkiewicz G and Slifirski P (2012):** Curcumin and curcuminoids in quest for medicinal status. Acta Biochim Pol., 59(2): 201–212.

23. **Houston MC, Fazio S and Chilton FH (2009):** Nonpharmacologic treatment of dyslipidemia. Progress in Cardiovascular Diseases, 52(2): 61–94.

24. **Igbakin AP and Oloyede OB (2009):** Comparative studies on the hypoglycemic, hypoproteinemic, hypoholesterolemic and hypolipidemic properties of ethanolic and normal saline extracts of the root of vernonia amygdalina in diabetic rats. Advance in Enviromental Biology, 3: 33-38.

25. **Joan F, Carroll W, Zenebe T and Strange T (2006):** Cardiovascular Function in Diet-Induced Obesity in Rat. Hypertension, 48: 65-72.

26. **Kahn SE, Hull RL and Utzschneider KM (2006):** Mechanisms linking obesity to insulin resistance and type 2 diabetes. Nature, 444 (7121): 840-846.

27. **Karpe F, Dickmann JR and Frayn KN (2011):** Fatty Acids, Obesity, and Insulin Resistance: Time for a Reevaluation. Diabetes, 60 (10): 2441-2449.

28. **Kim JH, Hahm DH, Yang DC, Kim JH, Lee HJ and Shim I (2005):** Effect of crude saponin of Korean red ginseng on high fat diet-induced obesity in the rat. J Pharmacol Sci., 97: 124-131.

29. **Kim J, Jeong SW, Quan H, Jeong CW, Choi JI and Bae HB (2015):** Effect of curcumin (Curcuma longa extract) on LPS-induced acute lung injury is mediated by the activation of AMPK. Journal of Anesthesia, 3: 1-9.

30. **Kim JH, Kim O, Yoon H, Park J, You Y, Kim K, Lee YH, Choi KC, Lee J and Jun W (2016)**: Anti-obesity effect of extract from fermented Curcuma longa L. through regulation of adipogenesis and lipolysis pathway in high-fat diet-induced obese rats. Food Nutr Res., 60: 10.3402.

31. **Kim JG, Mandal PK, Choi KD, Pyun CW, Hong GE and Lee CH (2011):** Beneficial dietary effect of turmeric and sulphur on weight gain, fat deposition and lipid profile of serum and liver in rats. Journal of Food Science and Technology, 44: 1-6.

32. **Kumar A, Tiwari P, Sahoo SS and Srivastava AK (2005)**: Prevalence of insulin resistance in 1st degree relative of type-2 diabetes mellitus parents: A Prospective Study of North Indian Population: IJCB., 20(27): 10-17.

33. **Lopez N (1977):** Cholesterol determination in high density lipoprotein separated by different three methods. Clin Chem., 23:882-885.

34. **Masur K, Thévenod F and Zaenker K (2008):** Pathophysiology of Diabetes Mellitus Type 2: Roles of Obesity, Insulin Resistance and β-Cell Dysfunction. Diabetes and Cancer, 19: 1–18.

35. **Micucci M, Aldini R, Cevenini M, Colliva C, Spinozzi S, Roda G, Montagnani M, Camborata C, Camardal L, Chiarini A Mazzella G and Budriesi R (2013):** Curcuma longa L. as a Therapeutic Agent in Intestinal Motility Disorders. Safety Profile in Mouse. PLoS ONE, 8 (11): 80925.

36. **Muscelli E, Pereira JA, Lazarin MA, Da Silva CA, Pareja JC and Saad MJ (2001):** Lack of insulin inhibition on insulin secretion in non-diabetic morbidly obese patients. Int J Obes Relat Metab Disord., 25(6): 798-804.

37. **Nathan DM, Singer DE, Hurxthal K and Goodson JD (1984):** The clinical information value of the glycosylated hemoglobin assay. N Engl J Med., 310 (6): 341-346.

38. **Nwozo S, Adaramoye O and Ajaiyeoba E (2009):** Oral administration of extract curcuma longa lowers blood glucose and attenuates Alloxan-induced hyperlipidemia in diabetic rabbits. Pakistan Journal of Nutrition, 8(5): 625-628.

39. **Olatunde A, Joel EB, Tijjani H, Obidola SM and Luka CD (2014):** Anti-diabetic Activity of Aqueous Extract of Curcuma longa (Linn) Rhizome in Normal and Alloxan-Induced Diabetic Rats. Researcher, 6 (7): 58-65.

40. **Olsen RH, Krogh-Madsen R, Thomsen C, Booth FW and Pedersen BK (2008):** Metabolic responses to reduced daily steps in healthy nonexercising men. Journal of the American Medical Association; 299: 1261–1263.

41. **Orellana-Paucar AM, Serruys AS, Afrikanova T, Maes J and De Borggraeve W (2012):** Anticonvulsant activity of bisabolenesesquiterpenoids of Curcuma longa in zebrafish and mouse seizure models. Epilepsy Behavior., 24: 14-22.

42. **Pashine L, Singh JV, Vaish AK, Ojha SK and Mehdi AP (2012):** Effect of turmeric (Curcuma longa) on overweight hyperlipidemic subjects: Double blind study. Indian Journal of Community Health, 24(2): 113-117.

43. **Pauli JR, Gomes RJ and Luciano E (2006):** Hypothalamo-pituitary axis: effects of physical training in rats administered with dexamethasone. Rev Neurol., 42(6):325-331.

44. **Pereira-Lancha LO, Campos-Ferraz PL, and Lancha AH (2012):** Obesity: considerations about etiology, metabolism, and the use of experimental models. Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy, 5:75–87.

45. **Peschel D, Koerting R and Nass N (2007):** Curcumin induces changes in expression of genes involved in cholesterol homeostasis. Journal of Nutritional Biochemistry, 18(2): 113–119.

46. **Philip J (2008):** Mechanisms behind GLP-1 induced weight loss. British Journal of Diabetes & Vascular Disease, 8: 34.

47. **Pinheiro A, Freitas S and Corso A (2004):** An epidemiological approach to obesity. Rev Nutr., 17(4): 523-533.

48. **Pischon T, Hankinson SE, Hotamisligil GS, Rifai N and Rimm EB (2003):** Leisure-time physical activity and reduced plasma levels of obesity-related inflammatory markers. Obes Res., 11: 1055-1064.

49. **Saltiel A and Kahn C (2001):** Insulin signalling and the regulation of glucose and lipid metabolism. Nature, 414: 799–806.

50. **Sengupta M, Sharma GD and Chakraborty B (2011):** Hepatoprotective and immunomodulatory properties of aqueous extract of Curcuma longa in carbon tetra chloride intoxicated Swiss albino mice. Asian Pac J Trop Biomed., 1: 193-199.

51. **Shehzad A, Ha T, Subban F and Lee Y (2011):** New mechanisms and the anti-inflammatory role of curcumin in obesity and obesity related metabolic diseases. Eur J Nutr., 50 (3): 151-161.

52. **Shishodia S, Sethi G and Aggarwal BB (2005):** Curcumin: getting back to the roots. Ann N Y Acad Sci., 1056: 206-217.

53. **Shoelson SE, Herrero L and Naaz A (2007):** Obesity, inflammation and insulin resistance. Gastroenterology, 132 (6): 2169–2180.

54. **Shrestha L, Jha B, Yadav B and Sharma S (2012):** Correlation between fasting blood glucose, postprandial blood glucose and glycated hemoglobin in non-insulin treated

type 2 diabetic subjects. Sunsari Technical College Journal, 1: 2091-2102.

55. **Sindelka G, Skrha J, Prazny M and Haas T (2002):** Association of Obesity, Diabetes, Serum Lipids and Blood Pressure Regulates Insulin Action. Czech Republic Physiol. Res., 51: 85-91.

56. **Sohaily S, Yadegary E, Parsian H and Baneifar A (2012):** The effect of intermittent aerobic exercise on serum leptin and insulin. Annals of Biological Research, 3(6):2636-2641.

57. **Tokmakidis SP, Zois CE, Volaklis KA, Kotsa K and Touvra AM (2004):** The effects of a combined strength and aerobic exercise program on glucose control and insulin action in women with type 2 diabetes. Eur J Appl Physiol., 92: 437–442.

58. **Vallon V, Rose M, Gerasimova M, Satriano J, Platt KA, Koepsell HT, Cunard R, Sharma K,Thomson SC, Rieg T (2013):** Knockout of Na-glucose transporter SGLT2 attenuates hyperglycemia and glomerular hyperfiltration but not kidney growth or injury in diabetes mellitus. Rev Med Chir Soc Med Nat Iasi., 117 (4): 954-958.

59. **Witkin JM and Li X (2013):** Curcumin, an active constituent of the ancient medicinal herb Curcuma longa L.: some uses and the establishment and biological basis of medical efficacy. CNS Neurol Disord Drug Targets, 12:487–97.

60. **Xi L, Qian Z, Xu G, Zhou C and Sun S (2007):** Crocetin attenuates palmitate-induced insulin insensitivity and disordered tumor necrosis factor and adiponectin expression in rat adipocytes. Br J Pharmacol., 151: 610-617.

61. **Zago L, Weisstaub A, Masselli MD, Ortiz V, Felipoff AL, Dupraz H, Perdomo C, Rio ME, Presner N, Rivera S and Infantino CG (2013):** HbA1c levels in non-diabetic overweight and obese subjects. The FASEB Journal, 27: 1067-1078.

62. **Zarghami N, Mohamadzadeh G and Zahedi A (2008):** Obesity in youth implications for advanced practice. Iran J Endocrinol Metab., 10 (3): 227-234.

تأثيرات مستخلص الكركم أو النشاط البدنى على بعض أوجه الأيض لدى ذكور الجرذان البيضاء البالغة البدينة

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خلفية للبحث: إنتشار وشدة السمنة والأمراض المتزامنة معها مثل داء السكر النمط الثاني، و أمراض القلب، والضغط، يتزايد بسرعة على مستوى العالم. ويعتبر الكركم من المنتجات النباتية الطبيعية التى لها نشاطات حيوية متعددة. كما يمثل النشاط البدني المنتظم جدار واقى ضد حدوث كثير من الأمراض.

الهدف من البحث: تحديد تأثيرات مستخلص الكركم أو النشاط البدنى على بعض أوجه الأيض لدى ذكور الجرذان البيضاء البالغة البدينة.

مواد وطرق البحث: أربعون من ذكور الجرذان البيضاء البالغة أستخدمت في هذه الدراسة وقد قسمت إلى أربعة مجموعات متساوية على النحو التالى: المجموعة الأولى: مجموعة ضابطة غير بدينة لم تتناول الكركم ولم تخضع للنشاط البدنى، والمجموعة الثانية: مجموعة ضابطة بدينة لم تتناول الكركم ولم تخضع للنشاط البدنى، والمجموعة الثالثة: مجموعة بدينة خضعت للنشاط البدنى، والمجموعة الرابعة: مجموعة بدينة أعطيت مستخلص الكركم. وفي نهاية التجربة تم سحب عينات الدم وتم قياس مستوى الجلوكوز، والهيموجلوبين السكري، وبروتين سي الببيتايد، والدهون الثلاثية، والكوليسترول، والبروتين الدهنى منخفض الكثافة، والبروتين الدهنى عالي الكثافة، كما تم تسجيل وزن الجسم والطول وحساب مؤشر كتلة الجسم.

النتائج: اظهرت النتائج ان الوجبة الغنية بالدهون المسببة للسمنة أحدثت ارتفاعا ذو دلالة إحصائية في مستوى الجلوكوز والهيموجلوبين السكرى وسي ببيتايد والدهون الثلاثية والكوليسترول والبروتين الدهنى منخفض الكثافة، وإنخفاض ذو دلالة احصائية فى مستوي البروتين الدهنى عالى الكثافة مقارنة بالمجموعة الضابطة غير البدينة. وعند إعطاء مستخلص الكركم او النشاط البدنى في الجرذان البدينة، أدى ذلك الى إنخفاض ذو دلالة احصائية فى مستويات الجلوكوز وسي ببيتايد والدهون الثلاثية والكوليسترول والبروتين الدهنى منخفض الكثافة، وإرتفاع ذو دلالة إحصائية فى مستوى البروتين الدهنى عالى الكثافة، وتغير بنسب غير دالة إحصائيا فى مستوى الهيموجلوبين السكرى مقارنة بالمجموعة البدينة. من الناحية الأخرى، أحدث مستخلص الكركم تغيرات في مستوى الجلوكوز، والهيموجلوبين السكرى، وسي ببيتايد، والكوليسترول بنسب غير دالة إحصائيا مقارنة بمجموعة النشاط البدنى، بينما كان التغير في مستويات الدهون الثلاثية والبروتين الدهنى منخفض الكثافة والبروتين الدهنى عالى الكثافة في المجموعتين بنسب دالة إحصائيا.

الإستنتاج: أظهرت الدراسة نتائج مبشرة لمستخلص الكركم والنشاط البدنى في علاج السمنة والمشاكل المتبوعة مع السمنة مثل مقاومة الانسولين والداء السكرى من النوع الثانى بتقليل وزن الجسم، ومستوى جلوكوز الدم ، وتحسين مستقبلات الانسولين، ودهنيات الدم، ومع ذلك أظهرت أن النشاط البدنى حسن من مستويات الجلوكوز ودهنيات الدم أكثر مما أظهره العلاج بمستخلص الكركم.