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Original Article

Coagulation, fibrinolytic parameters and cytokines response to weight reduction in obese Saudi women

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Abstract:

BACKGROUND: Obesity is a relevant risk factor for major cardiovascular events due to the atherosclerotic involvement of coronary, cerebral and lower limb arterial vessels. A major role in the increased cardiovascular risk is played by platelets, which show an increased activation and a reduced sensitivity to the physiological and pharmacological anti-aggregating agents. However, no studies have compared the effects of simple calorie restriction with those of calorie restriction combined with aerobic exercise on fibrinolytic and coagulative factors, as well as cytokine levels. **OBJECTIVE**: The aim of this study was to investigate the effect of weight reduction on the fibrinolytic, coagulative factors and cytokines in obese Saudi women. **MATERIALS and METHODS:** One hundred obese Saudi women participated in this study and were included into two equal groups. The first group (A) received physical training combined with dietary measures, three sessions per week for three months. The second group (B) maintained their baseline lifestyle without additional interventions. Measurements of body mass index (BMI), Fibrinogen, von Willbrand factor (vWF-Ag) antigen, plasminogen activator inhibitor-1 activity (PAI-1:Ac) and antigen (PAI-1:Ag) & prothrombin time (PT), partial thromboplastin time (PTT), tissue plasminogen activator activity (tPA:Ac) , antigen (tPA:Ag) , tumor necrotic factor - alpha (TNF-α), interleukin–6 (IL-6) and leptin were done before the study and after three weeks at the end of the study. **RESULTS:** The results of this study indicated a significant decrease in BMI, Fibrinogen, vWF-Ag, PAI-1:Ac and PAI-1:Ag & PT, PTT, tPA:Ac, tPA:Ag ,TNF-α, IL-6 and leptin in group (A), while these changes were not significant in group (B). **CONCLUSION:** Weight reduction modulates Coagulation, fibrinolytic parameters and cytokines in obese Saudi women.

Keywords: Obesity; inflammatory cytokines; Coagulation; fibrinolytic parameters.

Introduction

Obesity is a relevant risk factor for major cardiovascular events due to the atherosclerotic involvement of coronary, cerebral and lower limb arterial vessels. A major role in the increased cardiovascular risk is played by platelets, which show an increased activation and a reduced sensitivity to the physiological and pharmacological anti-aggregating agents [1].

Obesity is independently associated with an elevated risk of cardiovascular morbidity and mortality due to atherothrombotic events [2]. The susceptibility to the clinical manifestations of atherosclerosis is related to the presence of low grade inflammation together with the variable co-existence of impaired glucose metabolism atherogenic

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dyslipidemia, arterial hypertension, endothelial dysfunction and a prothrombotic state [3,4].

Mean platelet volume, a parameter closely associated with in vivo platelet activation [5], has been reported to be elevated in patients with obesity [6, 7]. Obese women also show an increase in platelet count [8]. Interleukin-6 (IL-6) induces a modest increase in platelet count and enhances platelet size and function, likely through its action at the megakaryocyte level [9], whereas Tumor necrosis factor- α (TNF-α) increases platelet adhesion to endothelial cells [10]. Despite the significant advancements in understanding the pathogenesis and treatment of atherothrombosis associated with obesity, coronary heart disease is projected to be the leading cause of mortality worldwide by 2020 [11].

Obesity is associated with reduced adipose tissue oxygenation, hypoxia, and increased chemotaxis of inflammatory cells [12]. Monocytes are recruited to adipose tissue, where they secrete tumor necrosis factor-alpha (TNF-α) and interleukin-6 [13], along with leptin and resistin produced by dysfunctional adipocytes [14].
Regular physical activity seems to induce improvement in fibrinolytic activity, as indicated by an increase in t-PA activity and a decrease in PAI-1 activity [15]. Exercise at moderate intensity may also suppress platelet activation and polymorphonuclear leukocyte interaction with surface-adherent platelets under shear flow. Also, weight reduction may reduce the risk of CVD [16].

Fibrinolytic activity on postmenopausal women could be improved by a 3-week regular submaximal training program. These changes on the hemostatic factors suggest that short-term aerobic training may prevent the decline in fibrinolytic function observed in sedentary postmenopausal women [17].

The presence of a prothrombotic state accounts in part for the high prevalence of cardiovascular events in obese subjects [18]. Weight reduction contributes to a decrease in CVD-related morbidity through improvement of fibrinolytic abnormality and endothelial dysfunction [19]. Dietary therapy, physical activity and combination therapy (diet and physical activity) have been adopted as weight reduction regimens [20]. The aim of this study was to investigate the effect of weight reduction on the fibrinolytic, coagulative factors and cytokines in obese subjects.

Materials and Methods

Subjects

One hundred obese Saudi women were selected from the Internal Medicine Department at King Abdulaziz University Hospital and other hospitals in the Jeddah area. Their ages ranged from 35 to 45 years, and their body mass index (BMI) ranged from 32 to 36 kg/m². The exclusion criteria included smoking; the use of prescribed medications, including regular aspirin and non-steroidal anti-inflammatory drugs (NSAIDs); hypertension; diabetes; a personal history of cardiovascular disease (CVD); thyroid disease; and orthopedic issues that could inhibit treadmill training. Informed consent was obtained from all participants.

Participants were divided into two equal groups. Group A received physical training combined with dietary interventions, with three sessions per week over the course of three months. Group B maintained their baseline lifestyle without any additional interventions. This study was approved by the Scientific Research Ethical Committee, Faculty of Applied Sciences, King Abdulaziz University. Informed consent was obtained from all participants. All participants were free to withdraw from the study at any time.

Equipment

1. Treadmill (Enraf Nonium, Model display panel Standard, NR 1475.801, Holland) was used in performance of aerobic walking exercise.

2. Plasma vWF was measured by commercial Enzyme Linked Immuno Sorbent Assay (ELISA) method (Zymutest vWF, Hyphen Biomed, Neuville sur Oise, France). PT and PTT were determined using (Tromboplastin D, Fisher Diagnostics, Middletown, USA) and (APTT-XL, Fisher Diagnostics, Middeltown, USA). tPA and PAI-1 activities and antigens were determined using the Imulyse™ enzyme-linked immunosorbent assay (ELISA) kits (Biopool, Umea, Sweden) and the activities using Chromolize™ tPA and Spectrolyse® pL PAI (Biopool, Umea, Sweden) in accordance with the manufacturer's instructions. While IL-6 level was measured using "Immulite 2000" immunassay analyzer (Siemens Healthcare Diagnostics, Deerfield, USA). However, TNF-α level was analyzed with ELISA kits using ELISA microplate strip washer (ELX 50), and ELISA microplate reader (ELX 808; BioTek Instruments, USA). Also, plasma samples with K2EDTA were collected after centrifugation (2000 × g for 10 min at 4°C) and stored at −80°C to analyze leptin. All analyses were carried out on a Hitachi 7170 Autoanalyser (Tokyo, Japan) or with commercial kits (Randox).

3. Weight and height scale (JENIX DS 102, Dongsang, South Korea) was used to measure weight and height to calculate the body mass index (BMI).

Measurements

1. Laboratory analysis: Blood samples were collected from the antecubital vein at the beginning and end of the treatment program. After a 12-hour fast, blood samples were drawn from subjects at the same time each morning, between 8 and 10 AM. Subjects were instructed to lie supine for 10 minutes prior to blood collection. A 10 mL blood sample was drawn into a tube containing 0.1 M sodium citrate. Blood was centrifuged at 2000 ×g for 10 min at 4 °C and stored at − 80 °C until analysis. Plasma vWF, PT, PTT, TPA and PAI-1 were measured in accordance with the manufacturer's instructions. All standards and samples were measured in duplicate and all samples from the one subject were measured on the same plate; Fibrinogen was measured by the time titration method employing the ST-4 coagulation instrument (Zymutest Fibrinogen, ELISA, Hyphen Biomed, Neuville sur Oise, France). While, IL-6 and TNF-α levels were analyzed with ELISA kits using ELISA microplate strip washer, and ELISA microplate reader. Also, plasma sample with K2EDTA was collected after centrifugation (2000 × g for 10 min at 4°C) and stored at −80°C to analyze leptin [21].

2. Evaluation of anthropometric parameters: All measurements were taken at baseline and after three months, at the conclusion of the study. Participants were measured while wearing undergarments and hospital gowns. Height was recorded using a digital stadiometer (JENIX DS 102, Dongsang, South Korea) to the nearest 0.1 cm. Body weight was measured on a calibrated balance scale to the nearest 0.1 kg (HC4211, Cas Korea, South Korea), and BMI was calculated using the formula: BMI = Body weight / (Height)². All measurements of BMI, PT, PTT, tPA:Ac , tPA:Ag, fibrinogen, vWF-Ag, PAI-1:Ac ,PAI-1:Ag, TNF-α, IL-6 and leptin were taken before the starting of the study and after three months.

Procedures of the study

Following the initial evaluation, all participants were randomly assigned to the following groups:

1. Group (A) : Participants underwent a 40-minute aerobic session on a treadmill (Enraf Nonium, Model Display Panel Standard, NR 1475.801, Netherlands). The session began with a 5-minute warm-up phase at a low load, followed by 30 minutes of walking or running, depending on heart rate, with intensity set at 65%-75% of the maximum heart rate (HRmax) according to a modified Bruce protocol. The session concluded with a 5-minute recovery and relaxation phase. The target heart rate was based on the guidelines of the American College of Sports Medicine. All participants completed three sessions per week, totaling 36 sessions over a 3-month period. Additionally, a prescribed low-calorie diet, providing 1,200 kilocalories per day, was provided to all participants throughout the study's duration. The prescribed diet included a breakfast consisting of 2 boiled eggs (80 calories), 50 g of cheese (100 calories), and one piece of bread (105 calories). Lunch included 2 pieces of boiled meat (100 g, 240 calories) or chicken (300 calories), 500 g of salad (105 calories), 300 g of boiled vegetables (110 calories), and one banana (100 calories). Dinner consisted of 200 g of light milk (120 calories)

2. Group (B): Participants were instructed to maintain their usual lifestyle without any additional interventions for a period of 3 months

Statistical analysis

A paired t-test was used to compare the pre-test and post-test values of the investigated parameters within each group, while an unpaired t-test was employed to compare the results between the two groups ($p<0.05$).

Results

The mean values of BMI, fibrinogen, vWF-Ag antigen, PAI-1:Ac, and PAI-1:Ag were significantly decreased in Group A, while the mean values of PT, PTT, tPA:Ac, and tPA:Ag were significantly increased . Conversely, the results for Group B, which did not receive any treatment intervention, were not statistically significant (Tables 1 and 2). Moreover, significant differences were observed between the mean levels of the investigated parameters in Group A and Group B following the intervention (Table 3) ($p<0.5$).

TABLE 1: MEAN VALUE AND SIGNIFICANCE OF THE PRE AND POSTTEST VALUES OF BMI, PT, PTT, TPA:AC AND TPA:AG FIBRINOGEN, VWF-AG, PAI-1:AC AND PAI-1:AG IN THE TRAINING GROUP.

	Mean ± SD		t-value	*p*-value
	Pre	Post		
BMI (Kg / m^2)	36.17 ± 6.52	28.25 ±5.20	6.34	<0.05
PT (s)	10.5 ± 0.54	12.13 ± 0.98	5.17	<0.05
PTT (s)	21.82 ± 2.78	25.36 ± 2.82	5.85	<0.05
tPA:Ac (IU/mL)	5.12 ± 0.23	6.7 ± 0.11	4.36	<0.05
tPA:Ag (ng/mL)	3.25 ± 0.41	4.67 ± 0.64	4.23	<0.05
Fibrinogen(mg/mL)	3.85 ± 0.61	2.16 ± 0.13	4.11	<0.05
vWF-Ag (%)	92.46 ± 10.77	74.56 ± 11.65	6.52	<0.05
PAI-1:Ac (AU/mL)	4.9 ± 0.38	3.06 ± 0.15	4.02	<0.05
PAI-1:Ag (ng/mL)	19.84 ± 2.24	10.53 ± 2.16	5.04	<0.05
TNF- α (pg/mL)	5.71± 1.76	4.22 ± 1.14	6.52	<0.05
IL-6 (pg/mL)	8.76 ± 2.32	5.34 ± 1.85	6.19	<0.05

BMI= Body Mass Index; PT= prothrombin time; PTT= partial thromboplastin time; tPA:Ac = tissue plasminogen activator activity ; tPA:Ag = tissue plasminogen activator antigen ; vWF-Ag = von Willbrand factor antigen; PAI-1:Ac = plasminogen activator inhibitor-1 activity; IL-6= Interleukin – 6; PAI-1:Ag = plasminogen activator inhibitor-1 antigen; TNF-α = tumor necrotic factor – alpha.

Table 2:Mean value and significance of the pre and posttest values of BMI, PT, PTT, tPA:Ac and tPA:Ag fibrinogen, vWF-Ag, PAI-1:Ac and PAI-1:Ag in the control group.

	Mean ± SD		t- value	*p*-value
	Pre	Post		
BMI (Kg / m^2)	35.98 ± 6.87	36.11 ± 6.22	0.81	>0.05
PT (s)	11.29 ± 0.88	11.53 ± 0.94	0.79	>0.05
PTT (s)	22.31 ± 3.26	23.45 ± 3.15	0.86	>0.05
tPA:Ac (IU/mL)	5.15 ± 0.67	5.76 ± 0.72	0.92	>0.05
tPA:Ag (ng/mL)	3.43 ± 0.54	3.75 ± 0.83	0.86	>0.05
Fibrinogen (mg/mL)	3.57 ± 0.81	3.32 ± 0.75	0.74	>0.05
vWF-Ag (%)	92.78 ± 11.25	91.54 ± 12.04	0.65	>0.05
PAI-1:Ac (AU/mL)	4.3 ± 0.47	4.01 ± 0.64	0.67	>0.05
PAI-1:Ag (ng/mL)	19.62 ± 2.33	19.35 ± 2.52	0.53	>0.05
TNF- α (pg/mL)	5.66± 1.45	5.87 ± 1.33	0.63	>0.05
IL-6 (pg/mL)	8.67 ± 2.01	8.82 ± 2.13	0.53	>0.05

BMI= Body Mass Index; PT= prothrombin time; PTT= partial thromboplastin time; tPA:Ac = tissue plasminogen activator activity ; tPA:Ag = tissue plasminogen activator antigen ; vWF-Ag = von Willbrand factor antigen; PAI-1:Ac = plasminogen activator inhibitor-1 activity; IL-6= Interleukin – 6; PAI-1:Ag = plasminogen activator inhibitor-1 antigen; TNF-α = tumor necrotic factor – alpha

Discussion

Abnormalities in coagulation and fibrinolysis may play an important role in the risk of cardiovascular event in obese subjects. Blood clotting and intravascular thrombus formation are important in the development of acute coronary thrombosis [22]. Plasma level of fibrinogen, PAI-1 activity and tPA antigen play a central role in the development of thrombosis and are associated with coronary heart disease [23]. We observed a significant reduction in fibrinogen following weight reduction, consistent with the findings of previous studies.

Weight reduction contributes to a decrease in CVD-related morbidity through improvement of fibrinolytic abnormality and endothelial dysfunction [21]. Dietary therapy, physical activity and combination therapy (diet and physical activity) have been adopted as weight reduction regimens [19]. In obese women, a successful program for weight loss was shown to reduce chronic inflammation, oxidative stress as well as persistent platelet activation [24]. A study conducted on individuals with central obesity reported that a dietary intervention program, resulting in a 10% reduction in initial body weight, effectively reversed platelet resistance to the anti-aggregatory effects of nitric oxide (NO), prostacyclin, and cyclic nucleotide [1]. Weight loss in obese patients can therefore be considered a very effective strategy to improve the platelet abnormalities linked to insulin resistance [1].

In the present study, after weight reduction, tPA activity and tPA antigen were increased and PAI-1 activity and antigen were decreased. Murakami et al. (2007) reported

Table 3: Mean value and significance of the posttest values BMI, PT, PTT, tPA:Ac and tPA:Ag fibrinogen, vWF-Ag, PAI-1:Ac and PAI-1:Ag in the training and control groups.

	Mean ± SD		t- value	*p*-value
	Training group	Control group		
BMI (Kg / m^2)	28.25 ±5.20	36.11 ± 6.22	5.20	<0.05
PT (s)	12.13 ± 0.98	11.53 ± 0.94	4.12	<0.05
PTT (s)	25.36 ± 2.82	23.45 ± 3.15	4.31	<0.05
tPA:Ac (IU/mL)	6.7 ± 0.11	5.76 ± 0.72	3.02	<0.05
tPA:Ag (ng/mL)	4.67 ± 0.64	3.75 ± 0.83	3.46	<0.05
Fibrinogen (mg/mL)	2.16 ± 0.13	3.32 ± 0.75	3.32	<0.05
vWF-Ag (%)	74.56 ± 11.65	91.54 ± 12.04	5.75	<0.05
PAI-1:Ac (AU/mL)	3.06 ± 0.15	4.01 ± 0.64	3.28	<0.05
PAI-1:Ag (ng/mL)	10.53 ± 2.16	19.35 ± 2.52	4.49	<0.05
TNF- α (pg/mL)	4.22 ± 1.14	5.87 ± 1.33	6.65	<0.05
IL-6 (pg/mL)	5.34 ± 1.85	8.82 ± 2.13	6.46	<0.05

BMI= Body Mass Index; PT= prothrombin time; PTT= partial thromboplastin time; tPA:Ac = tissue plasminogen activator activity ; tPA:Ag = tissue plasminogen activator antigen ; vWF-Ag = von Willbrand factor antigen; PAI-1:Ac = plasminogen activator inhibitor-1 activity; IL-6= Interleukin – 6; PAI-1:Ag = plasminogen activator inhibitor-1 antigen; TNF-α = tumor necrotic factor - alpha

that PAI-1 activity and t-PA antigen values positively correlated with BMI and fat tissue mass. These high values were reduced after weight reduction.

A significant positive correlation was observed between the percentage changes in BMI, waist circumference, and fat tissue mass and the changes in PAI-1 activity [15]. These associations were in line with data from previous weight reduction trials [23-25]. Consistent with previous findings, our study demonstrates that weight reduction facilitates fibrinolysis by upregulating tissue plasminogen activator (tPA) activity and downregulating plasminogen activator inhibitor-1 (PAI-1) activity.

The results of the current study regarding prothrombin time (PT) and partial thromboplastin time (PTT) are consistent with the findings of Piccone et al.(2005) and Stratton et al (1997) [26, 27]. However, the present investigation shows that there was a significant reduction of vWF. These results are in agreement with the results of Paton et al. (2004) [28]. Saenko et al. (1999) reported that it is possible that the active cool down results in an increase in hepatic blood flow and clearance of vWF-Ag [29].

The results of the current study regarding fibrinogen indicate that weight reduction led to a decrease in fibrinogen concentration. This finding is consistent with the study by DeSouza et al. (1998), which demonstrated that plasma fibrinogen concentrations are lower in physically active postmenopausal women compared to their sedentary counterparts, with age-related increases in fibrinogen levels being twice as pronounced in sedentary women [30]. It has been suggested that the favorable association between plasma fibrinogen levels and regular exercise are likely due to lower body fatness [31, 32].

The results of this study demonstrated a significant reduction in TNF-α, IL-6, and BMI in Group A, whereas no significant changes were observed in Group B. These findings suggest that weight reduction is an effective intervention for modulating inflammatory cytokines in obese individuals. This is consistent with the findings of Esposito et al. (2003), who reported that medical weight loss in obese women led to significant decreases in elevated levels of IL-6, IL-18, C-reactive protein, and insulin resistance, along with a significant increase in the anti-inflammatory adipokine, adiponectin [33]. Reinher et al. (2005) demonstrated that weight loss resulting from a combined diet, physical activity, and behavioral intervention led to a significant reduction in TNF-α levels [34]. Also, significant reductions in BMI, fat mass, IL-6 and leptin concentrations was achieved after only 3weeks following a diet and physical activity intervention [35]. Bladbjerg et al. (2010) confirmed that weight loss by dietary intervention or gastric banding modulates hemostasis parameters in obese patients [36].

Overall, these studies support the notion that weight loss is associated with improvements in coagulation and inflammation profiles, potentially reducing thrombotic risk. Furthermore, Lijnen et al. (2012) demonstrated that caloric restriction and significant weight loss in obese mice were associated with improved plasma coagulation profiles, as well as reduced oxidative stress and inflammation in adipose tissues [37].

Conclusion

Coagulation, fibrinolytic activity and inflammatory cytokines could be improved by weight reduction in obese Saudi women received aerobic exercise training in addition to diet regimen.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

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استجابة التخثر ودلالات الإلتهاب لإنقاص الوزن لدى النساء السعوديات البدينات

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المستخلص:

الخلفية: السمنة هي عامل خطر ذي صلة بأمراض القلب والأوعية الدموية بسبب تصلب الشرايين في الأوعية الشريانية التاجية والدماغية. تلعب الصفائح الدموية دورا رئيسيا في زيادة مخاطر الإصابة بأمراض القلب والأوعية الدموية ، والتي تظهر زيادة التنشيط وانخفاض الحساسية للعوامل الفسيولوجية والدوائية المضادة للتجميع. ومع ذلك ، لم يتم إجراء أي دراسات لمقارنة آثار تقييد السعرات الحرارية البسيطة وآثار تقييد السعرات الحرارية جنبا إلى جنب مع التمارين الهوائية على عوامل التخثر ودلالات الإلتهاب. **الهدف:** تهدف هذه الدراسة إلى التحقيق في تأثير إنقاص الوزن على عوامل التخثر ودلالات الإلتهاب لدى النساء السعوديات البدينات. **المواد والأساليب:** شاركت في هذه الدراسة مائة امرأة سعودية تعاني من السمنة المفرطة ، وتم إدراجهن في مجموعتين متساويتين. تلقت المجموعة الأولى (أ) تدريبا بدنيا مقترنا بتدابير غذائية، ثلاث جلسات في الأسبوع لمدة ثلاثة أشهر. المجموعة الثانية (ب) لم تتلق أي تدخل علاجي. تم إجراء قياسات مؤشر كتلة الجسم عوامل التخثر ودلالات الإلتهاب قبل الدراسة وبعد ثلاثة أسابيع في نهاية الدراسة. **النتائج:** أشارت نتائج هذه الدراسة إلى انخفاض كبير في مؤشر كتلة الجسم، عوامل التخثر ودلالات الإلتهاب واللبتين في المجموعة الأولي، بينما لم تكن هذه التغيرات ذات دلالة إحصائية في المجموعة الثانية. **الخلاصة:** يعدل إنقاص الوزن عوامل التخثر ودلالات الإلتهاب لدى النساء السعوديات البدينات.

الكلمات الدالة: السمنة; عوامل التخثر ودلالات الإلتهاب.

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