The Association between Certain Proinflammatory Biomarkers and Body Composition in a Group of Overweight Students at the University of Jordan

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ABSTRACT

The objectives of this study were to determine the circulatory levels of proinflammatory biomarkers including interleukin-1β (IL-1β), interleukin-6 (IL-6), tumor necrosis factor-α (TNF-α), and high sensitivity-C reactive protein (hs-CRP) in a group of overweight (OWT) and normal body weight (NWT) students, and to examine their association with adiposity assessed by using classical anthropometric measurements and bioelectrical impedance analysis (BIA). A case-control study was conducted among 90 (45 OWT and 45 NWT) students (18-25 years) recruited from all faculties of the University of Jordan, Jordan. Height, weight, Waist circumference (WC) and hip circumference (HC) were measured using standard procedures, whereas percent fat mass (%FM) and percent fat free mass (%FFM) were determined using BIA. Serum levels of the examined proinflammatory biomarkers were also determined. Results showed that mean concentration of hs-CRP (0.79 ±0.85) and IL-6 (7.72 ±2.31) in OWT were significantly higher than that in NWT counterparts (0.45 ±0.52, 6.38 ±1.37; respectively, $P<0.05$); whereas no significant differences were observed in the mean concentration of IL-1β and TNF-α between the two groups. CRP was significantly associated with BMI ($r=0.538$, $P<0.01$), weight ($r=0.445$, $P<0.01$), waist circumference ($r=0.440$, $P<0.01$), waist-to-hip ratio ($r=0.229$, $P<0.05$), and %FM ($r=0.266$, $P<0.05$). Whereas, IL-6 was positively correlated with %FM in males (r=0.306, $P<0.05$) and negatively correlated with %FFM in females ($r=-0.297$, $P<0.05$). No significant association was observed between any of the body composition measurements and IL-1β and TNF-α. In conclusion, progressive increase in body fat is responsible for the activation of the immune system even before reaching the obesity stage.

Keywords: Obesity, Adiposity, Fat mass, Proinflammatory, Interleukin, TNF, CRP.

INTRODUCTION

The massive rampant global rise in obesity rates over the past three decades has been described as a global pandemic affecting both developed and developing populations, regardless of geographic location or socioeconomic status with no signs of declining or devoting efforts to fight against (Ng *et al.*, 2014; Flegal *et al*., 2012). In 2014, the World Health Organization's (WHO) estimated that 600 million in 2014 were diagnosed with obesity contributing to 13% of adults aged 18 years and older (WHO, 2015). Moreover, Ng and colleagues (2014) have estimated that the proportion of adults (body-mass index (BMI)≥ 25 kg/m²) increased from 28·8% to 36·9% in men, and from 29·8% to 38·0% in women throughout the world. In Jordan, 24.1% of boys, and 25.4% of girls less than 20 years were either overweight or obese, whereas 8.0% of boys, and 8.0% of girls less than 20 years were obese. In addition, 71.6% of men,, and 75.6% of women more than or equal 20 years

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were overweight and obese, whereas 27.5% of men ≥20 years, and 45.6% of women more than or equal 20 years were obese.

Obesity is a complex multifaceted chronic disease of subclinical low-grade systemic inflammation state that could lead to obesity-associated cardiometabolic health complications (Gariballa *et al.,* 2013; Al-Domi, 2013; Albakri *et al.,* 2014). Obesity induces adipose tissue (AT) expansion characterized by adipocytes enlargement and macrophage accumulation; and elevated leptin levels, proinflammatory cytokines including interleukin-1β (IL-1β), interleukin-6 (IL-6), tumor necrosis factor-α (TNF-α), and C-reactive protein (CRP) as well as chemokines, including visfatin, resistin, angiotensin II, plasminogen activator inhibitor 1, and monocyte chemoattractant protein-1 (MCP-1)], and lower adiponectin levels (Rudman *et al.,* 1990). The adverse effects of proinflammatory state of AT have been linked to the cardiometabolic consequences of obesity, particularly insulin resistance, type 2 diabetes and cardiovascular disease. As such, modulation of cytokine systems presents the possibility of major changes in AT behaviour (Cifuentes *et al.,* 2012; Matsuda and Shimomura, 2013).

Body mass index (BMI) is the crude standard metric for determining body weight status (WHO, 2012); it cannot differentiate fat mass (FM) from fat free mass (FFM), and may underestimate the level of adiposity (Nevill et al., 2006). To overcome these limitations, advanced techniques including bioelectrical impedance analysis (BIA) are used to measure FM and FFM. BIA divides the body weight into 4-component model of body composition; fat, water, mineral, and protein (Wells *et al.,* 1999). It is a more advanced reliable and sensitive method compared to classical anthropometry; It provides more accurate correlation between fat mass and serum levels of proinflammatory biomarkers than merely depending on BMI (Meeuwsen *et al.,* 2010).

Disease pathogenesis integrates the knowledge on the possible relationship between adiposity, immune responses, and obesity-related cardiometabolic disorders. Hence, understanding possible relationship between various body components and proinflammatory serum levels and determination of the stage at which the stimulation of the immune response occurs could provide further evidence on the progression of the inflammatory process. The essentiality of characterizing the genetic, endocrine and metabolic consequences that contribute to obesity and obesity-related cardiometabolic complications, and understanding the underlying mechanisms of these cardiometabolic complications necessitate the need to examine the ability of different assessment methods to predict the risk of those diseases. Therefore, the objective of this study was to determine the levels of certain serum pro-inflammatory biomarkers in a group of overweight (OWT) and normal weight (NWT) young Jordanian students at the University of Jordan, and their associations with adiposity measured by classical anthropometric measurements and BIA.

2. METHODS

2.1 Design

A case-control study was carried out between April to August, 2008 to determine the serum levels of certain proinflammatory biomarkers in a group OWT and NWT students (18-25 years) at the University of Jordan, Jordan using classical anthropometric measurements and BIA.

2.2 Study Population

A total of 45 OWT (22 males and 23 females), and 45 NWT (22 males and 23 female) undergraduate students (18-25 years) were recruited by using a convenience sampling procedure from all nineteen faculties (Health, Scientific, and Humanitarian) of the

University of Jordan. Students who consented were invited to participate in the study. Students having chronic or acute illnesses or receiving any medical treatments or smoking or having weight alteration within the last three months of the study or under weight (BMI <18.5 kg/m^2) or obese (BMI ≥30 kg/m^2) or having %FM <20 for males and <31 for females were excluded from the study.

2.3 Ethical Approval

The study protocol was approved by the Research Review Committee, Deanship of Scientific Research, the University of Jordan. Participants were informed briefly about the nature and objectives of the study. All participants were asked to sign a consent form. All data were collected and reported in a confidential manner.

2.4 Assessment of Body Composition

Height, weight, Waist circumference (WC) and hip circumference (HC) were measured using standard procedures. BMI and waist to hip ratio (WHR) were calculated (WHO, 2011).

BIA was undertaken by using calibrated BIA equipment (Bodystat®, Isle of Man, British Isles) for research purposes, which depends on two-compartment model of body composition. Prior to the procedure, students were asked to avoid excessive caffeine intake or intensive exercises for 12 hours or eating or drinking for 5 hours. Two sets of electrodes were attached to the dorsal surface of the wrist and the dorsal surface of the ankle on the right side of the body. After that, the current was applied at a frequency of 50 kHz to detect impedance (Meeuwsen *et al*., 2010). Body composition data were automatically downloaded.

2.5 Biochemical Analysis

In a follow up visit, blood samples (5 mL) were drawn from each student following overnight fasting. Blood samples were centrifuged (4ºC for 10 min at 1800xg), and serum aliquots were stored at -20ºC until analyzed (WHO, 2010).

Serum samples were thawed at room temperature. Standardized sandwich enzyme-linked immunosorbent assay (ELISA) kits was used to determine IL-1β, IL-6, and TNF-α serum levels (ELISA-Ready-set-Go!®, eBioscience, San Diego, CA, USA). Briefly, Elisa kits (stored at 2-8°C) were allowed to reach room temperature at the time of analysis. Then, multiwell, high-binding flat-bottom microtitre plates (Coring Coster ELISA plate®, NY, USA) were coated with capture antibody (100µl/well). Plates were sealed and incubated at 4°C for 12 hours. After washing (0.05% Tween 20 in 0.1M PBS), assay diluents was added (200 µL/well) and the plates were sealed and incubated for one hour at room temperature. Following several washings, a 100 µL diluted standards and sera were added and the plates were sealed and incubated for two hours at room temperature. After another washing step, a 100 µL/well of biotin-conjugated detecting antibody diluted in 1X assay diluent was added and incubated for one hour at room temperature. Following several washing steps, diluted avidine horseradish peroxides enzyme was added and incubated for 30 minutes at room temperature. After washing, a 100 µL/well of tetramethylbenzidine enzyme substrate was added to each well and incubated for 15 minutes at room temperature. The reaction was stopped by adding 50 µL/well 1M H_3PO_4, and the end-point was measured with microplate reader (BioTek®, ELx808 Absorbance Reader, VT, USA) at 450nm. Duplicates varying by more than 5% error were retested (Esmaillzadeh and Azadbakht, 2010).

High sensitivity CRP was measured by commercially available ELISA kits (C-reactive protein high sensitivity®, Abcam, Cambridge, MA, USA). After all reagents and serum samples allowed to reach room temperature, serum were diluted 100 fold prior to analysis, then a 10 µL of standards (0, 0.005, 0.01,

0.025, 0.05, and 0.1 mg/L CRP in serum based buffer solution with preservatives) and diluted serum samples were added to a multiwell microtiter plate coated with capture mouse monoclonal anti-CRP antibody. Then a 100µl of CRP horseradish peroxides enzyme conjugate reagent was added to each well.

After shaking for 30 seconds, microtiter plates were incubated at room temperature for 45 minutes, incubated mixture was dispensed and microtiter wells were washed several times using distilled water. Then a 100 µL of chromogenic substrate for horseradish peroxidase enzyme (Tetra-methyl Benzidine) was added to each well, plates were shacked and incubated at room temperature for 20 minutes. Finally, the reaction was stopped by adding 100 µL of 1M H_3PO_4 stop solution to each well and the plate was gently mixed for about 30 seconds. Absorbance was recorded at 450nm using microplate spectrophotometer (BioTek®, ELx808 Absorbance Reader, VT, USA) within 15 minutes. Duplicates varying by more than 5% error were retested (De Beer and Pepys, 1982).

2.6 Statistical analysis

The statistical analysis was performed using the SPSS for windows 2008 version 17.0. The group differences in anthropometric parameters, body composition, and serum levels of proinflammatory biomarkers were examined using analysis of variance (ANOVA). The associations between weight, BMI, WC, WHR, %FM, and %FFM and serum level of proinflammatory biomarkers were examined through Spearman's correlation coefficient (r). All P values less than or equal to 0.05 were considered as significant. Data were presented as means ± standard deviation (SD), and correlation coefficient (r).

3. RESULTS

Table 1 illustrates the anthropometric indicators of the sample by groups. There was no significant age difference among all groups. Generally, anthropometric indicators were significantly (P<0.05) higher in OWT students as compared to NWT counterparts. BMI, WC, HC, and WHR in male and female students were significantly higher in OWT as compared to NWT (P<0.05). While %FM significant difference was found between OWT and NWT female (P<0.001) and male (P≤0.05) participants in relation to %FM, (21.4±1.3, 12.2 ±3.5; respectively, P≤0.05)., %FFM in OWT male and female students was significantly lower than that among NWT counterparts (P<0.001).

Table 1. Anthropometric measurements and body composition of female and male participants.

Indicator*		Normal weight (n=45)	Overweight (n=45)
Age	Male (n=22)	21.5±1.9[a]	21.6±2.6[a]
	Female (n=23)	20.9±1.7[a]	21.2±2.6[a]
Weight (kg)	Male (n=22)	65.2±9.6[a]	86.3±9.7[b]
	Female (n=23)	56.4±7.7[a]	69.9±9.1[b]
Height (cm)	Male (n=22)	171.3±7.6[a]	174±8.5[a]
	Female (n=23)	160.8±6.5[a]	159.2±6.5[a]
BMI (kg/m^2)	Male (n=22)	22.3±2.1[a]	28.3±1.2[b]

	Female (n=23)	21.7±2.2[a]	27.6±2.2[b]
WC (cm)	Male (n=22)	77.9±7.5[a]	97.3±8.2[b]
	Female (n=23)	71.2±5.0[a]	81.4±5.9[b]
HC (cm)	Male (n=22)	96±7.9[a]	110±4.2[b]
	Female (n=23)	97.5±5.8[a]	109±11.7[b]
WHR	Male (n=22)	0.81±0.05[a]	0.87±0.06[b]
	Female (n=23)	0.73±0.05[a]	0.76±0.06[b]
%FM	Males (n=22)	12.2 ±3.5[a]	21.4 ±1.3[b]
	Females (n=23)	24.5±3.3[a]	32.1 ±1.2[b]
%FFM	Males (n=22)	85.8 ±9.5[a]	78.5 ±2.6[b]
	Females (n=23)	73.2 ±10.1[a]	66.9 ±5.6[b]

*Values are presented as mean ± standard deviation (SD); values in rows with different letters are significantly different from each other at $P<0.001$.

BMI: body mass index; WC: waist circumference; HC: hip circumference; WHR: waist to hip ratio; %FM: percent fat mass; %FFM: percent fat free mass.

Figure 1 shows that mean serum concentrations of CRP and IL-6 were significantly higher in OWT students than that in NWT counterparts ($P<0.05$). Whereas, no significant difference was found in mean concentrations of IL-1β and TNF-α among groups.

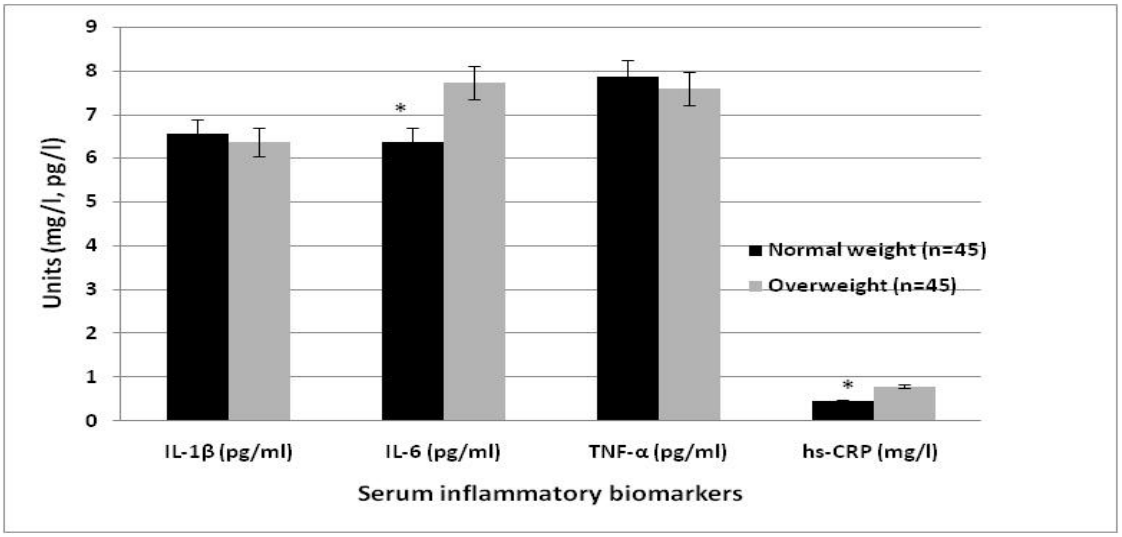

Figure 1. Mean serum inflammatory biomarkers levels in overweight and normal participants. *Data are significantly different at $P<0.05$. IL-1β: Interleukin-1β; Il-6: Interleukin-6; TNF- α: Tumor necrosis factor-α; hs-CRP: High sensitivity C-reactive protein.

Table 2 shows that there was a significant correlation between IL-6 and all anthropometric indicators regardless of gender, whereas there was no significant correlation found between serum IL-6, and weight and WC in males, and WC and WHR in females. Serum levels of CRP concentrations were significantly correlated with all anthropometric indicators among groups regardless of gender. In addition, there were no significant correlations between IL-1β and TNF-α and all anthropometric indicators among participants regardless of weight status or gender.

Table 2. Association between anthropometric indicators and inflammatory biomarkers in male and female participants.

Indicator†		IL-1β	IL-6	TNF-α	hs-CRP
Weight (Kg)	All (n=45)	-0.012	0.346**	0.031	0.445**
	Males (n=22)	-0.087	0.098	0.149	0.390**
	Females (n=23)	-0.0126	0.415**	-0.054	0.55**
BMI (Kg/m^2)	All (n=45)	-0.080	0.394**	0.083	0.538**
	Males (n=22)	0.011	0.292*	0.180	0.531**
	Females (n=23)	-0.201	0.417**	-0.011	0.518**
WC (cm)	All (n=45)	0.067	0.283**	0.024	0.440**
	Males (n=22)	0.022	0.081	0.10	0.418**
	Females (n=23)	0.104	0.284	-0.059	0.547**
WHR	All (n=45)	0.160	0.228*	0.075	0.229*
	Males (n=22)	0.160	0.228*	0.075	0.229*
	Females (n=23)	-0.044	0.142	0.172	0.450**

†Values are presented as correlation coefficient (r). Correlation is significant at *P<0.05 and at **P<0.01.

IL-1β: Interleukin-1β; Il-6: Interleukin-6; TNF-α: Tumor necrosis factor-α; hs-CRP: High sensitivity C-reactive protein; BMI: Body mass index; WC: Waist circumference; WHR: Waist to hip ratio.

Table 3 shows the correlation between body composition and proinflammatory biomarkers in OWT and NWT students. CRP was significantly correlated with %FM in males and females, whereas CRP was inversely correlated with %FFM among female participants (P<0.05); whereas there was no significant correlation between CRP and %FFM among male students. Mean IL-6 serum levels was significantly positively correlated with %FM in male students (P<0.05). Conversely, mean IL-6 serum levels was significantly negatively correlated with %FFM in females (P<0.05). moreover, there were no significant correlations between IL-1β and TNF-α and %FM or %FFM among all participants regardless of weight status or gender.

Table 3. Association between body composition and inflammatory biomarkers in male and female participants.

Indicator†		**IL-1β**	**IL-6**	**TNF-α**	**hs-CRP**
% FM	All (n=45)	0.168	-0.14	0.005	0.266*
	Males (n=22)	-0.098	0.306*	-0.088	0.380*
	Females (n=23)	-0.049	0.159	0.061	0.461**
% FFM	All (n=45)	0.189	0.189	0.033	-0.22*
	Males n=22	0.179	-0.236	0.041	-0.289
	Females (n=23)	0.001	-0.297*	-0.175	-0.489**

†values are presented as correlation coefficient (r). Correlation is significant at *P<0.05 and at **P<0.01.

%FM: Percent fat mass; %FFM: Percent fat free mass; IL-1β: Interleukin-1β; Il-6: Interleukin-6; TNF-α: Tumor necrosis factor-α; hs-CRP: High sensitivity C-reactive protein.

4. DISCUSSION

The results of the current study are consistent with other previous studies investigated the relation between obesity and inflammation among OWT participants. It shows a significant difference in serum CRP concentration between NWT and OWT participants, which is considered the most sensitive indicator of immune activation in OWT participants even in young adults (Wang *et al*., 2011; Kao *et al*., 2009). Previous findings showed that IL-6 is the most cytokine associated with CRP and this could be explained due to the activation role of TNF-α and IL-6 on the secretion of CRP from the liver (Kasapis and Thompson, 2005). Wang *et al.,* 2011 reported a significantly higher level of CRP in OWT young adults than control counterparts, with no differences found between NWT and OWT in neither IL-6 nor TNF-α levels. This could be attributed to a variation in cytokines secretion from different anatomical deposits of AT given that TNF-α is more secreted by subcutaneous AT (Hube *et al.,* 1999), while

IL-6 is more expressed in the visceral AT (Winkler *et al*., 2003). Therefore, insignificant difference in TNF-α concentration may be ascribed to the small sample size or the inability of the current study to compare visceral and subcutaneous fat contents, which might play a significant role in this relation (Fontana *et al*., 2007). Consistent with our findings, several studies have found a significant difference in IL-6 and CRP with no significant difference has been found in TNF-α concentration between NWT and OWT (Browning *et al*., 2008; Kitsios *et al*., 2012).

Findings of the current study demonstrated no significant difference was found between OWT and NWT students with regard to IL-1β serum levels. These findings are inconsistent with the previous findings> it was reported that IL-1β could induce anorexia more potently than other cytokines when it has been administered to the brain (Fruehauf e*t al*., 2003). These observations suggest a protective role of IL-1β at the onset of weight gain progression (Um *et al*., 2004).. Available data cannot be conclusive regarding the association between IL-1β and OWT; provided that studies on OWT individuals are scarce and the relationship is not fully understood (Jung *et al*., 2010). Although Han, *et al.* (2011) revealed that immune response was not significantly impaired in young adults with a BMI under 30 kg/m^2, these findings cannot be generalized due to the relatively small sample size that has been examined as compared to other similar studies that showed a significant difference (Gnacińska *et al*., 2010). Moreover, when Jung *et al.* (2010) have compared the concentration of IL-1β between NWT and OWT adolescent; they found that the concentration of IL-1β was under the detection sensitivity of the used biochemical assay.

Results of the present study revealed a significant association between CRP and some anthropometric indicators including BMI and WC. CRP was also associated with %FM as determined by BIA, which indicates that advanced obesity assessment methods are more effective tools and are able to identify complex associations related to fat distribution and FM that might explain the association between adiposity and inflammation (Forouhi *et al*., 2001). Accumulated evidence suggested that CRP as the strongest inflammatory biomarker is associated with BMI (Lyon *et al*., 2003; Park *et al*., 2005). Nonetheless, obesity and fat accumulation in the abdominal area are significantly correlated with elevation of CRP in men with atherogenic insulin resistance (Lemieux *et al.,* 2001). Lim and colleagues (2006) showed that %FM was strongly correlated with hs-CRP concentration, whereas there was no correlation between lean mass and hs-CRP levels in normal body weight men, which suggest that fat percent may affect CRP concentration even in in normal body weight individuals.

The present study demonstrated a significant association between serum level of IL-6, and weight, BMI, WC and WHR; no significant association was found between serum level of TNF-α and these anthropometric indicators. This could be attributed to differences in the relative rate of AT secretion or expression of the proinflammatory cytokines of IL-6 and TNF-α and their soluble receptors (Rexrode *et al*., 2003). Similar results were reported by Park, *et al*., (2005) and Browning, *et al*., (2008). On the other hand, Browning and colleagues (2008) provided evidence indicating that TNF-α could cause local inflammation and promote production of other inflammatory mediators, therefore TNF-α may not be a useful marker of inflammation at the systematic level. However, findings of a study that investigated the relation between TNF-α and obesity measurements found a significant increase in serum concentration of TNF-α among OWT women as

compared to NWT (Olszanecka-Glinianowicz *et al.,* 2011), and a significant relation between TNF-α concentration and FM and %FM were also revealed (Olszanecka-Glinianowicz *et al*., 2004).

Moreover, most studies suggested that TNF-α mRNA expression in AT is affected by many factors including, lipopolysaccharides, catecholamines in addition to adipocyte size (Aygun *et al*., 2005). Although no significant correlation was found between TNF-α level and anthropometric indicators of obesity in some studies (Kern *et al*., 2001; Chaikate *et al.,* 2006), Park, *et al.* (2005) reported a significant difference between NWT and OWT regarding the TNF-α level. This discrepancy may be related to a pre-existing state of TNF-α elevation (Park *et al*., 2005) or that the contradiction is due to the difference in mean age in each study population (Suzuki *et al.,* 2002).

Findings of the present study are not in line with findings of Aygun *et al.,* (2005) who reported an elevation of IL-1β levels in obese participants. A few studies have investigated the correlation between IL-1β and obesity indicators; yet the majority of which were interested in the genetic background of IL-1β up-regulation (Pachler *et al.,* 2007; Jager *et al*., 2010). Findings showed that IL-1β expression in AT is of a minor importance in quantitative terms. On the other hand, Bunout, *et al*. (1996) found a significant correlation between IL-1β production and abdominal obesity that was assessed by WC in alcoholics, however, there findings cannot be generalized to healthy individuals, given the possible negative impact of alcoholism on the whole body. The findings of the current study revealed that there is no significant correlation between IL-1β level and %FM or %FFM. Contradicting data were suggested by Manica-Cattani, *et al.* (2010) who linked IL-1 system to obesity development and found a significant association between genetic polymorphism of IL-1β and FM.

Findings of the current study showed that while there was a positive significant correlation between IL-6 concentration and %FM in males and a significant negative correlation between IL-6 and %FFM in females, no significant correlation was found between IL-1β and TNF-α with body composition. Thorand *et al.* (2006) investigated the effect of gender on the correlation between body composition and inflammatory biomarkers. Findings showed a significant positive correlation between IL-6 concentration and %FM in males and females, a significant negative correlation between IL-6 concentration and %FFM in females, and no significant association between IL-6 and %FFM in males. Differences in the inflammatory response could be attributed to body composition and fat distribution differences in males and females. Men have more intra-abdominal fat deposits, whereas women have more total %FM and larger subcutaneous fat deposits (Schreiner *et al.,* 1996).

Android fat distribution pattern abundance among males connects increased total body FM with abdominal obesity that was reported to be associated with IL-6 level (Winkler *et al.*, 2003). In females, the current study results showed an inverse significant correlation between %FFM and IL-6 concentration, which is consistent with that of Blain, *et al*. (2012) who suggested that the relation between IL-6 and physical fitness is significant, and independent of FM in women (20-70 years). Physical activity is connected to muscle mass activation; whenever active muscle mass is high that will be reflected on the level inflammatory markers. Moreover, some studies found a correlation between lean mass and TNF-α level and suggested a role of muscles in the production of TNF-α (Straczkowski *et al*., 2001).

5. CONCLUSION

The current study demonstrated the role of excess

weight in the activation of immune system even in the initial stage of obesity among a group of young Jordanian adults. Excess body fat associated with OWT status is enough to potentiate the immune response, but to a lower extent than that of the advanced stages of obesity, where more proinflammatory biomarkers level increase. Although field methods of obesity assessment including anthropometry and BIA are effective tools to track physiological changes even in initiation stages of obesity, BIA method has a better ability to detect the role of body composition and the distribution of FM and FFM in obesity-associated metabolic disorders.

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العلاقة بين بعض المؤشرات الحيوية الدالة على الالتهاب ومكونات الجسم لدى مجموعة من ذوي الوزن الزائد من طلبة الجامعة الأردنية

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ملخص

هدفت هذة الدراسة إلى تقدير مستويات عدد من المؤشرات الحيوية المحفزة للالتهاب: انترلوكين 1 بيتا (IL-1β) وانترلوكين 6 (IL-6) وعامل تنخّر الأورام ألفا (TNF-α) وبروتين سي التفاعلي عالي الحساسية (hs-CRP) لدى مجموعة من طلبة الجامعة الأردنية وهدفت أيضا إلى مقارنة الطرق التقليدية في تقييم السُمنة كمؤشر كتلة الجسم ووزن الجسم ومحيط الخصر ونسبة الخصر إلى الورك مع الطريقة المتقدمة والمتمثلة في تحليل مقاومة مرور الشحنات الكهربائية في الأنسجة الحية، وفعالية كلتا الطريقتين في تقييم العلاقة بين السُمنة والاستجابة المناعية بمراحل السُمنة الأولى. تكونت عينة الدراسة من 90 طالبا وطالبة (45 ذوي وزن زائد و45 ذوي وزن طبيعي). تكونت كل مجموعة من 22 طالبا و 23 طالبة (18−25 سنة) . تم أخذ القياسات الجسمية، وتحليل مكونات بنية الجسم وتقدير مستويات محفزات الالتهاب لكل مشارك بالدراسة. أظهرت نتائج الدراسة وجود فرق معنوي ذو دلالة إحصائية بين متوسط مستويات hs-CRP بين الطلاب في كلتا المجموعتين ($p<0.05$) ؛ حيث كان معدل التركيز±التشتت المعياري hs-CRP 0.45±0.52 و 0.79±0.85 بين الطلاب ذي الوزن الطبيعي وزائدي الوزن على التوالي، كذلك ارتبط معدل مستويات مصل الدم hs-CRP مع كل من موشر كتلة الجسم ووزن الجسم ومحيط الخصر بمعامل ارتباط جزئي معنوي طردي ($p< 0.01$) وايضا مع نسبة الخصر إلى الورك ونسبة كتلة الدهون وعكسيا مع نسبة الكتلةالخالية من الدهون (الكتلة العضلية) ($p< 0.05$). وأظهرت نتائج الدراسة وجود فرق معنوي ذو دلالة احصائية بين متوسط مستويات IL-6 بين الطلاب في كلتا المجموعتين ($p<0.05$)؛ حيث كان معدل التركيز±التشتت المعياري IL-6 6.38 1.37±و 2.3±7.72 بين الطلاب ذي الوزن الطبيعي وزائدي الوزن على التوالي، كذلك إرتبطت مستويات مصل الدم IL-6 مع كل من مؤشر كتلة الجسم ووزن الجسم ومحيط الخصر بمعامل ارتباط جزئي معنوي طردي ($p< 0.01$) وايضا مع نسبة الخصر الى الورك ($p< 0.05$) وكذلك ارتبط بمعامل ارتباط جزئي معنوي طردي مع نسبة الدهون عند الذكور والإناث وعكسيا مع النسبة الخالية من الدهون عند الإناث فقط ($p<0.01$). خلصت هذه الدراسة، مع الأخذ بعين الاعتبار ظروف الدراسة و حجم العينة المستخدمة، الى أن زيادة الوزن تعد كافية لتحفيز الاستجابة المناعية في الجسم, لكن بدرجة أقل من التحفيز الناتج عن السُمنة. حيث إنه في السُمنة يحدث زيادة في مستويات عدد أكبر من المؤشرات الحيوية المحفزة للالتهاب و التي تفاقم التأثير السلبي للسُمنة. و كما تجدر الاشارة هنا الى أن الطرق التقليدية لتقييم السُمنة تعد أدوات فاعلة لتتبع التغيرات الفسيولوجية، لكنها ما تزال غير قادرة على تقييم دور الكتلة العضلية الفاعل في الحماية من الحالات المرضية المرتبطة بالسُمنة ، كما هو الحال عند استخدام الطرق المتقدمة مثل تحليل مقاومة مرور الشحنات الكهربائية في الأنسجة الحية.

الكلمات الدالة: السُمنة، الشحمية، المؤشرات الحيوية المحفزة للالتهاب، انترلوكين، بروتين سي التفاعلي.

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