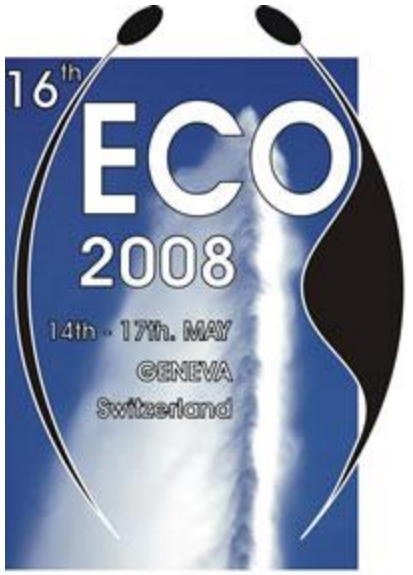
Relationship between White Blood Cell number and Total Body Fat as well as Visceral Fat, in Smoking and Non-smoking subjects.

Chala E, Kapantais E.

Diabetes, Obesity and Metabolism Department, Metropolitan Hospital

Neo Faliro, Athens

Greece



Introduction

Human adipose tissue is characterized by the ability to produce and release inflammatory proteins collectively known as adipokines, such as TNF-a, Interleukin-6, Interleukin-8 and monocyte chemoattractant protein-1. Visceral adipose tissue seems to be more closely associated with the inflammatory state than subcutaneuous adipose tissue, since higher amounts of Interleukin-6, Interleukin-8 and monocyte chemoattractant protein-1 are released from the visceral adipose tissue depot.

In clinical practice, activation of the immune system and inflammation may be detected by an increase in a number of markers. Among them, white blood cell count is undoubtedly not only the easiest to obtain and the least expensive but also the most robust, so that if a relationship could be shown between white blood cells number and obesity, this would further prove the connection of obesity and low-grade inflammation.

Introduction

White blood cells, as markers of inflammation are very sensitive but are not specific, since a number of conditions other than inflammation could lead to an increase in their number: corticosteroid treatment, leukemia and other hematologic disorders, trauma or tissue injury, malignancies, nausea, vomiting, stress of any kind such as excitement, exercise, pain etc. Smoking has also been shown to have an influence on white blood cell count. It is noteworthy that smokers, on average, exhibit an elevated peripheral white blood cell count, about 30% higher than non-smokers.

Aim

Aim of our study was to investigate:

A) The existence of any relationship between white blood cell count, as a marker of low-grade inflammation, and obesity, as expressed by total body fat and by visceral fat.

B) The effect of smoking on this relationship.

Subjects-Methods

For this purpose, we studied retrospectively 582 subjects (247 males and 335 females), all recruited from the Outpatient Clinic of our department. The characteristics of the subjects studied are shown in table 1.

Since white blood cell count is not a specific marker of inflammation,we excluded from the study conditions known to have an influence on White Blood Cells. (table 2). We also excluded persons with White Blood Cells>11.000/mm^3 since our aim was low grade systemic inflammation in otherwise healthy and not overtly stressed of infected subjects.

Subjects-Methods

After an overnight fasting, blood was drawn and anthropometric measurements were performed (table 3).

	Males (247)	Females (335)
Age (years)	47.4 ± 13.7	44.4 ± 13.4
BMI (kg/m^2)	34.5 ± 6.0	33.7 ± 6.5
Smoking (Yes/No)	82/165	135/200

(Table 1: Subjects studied)

- **Medications affecting White Blood Cells**
- **Infections**
- **Liver dysfunction**
- **Sedimentation Rate >40/1h**
- **White Blood Cells >11000/mm^3**
- **Thyroid dysfunction**
- **Type 1 diabetics**
- **Uncontrolled type 2 diabetics**

(Table 2: Exclusion criteria)

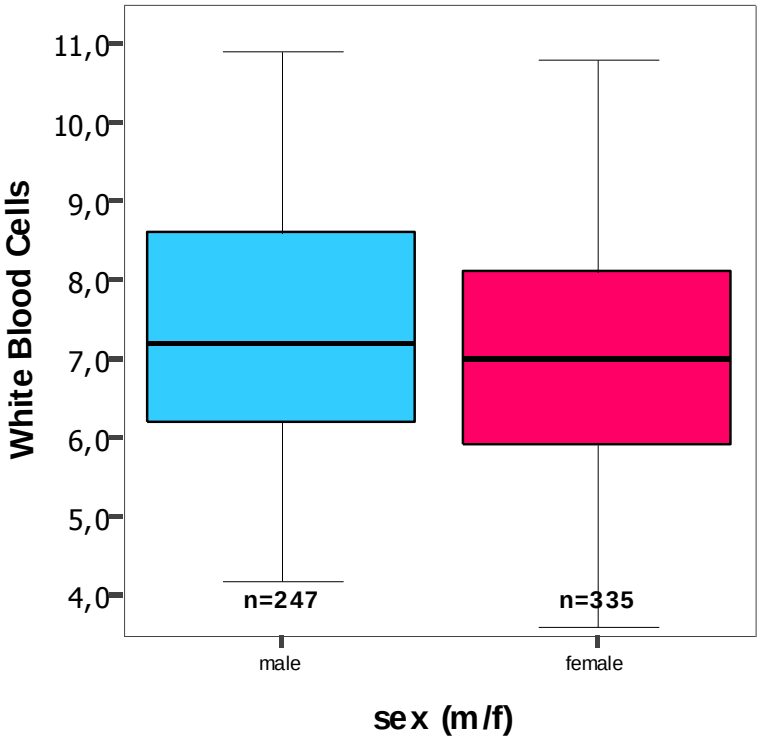
Fasting Blood Measurements	Anthropometric Measurements
Hematology	BMI
Sedimentation Rate	Waist Circumference
Biochemistry	WHR
HbA1c	% Total Body Fat (BIA)
Insulin	Sagittal Abdominal Diameter

(Table 3: Fasting blood measurement and anthropometric measurements)

	Males	Females	p
Age (years)	47.4 ± 13.7	44.4 ± 13.4	***0.008***
BMI (kg/m^2)	34.5 ± 6.0	33.7 ± 6.5	**NS**
Waist Circumference (cm)	114.8 ± 13.1	101.6 ± 13.8	***0.000***
WHR	1.09 ± 0.08	0.93 ± 0.11	***0.000***
Sagittal Abdominal Diameter (cm)	27.18 ± 3.88	24.23 ± 3.83	***0.000***
Total Body Fat % (BIA)	35.94 ±6.46	43.90 ±7.23	***0.000***
Visceral Fat (kg)	7.647 ± 2.647	3.799 ± 1.309	***0.000***
White Blood Cells (x1000/mm^3)	7.39 ± 1.58	7.00 ± 1.50	***0.002***
Hematocrit (%)	45.1 ± 3.2	39.9 ± 3.0	***0.000***
Platelets (x1000/mm^3)	238 ± 51	273 ± 65	***0.000***
Sedimentation Rate (mm/1h)	10.1 ± 8.3	16.3 ± 8.5	***0.000***
Plasma Glucose (mg/dl)	127 ± 51	106 ± 37	***0.000***
Plasma Insulin (µIU/ml)	15.75 ± 12.44	13.23 ± 9.99	***0.02***
HbA_{1c} (%)	6.77 ± 1.81	6.35 ± 1.59	***0.02***
HOMA-IR	4.85 ± 4.07	3.58 ± 3.13	***0.000***

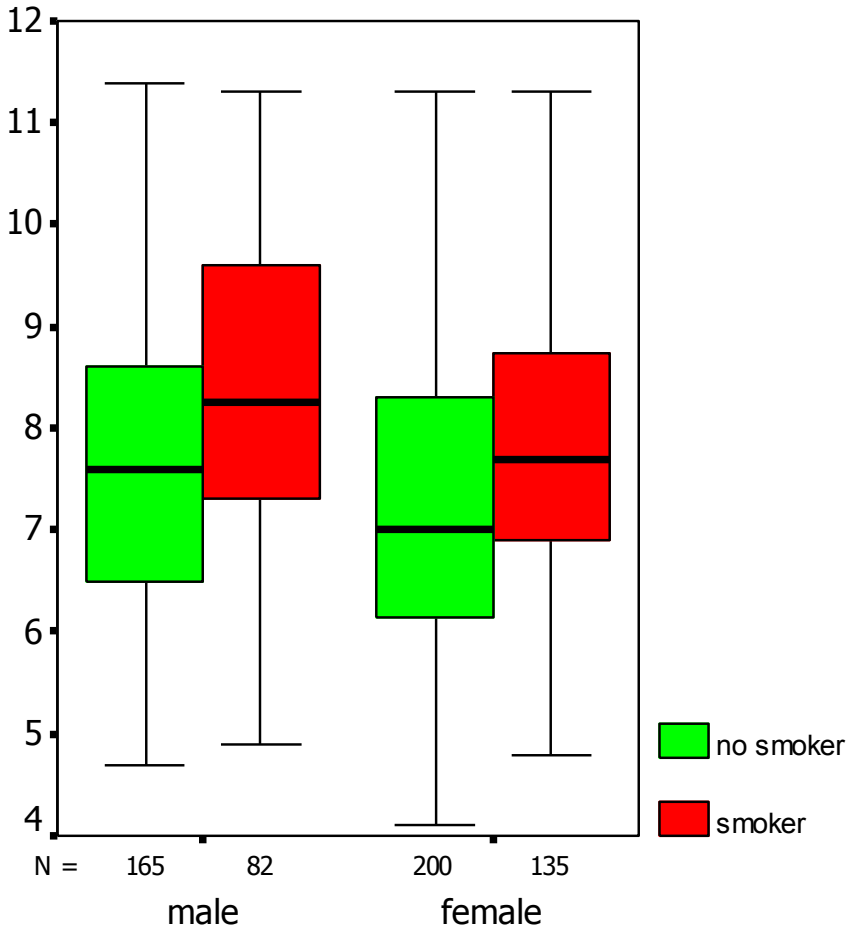
(t-test and non-parametric test were used as appropriate)

Results



Males had higher WBC than females
(7.394 ± 1.584 vs. 6.995 ± 1.495, p=0.002)

Results



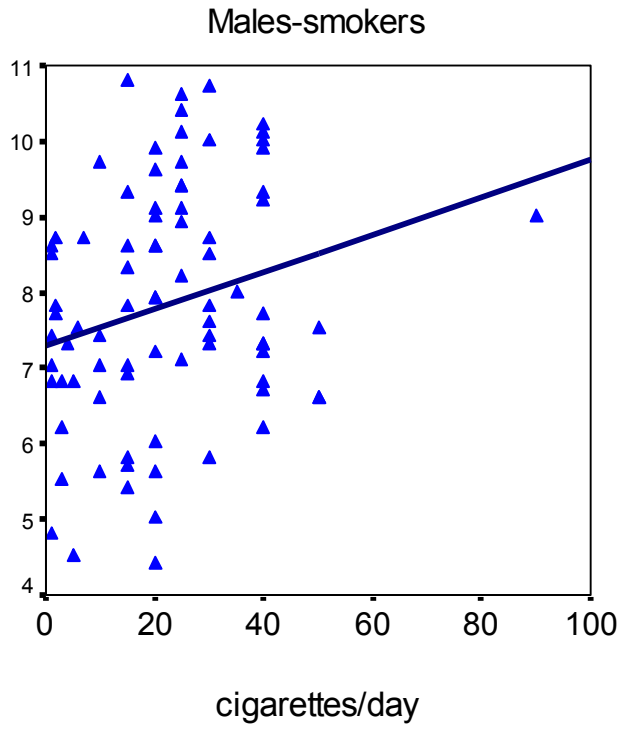
Smokers had higher WBC than non-smokers, in both sexes (Males: 7.849 ± 1.566 vs. 7.168 ± 1.548, p=0.001 Females: 7.321 ±1.353 vs. 6.775 ± 1.549, p=0.001)

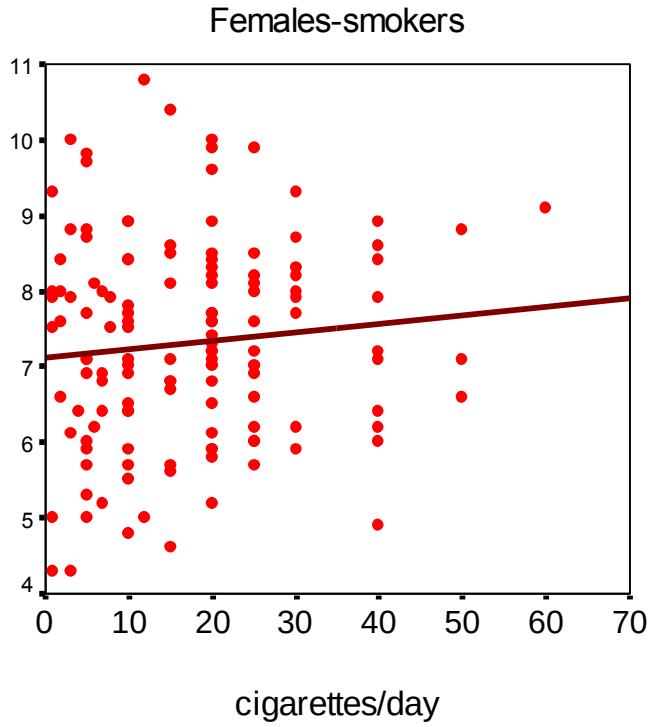
Results

82 out of 247 males and 135 out of 335 females were smokers
(X^2=3.065, p=0.08)

Male smokers were more fanatic than female ones:
Males: 22.23 ± 15.55 cigarettes/day
Females: 17.44 ± 12.40 cigarettes/day
(p=0.028)

Results

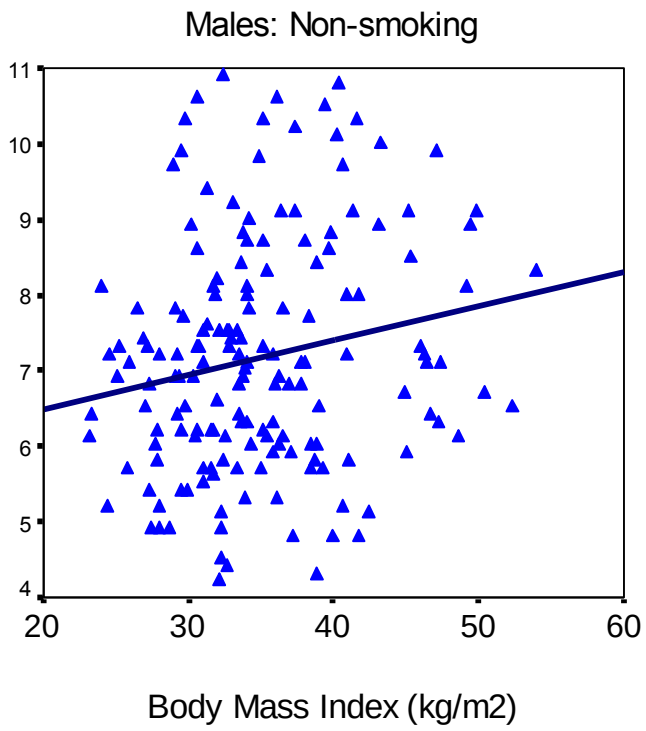


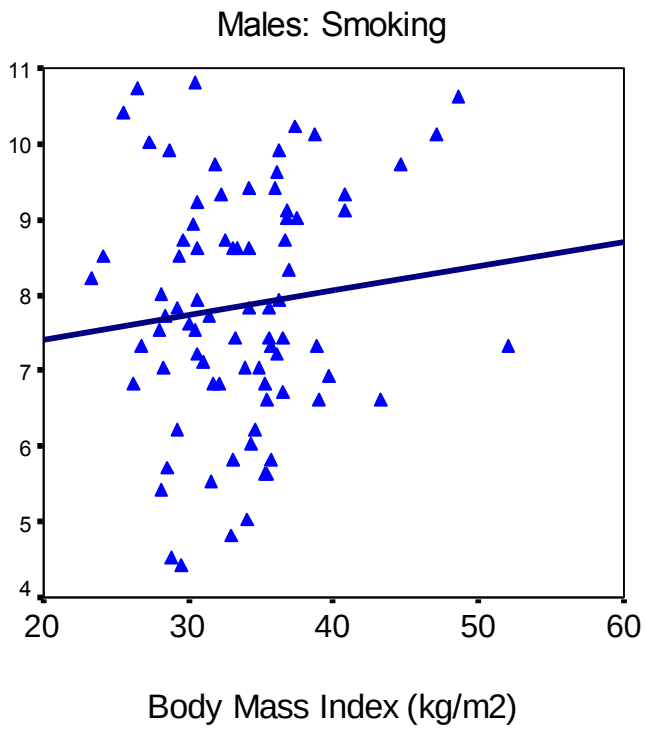


In male smokers, there was a positive relationship between WBC and number of cigarettes per day. (r=0.244, p=0.027)

In female smokers, no relationship was found between WBC and number of cigarettes per day. (r=0.101, p=0.246)

Results

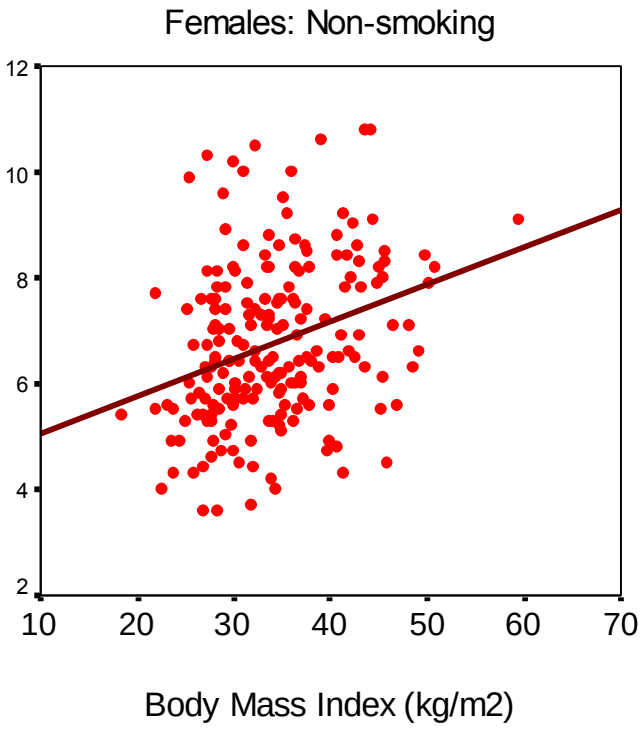


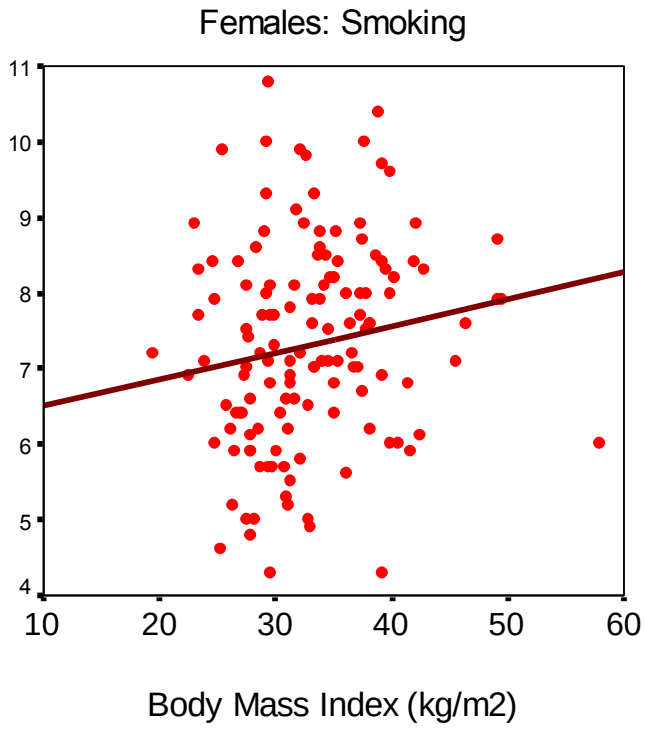


In male non-smokers, there was a positive relationship between WBC and BMI. (r=0.186, p=0.017)

In male smokers, no relationship was found between WBC and BMI. (r=0.110, p=0.326)

Results

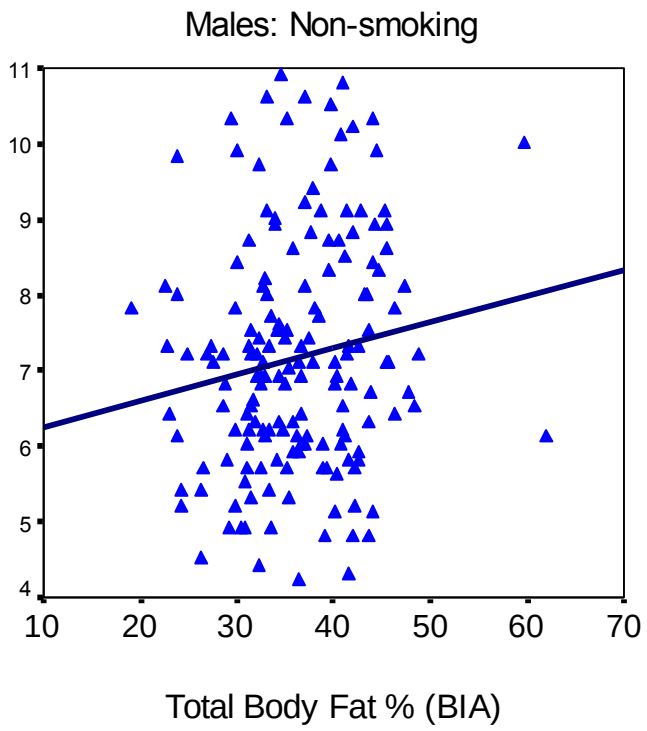


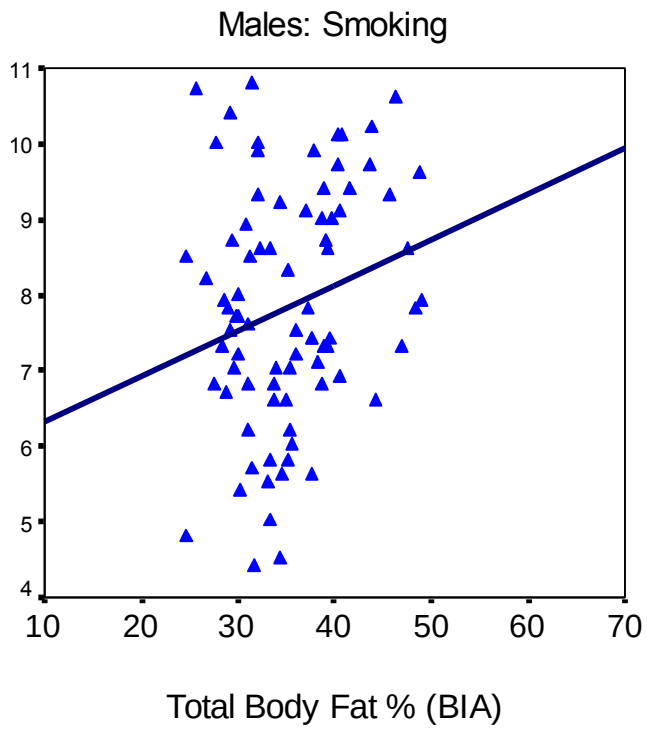


In female non-smokers, there was a positive relationship between WBC and BMI. (r=0.306, p=0.000)

In female smokers, no relationship was found between WBC and BMI. (r=0.162, p=0.061)

Results

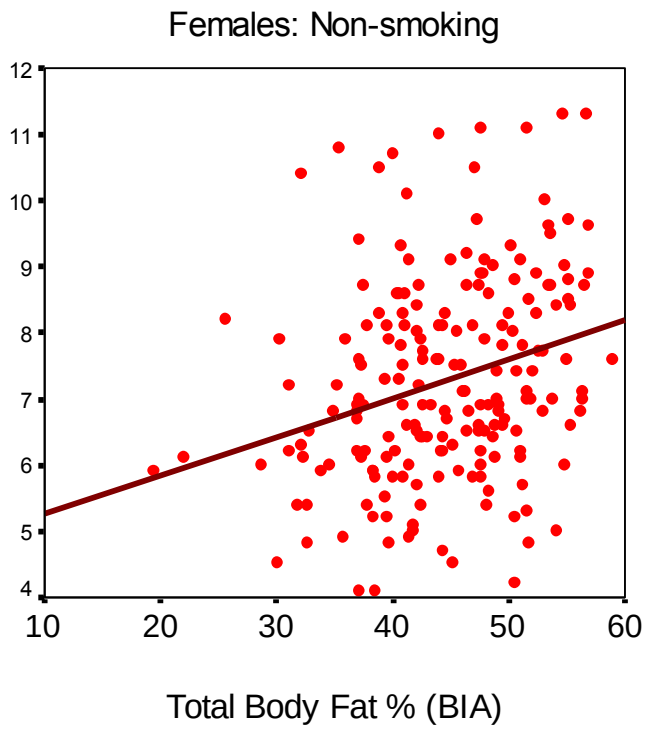


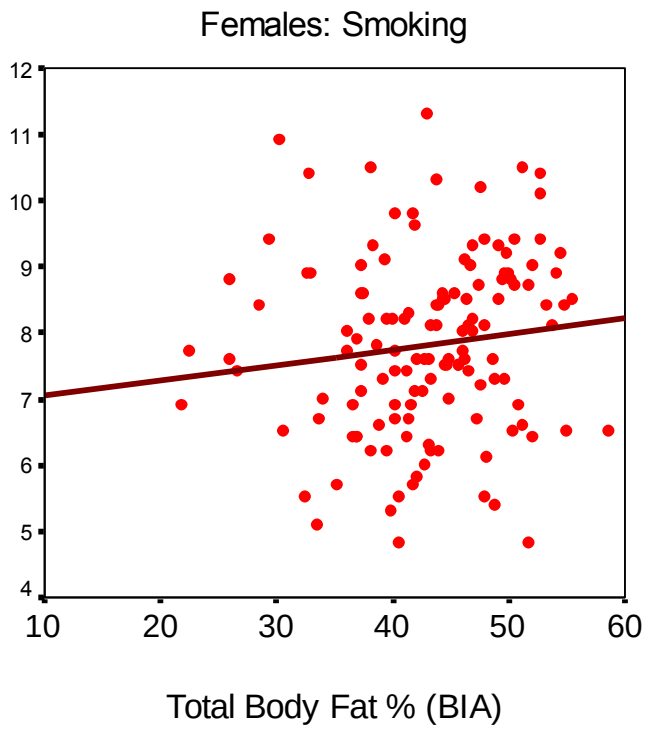


In male non-smokers, there was a positive relationship between WBC and Total Body Fat % (BIA) (r_s=0.156, p=0.045)

In male smokers, no relationship was found between WBC and Total Body Fat % (BIA). (r_s=0.211, p=0.058)

Results

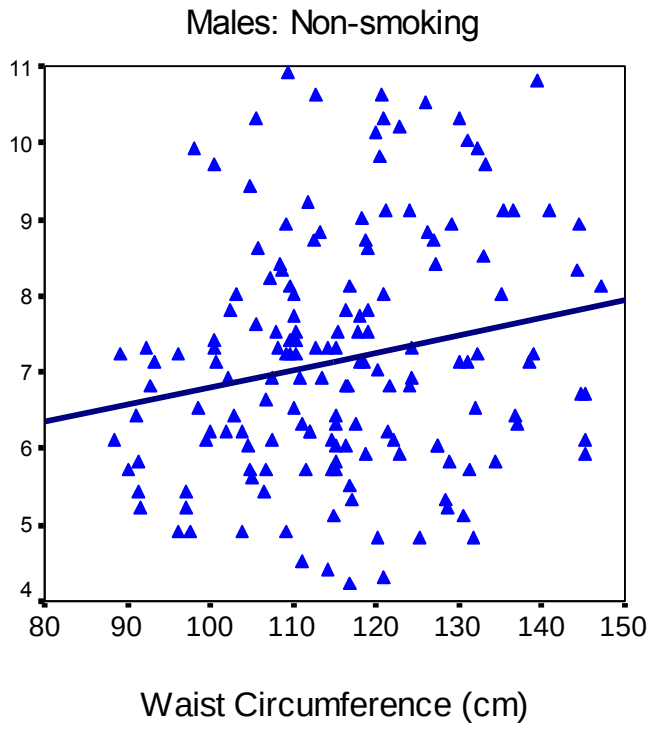


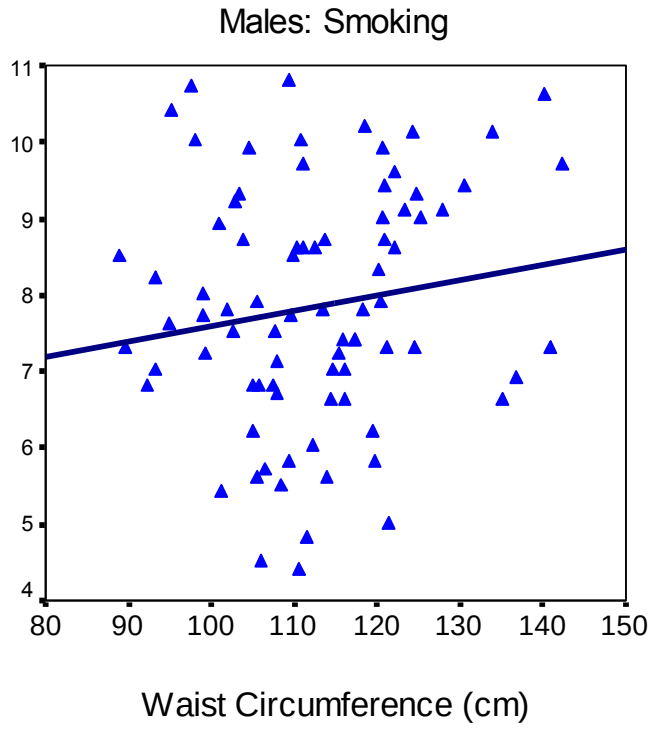


In female non-smokers, there was a positive relationship between WBC and Total Body Fat % (BIA). (r=0.288, p=0.000)

In female smokers, there was a positive relationship between WBC and Total Body Fat % (BIA). (r=0.180, p=0.037)

Results

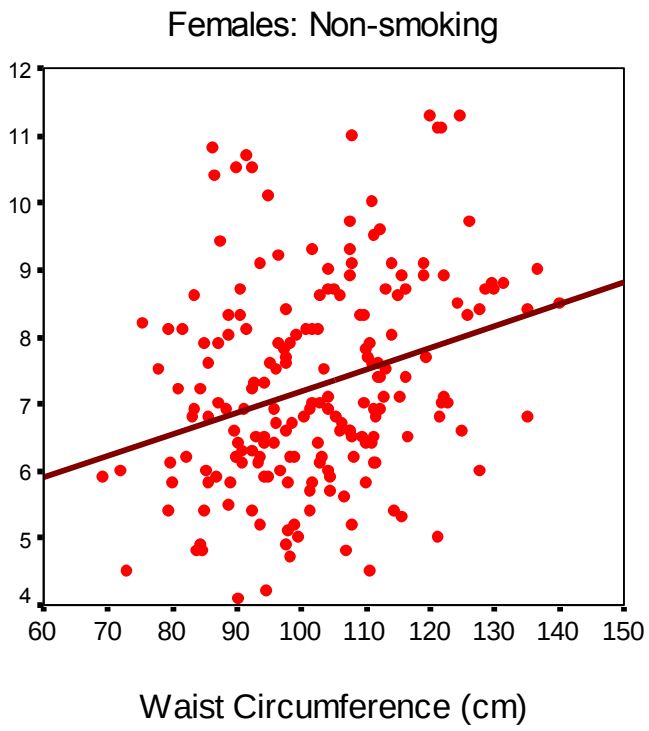


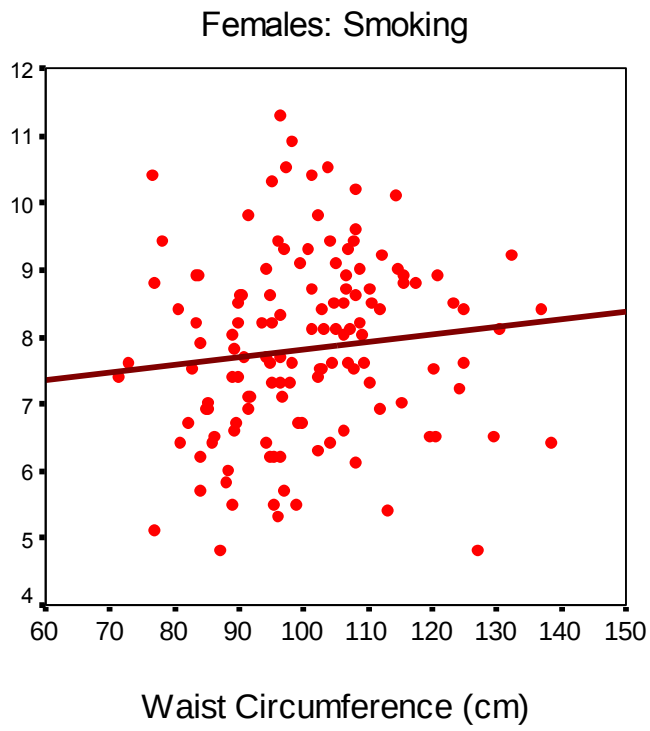


In male non-smokers, there was a positive relationship between WBC and Waist Circumference (r=0.198, p=0.012)

In male smokers, no relationship was found between WBC and Waist Circumference. (r=0.151, p=0.176)

Results

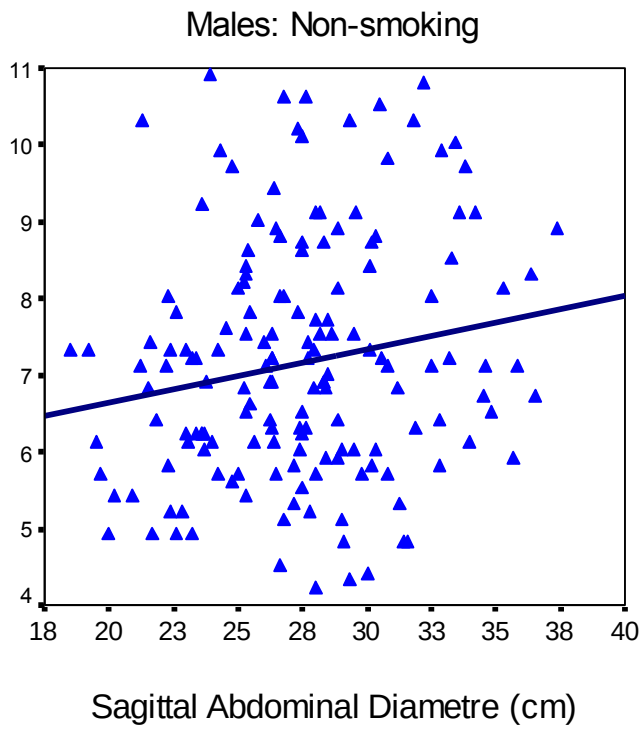


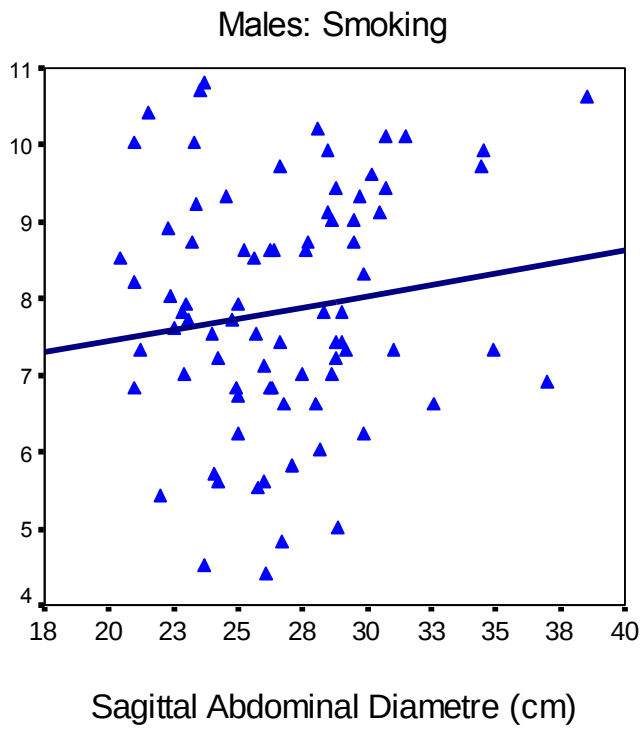


In female non-smokers, there was a positive relationship between WBC and Waist Circumference. (r=0.291, p=0.000)

In female smokers, no relationship was found between WBC and Waist Circumference. (r=0.112, p=0.201)

Results

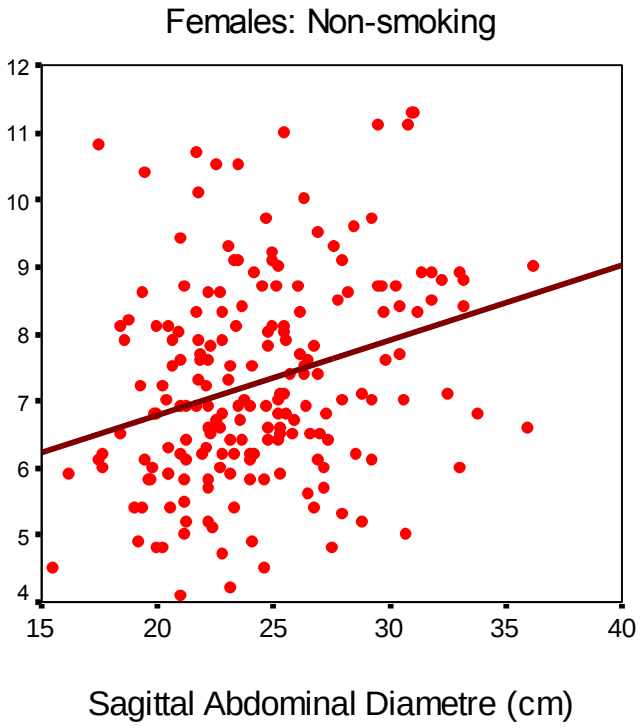


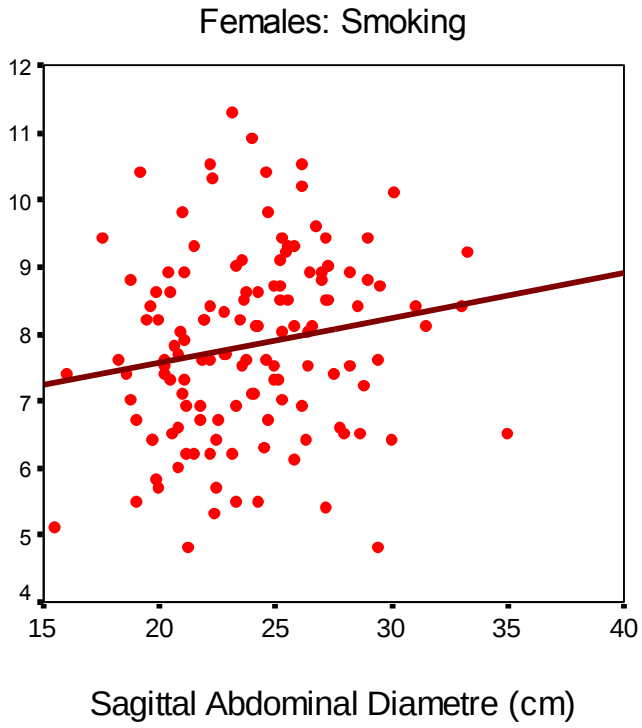


In male non-smokers, there was a positive relationship between WBC and Sagittal Abdominal Diameter (r=0.177, p=0.025)

In male smokers, no relationship was found between WBC and Sagittal Abdominal Diameter. (r=0.141, p=0.206)

Results

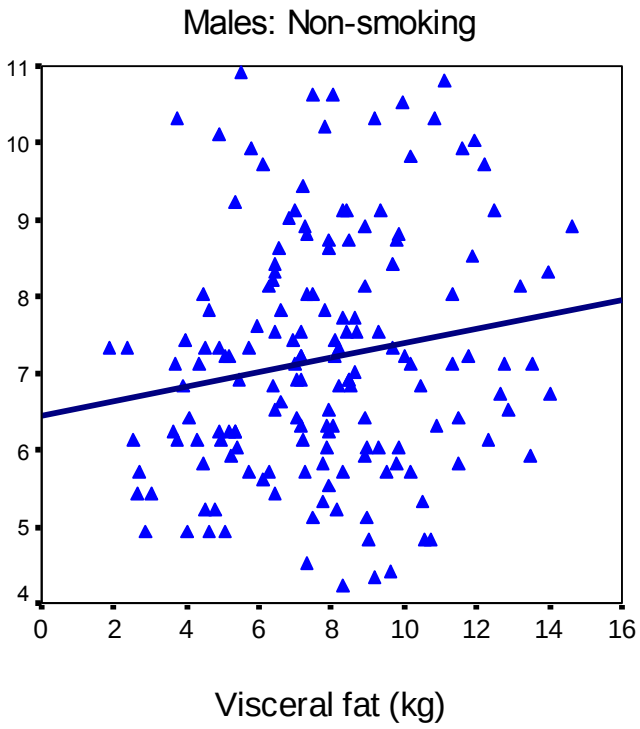


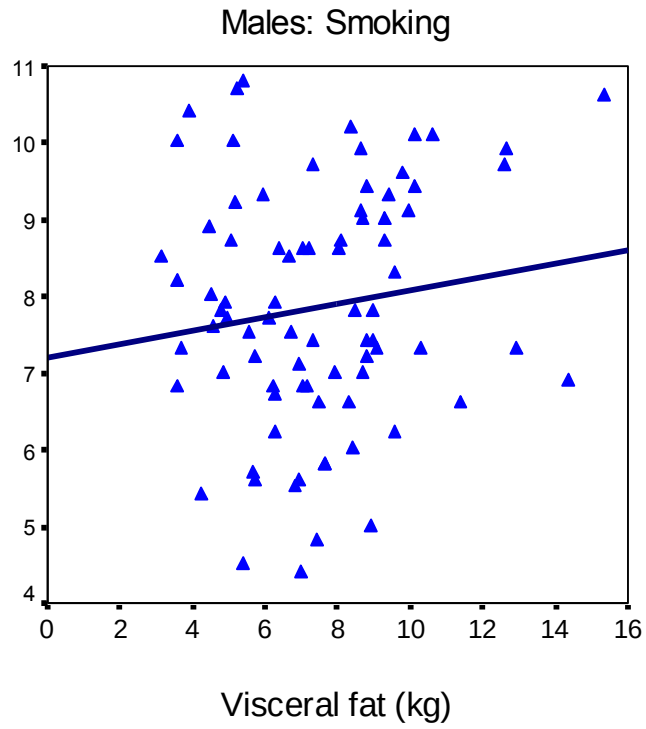


In female non-smokers, there was a positive relationship between WBC and Sagittal Abdominal Diameter (r=0.289, p=0.000)

In female smokers, there was a positive relationship between WBC and Sagittal Abdominal Diameter (r=0.177, p=0.042)

Results

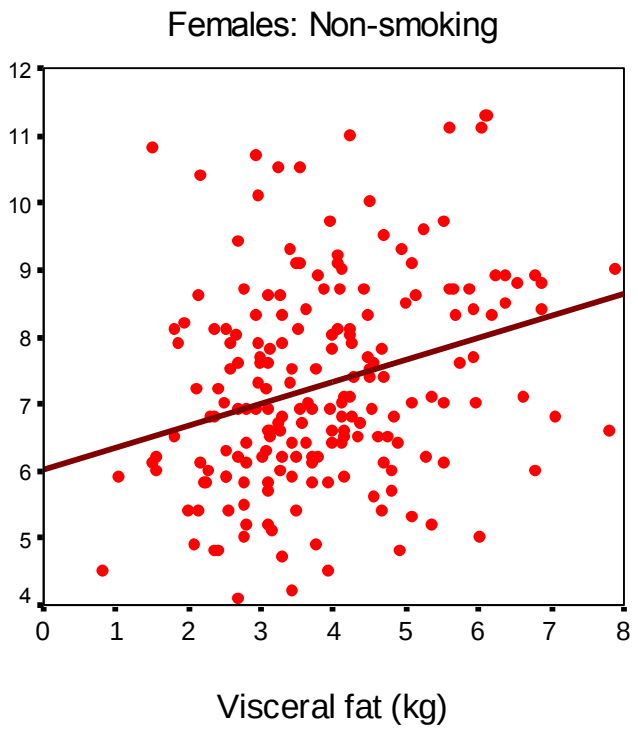


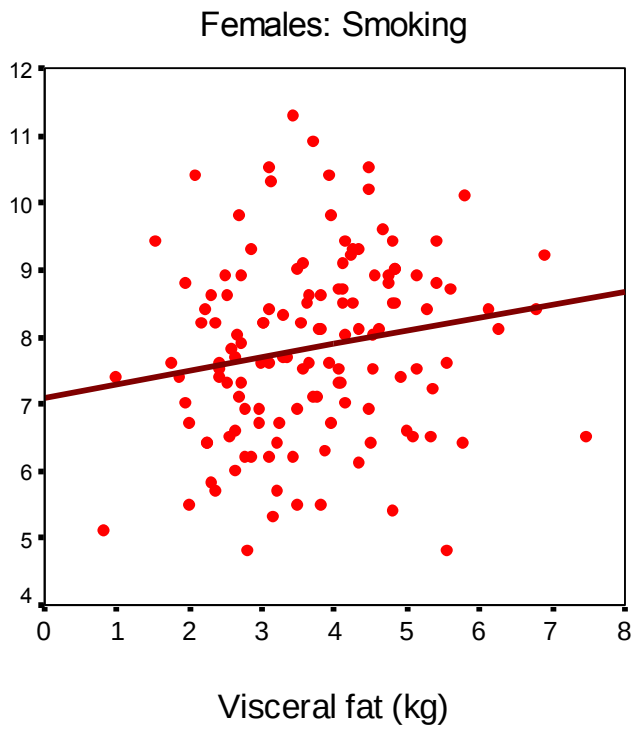


In male non-smokers, there was a positive relationship between WBC and kg of Visceral Fat. (r=0.164, p=0.038)

In male smokers, no relationship was found between WBC and kg of Visceral Fat. (r=0.141, p=0.206)

Results

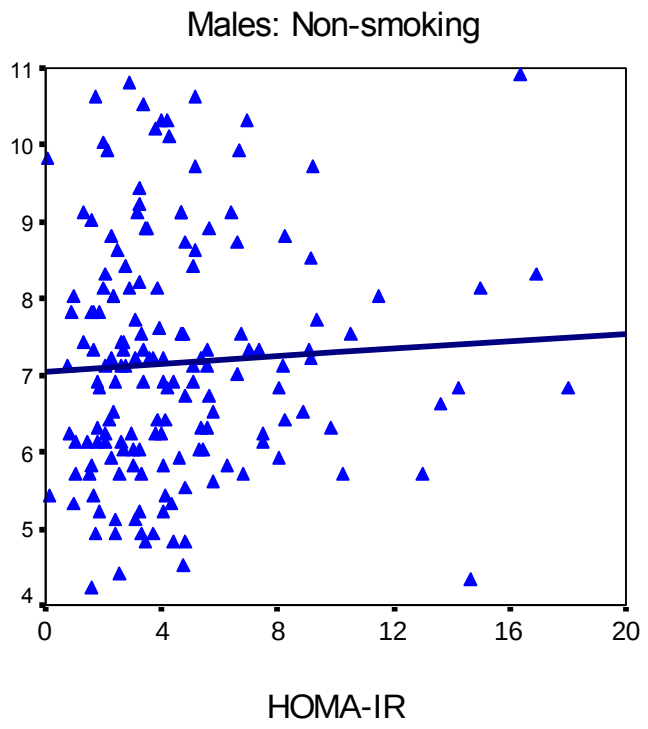


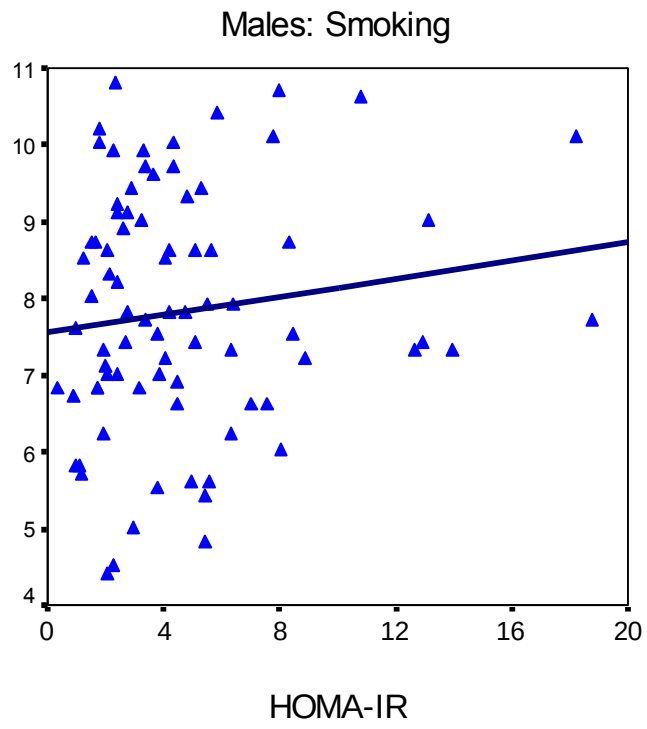


In female non-smokers, there was a positive relationship between WBC and kg of Visceral Fat. (r=0.288, p=0.000)

In female smokers, there was a positive relationship between WBC and kg of Visceral Fat. (r=0.177, p=0.042)

Results

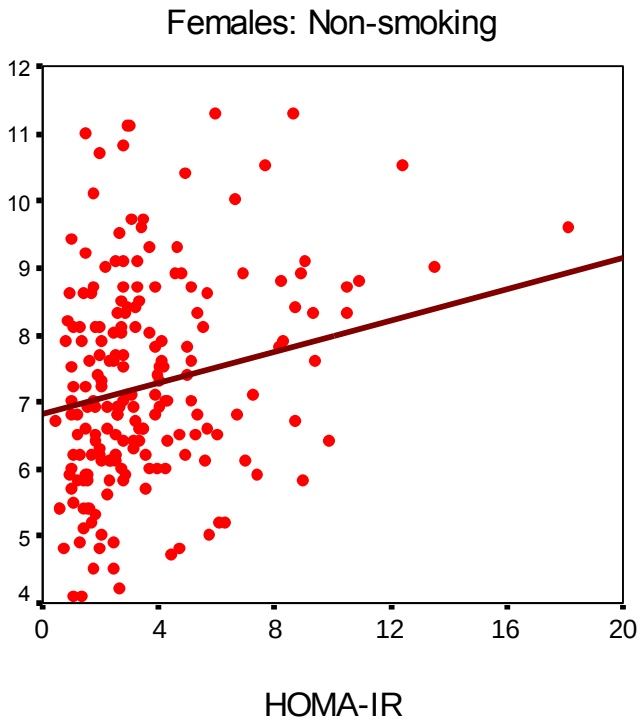


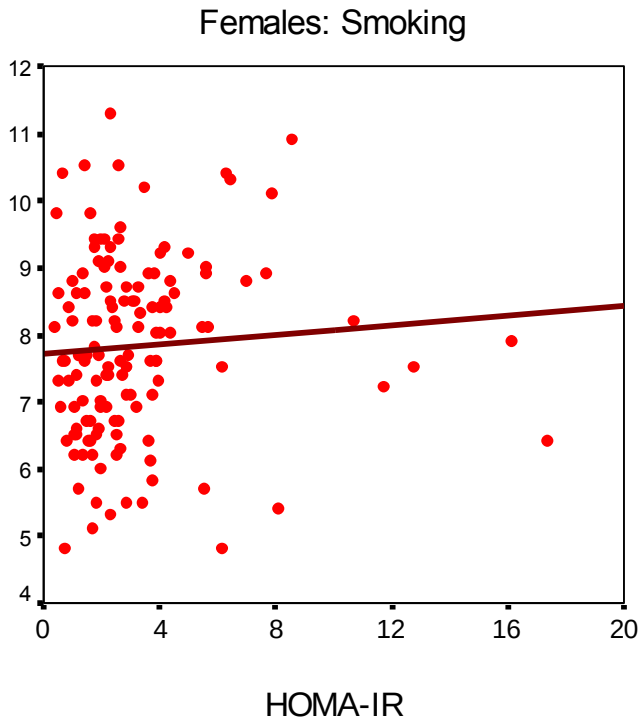


In male non-smokers, no relationship was found between WBC and HOMA-IR. (r_s=0.080, p=0.308)

In male smokers, no relationship was found between WBC and HOMA-IR. (r_s=0.123, p=0.271)

Results





In female non-smokers, there was a positive relationship between WBC and HOMA-IR. (r_s=0.285, p=0.000)

In female smokers, no relationship was found between WBC and HOMA-IR. (r_s=0.161, p=0.063)

Results

Multiple regression analysis

(Dependent variable: White Blood Cell count)

Males

R=0.277, R square=0.077, F=9.979, p=0.000

Smoking (no/yes): beta=0.217, p=0.001
% Total Body Fat (BIA): beta=0.189, p=0.003

Females

R=0.401, R square=0.161, f=20.683, p=0.000

Age: beta= -0.270, p=0.000
Smoking (no/yes): beta=0.166, p=0.001
Sagittal Abdominal Diameter: beta=0.306, p=0.000

Conclusions

- **Smoking is an important inducer of low grade systemic inflammation as expressed by WBC, mainly in males.**
- **In non-smoking males as well as in smoking and non-smoking females, WBC are related to obesity and more importantly to its distribution as it is expressed by sagittal abdominal diameter and by kg of visceral fat.**

Discussion

Smoking seems to be a very important inducer of low-grade systemic inflammation. It has been proposed that nicotine-induced catecholamine release might be the mechanism for this effect. Other studies support the hypothesis that cigarette smoking causes bone marrow stimulation, probably through proinflammatory factors released from alveolar macrophages, such as TNF-a, IL-1, IL-8 and granulocyte-macrophage colony stimulating factor. It is of note that the same relationship between smoking and increased leukocyte count has been shown in adolescents, indicating that there appears to be a rapid effect of smoking on white blood cells count that is unlikely to be due to smoking induced chronic disease as seen in adult smokers.

Discussion

Despite the fact that in our study, there was a higher percentage of smokers between women than in men, in men, who are more fanatic smokers, smoking overwhelms obesity when it comes to low-grade inflammation.
Women, who are more amateurs when it comes to smoking, retain the relationship between low-grade systemic inflammation as expressed by White Blood Cells, and obesity, especially of central distribution, irrespectively of smoking status.

Suggested Bibliography

- Lidia Arcavi, Neal L. Benowitz. Cigarette smoking and infection. Arch Intern Med 2004;164:2206-2216
- Marjolein Visser et al. Elevated c-reactive protein levels in overweight and obese adults. JAMA 1999;282:2131-2135
- Barbora Vozarova et al. High white blood cell count is associated with a worsening of insulin sensitivity and predicts the development of type 2 diabetes. Diabetes 2002; 51:455-461
- Stuart P. Weisberg et al. Obesity is associated with macrophage accumulation in adipose tissue. J Clin Invest; 112:1796-1808
- Desai MY et al. Association of body mass index, metabolic syndrome and leukocyte count. Am J Cardiol 2006; 97:865-868.
- Pratley RE et al. Relation of the white blood cell count to obesity and insulin resistance: effect of race and gender. Obesity Research 1995; 3:563-571