ÖZGÜN ARAŞTIRMA/ORIGINAL ARTICLE

Sağlıklı İnsanlarda Vücut Kitle İndeksi ile Sedimantasyon Arasındaki İlişki

Correlation Between Body Mass Index and Erythrocyte Sedimentation Rates in Healthy Participants

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ÖZ

Amaç: Uzun yıllardır kullanılan ucuz, kolay ve hızlı bir test olan sedimantasyon hala birçok durumda tanıya yardımcı olmaktadır. Bu çalışmada, sağlıklı bireylerde sedimantasyon, kolesterol değerleri ve monosit yüksek dansiteli lipoprotein oranı (MHR) ile vücut kitle indeksi arasındaki ilişki değerlendirilmiştir.

Gereç ve Yöntem: Ocak 2020 ile Aralık 2020 tarihleri arasında; iç hastalıkları kliniğine belirgin şikayeti olmadan, rutin sağlık kontrolü ve check-up için başvuran 689 sağlıklı bireylerin sonuçları retrospektif olarak değerlendirilmiştir. Hastaların demografik özellikleri, vücut kitle indeksi ve kan parametreleri değerlendirilmiştir. Katılımcılar; vücut kitle indeksine göre; Grup 1 (normal kilolu), Grup 2 (aşırı kilolu) ve Grup 3 (obez) olarak sınıflandırılmıştır.

Bulgular: Gruplar arasında; vücut kitle indeksi ile; boy, kilo, sedimantasyon değeri, glikoz, monosit sayısı, total kolesterol, düşük dansiteli lipoprotein, yüksek dansiteli lipoprotein dışı kolesterol ve MHR arasında anlamlı bir ilişki saptanmıştır. Kadınların sedimantasyon değeri erkeklerden anlamlı olarak fazla saptanmıştır. Vücut kitle indeksi ile sedimantasyon değeri (r=0.346, p=0.001), glikoz (r=0.239, p=0.001) ve monosit sayısı (r=0.096, p=0.013) arasında anlamlı bir korelasyon bulunmuştur.

Sonuç: Bu çalışmanın neticelerine göre sedimantasyon hızı sağlıklı bireylerde VKI ile ilişkili bir parametre olarak sağlıklı bireylerde inflamasyon şiddetini göstermek için kullanılabilir. Sedimantasyon değeri yüzyıl önce bulunmasına rağmen kullanışlılığını devam ettirmektedir.

ABSTRACT

Objective: Erythrocyte sedimentation rate (ESR) is a cheap, fast, and readily available test. It is still being used for many medical conditions to help diagnose and evaluate diseases. This study inspected the association of ESR, cholesterol levels, and monocyte to high-density lipoprotein ratio (MHR) with body mass index in healthy populations.

Material and Method: This study is an observational, retrospective study. It has been conducted in a university hospital with people admitting to internal medicine outpatient clinics between January 2020 and December 2020. Demographic characteristics, body mass indexes, and laboratory parameters of 689 patients were evaluated. Participants were divided into three groups according to body mass indexes; Group 1 (normal weight), Group 2 (overweight), Group 3 (obese). Data obtained from three groups were compared.

Results: There were significant associations between body mass index and height, weight, ESR, glucose, monocyte counts, total cholesterol, low-density lipoprotein, Non-HDL cholesterol, and MHR among groups. ESR was significantly higher in women compared to men. There were significant correlations between body mass index and ESR (r=0.346, p=0.001), glucose (r=0.239, p=0.001) and monocyte count (r=0.096, p=0.013).

Conclusion: According to the results of this study, ESR is a parameter associated with BMI, and it may reflect the magnitude of inflammation taking place in obesity.

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Introduction

Erythrocyte sedimentation rate (ESR) is determined by measuring aggregation of cellular components of blood sample in a vertically placed test tube containing anticoagulants in one hour and is reported as millimeters/hour. It has been used for many years and is still an important and usable inflammatory marker in many conditions (1). ESR is directly affected by acute phase reactant proteins circulating in the blood (2). Proteins related to inflammation, such as fibrinogen and immunoglobulins, decrease negative electrically repulsive charge at the surface of erythrocytes and increase ESR (3). Inflammatory cytokines are reported to be increased in obesity (4). Inflammation in obese patients results in an increase in fibrinogen and immunoglobulin levels (5,6). These proteins increase ESR (7). Thus, it has been presumed that obesity and inflammation have associations.

ESR increases in many conditions. In a study with older people, ESR was significantly higher in participants with high cholesterol levels (8). An association between body mass index (BMI) and ESR has been reported previously in patients with diabetic polyneuropathy (9). Monocyte counts were reported to be elevated in obese people (10). Monocyte to high-density lipoprotein ratio (MHR) and ESR is being used to reflect the magnitude of inflammation. These values were higher in patients with metabolic syndrome than people who do not have metabolic syndrome (11). MHR was also reported to be high in patients with polycystic over syndrome (12). Association between BMI and MHR and ESR in healthy populations was not sufficiently inspected previously.

Cholesterol levels increase as the body mass index of relevant people increases (13). A study reported that non-high-density lipoprotein levels (non-HDL) increase as BMI increase (14). The association between BMI and cholesterol levels in the healthy population is not clear yet.

The purpose of this study is to evaluate the association between BMI and lipid parameters [High-density lipoprotein (HDL), low-density lipoprotein (LDL), triglycerides and total cholesterol levels], ESR, and MHR in the healthy population.

Material and Method

This study was conducted in a tertiary university hospital with 689 participants admitted to internal medicine outpatient clinics and had an observational retrospective design. Participants who did not have any active complaints and were admitted to the hospital for annual routine occupational examinations or check-ups between 1 January 2020 and 31 December 2020 were evaluated. People who accepted to participate in the study were enrolled and patients who had the previous history of hypertension, diabetes mellitus, coronary artery disease, chronic obstructive pulmonary diseases, renal or hepatic failures, active infectious diseases, rheumatic diseases, malignancies, who were using antihyperlipidemic medications and people who were under 18 years age were excluded. This study was approved by Lokman Hekim University Non-Interventional Clinical Research Ethics Committee (App. No: 2021/032) and conducted in compliance with the Declaration of Helsinki and good clinical practices updates.

Participants' demographic characteristics; age, gender, height, weight measurements were recorded at admission, laboratory parameters ESR, glucose, HDL, LDL, triglycerides, total cholesterols levels were analyzed after blood samples were taken, and MHR was calculated after obtaining related results; all data were recorded. Non-HDL cholesterol was calculated by subtraction of HDL value from total cholesterol value. BMI was calculated by the division of body weight in kilograms to the square of body height in meters. Participants were divided into three groups according to BMI values; Group 1 (normal weight); 19-<25, Group 2 (overweight); 25-30 and Group 3 (obese); 30 and over. ESR and cholesterol levels may be directly affected by the age and gender of participants. For this reason, participant distribution in groups was tried to be balanced, and groups similar in means of age and gender were tried to be constituted.

Blood samples were obtained after 12 hours of fasting. Complete blood counts were analyzed using an XN-1000 analyzer (USA). Glucose, LDL, HDL, triglycerides, and total cholesterol levels were analyzed by Roche Hitachi Cobas 501 (Switzerland) device. Erythrocyte sedimentation rates were measured automatically using the Biosed 100 (Italy) device in blood sample tubes.

Statistical Analysis

SPSS for Windows 25.0 statistical software package (SPSS Inc., Armonk, NY, USA) was used for statistical analysis of the data. Data distributions or normality tests were evaluated by the Shapiro-Wilk test. Data were presented as mean ± standard deviation for normally distributed variables, as median (minimum-maximum) for non-normal distributed variables. The comparisons between groups were evaluated by One Way ANOVA tests. Associations between data were inspected by the Pearson correlation test. P values below 0.05 were considered significant.

Results

A total of 689 participants was enrolled, and 432 (62.6%) were males, and 257 (37.4%) were females. The average age of participants was 39.39±10.72 (males 39.40±10.60 and females 39.38±10.93). Demographic characteristics and laboratory parameters of participants are shown in Table 1. Mean ESR for men was 10.80±8.52 mm/hr and 18.17±11.56 mm/hr for women (*p*=0.001). The mean BMI value of men was 26.84±4.02, and women's was 28.31±6.25 (*p*=0.001). The number of participants in Group 1 was 247 (35.8%), Group 2 was 248 (35.9%), and Group 3 was 194 (28.3%).

There were significant differences between BMI and height, weight, ESR, glucose, monocyte counts, total cholesterol, LDL, Non-HDL cholesterol, and MHR between groups in healthy participants in this study. Comparison of data about demographic characteristics and laboratory parameters are shown in Table 2.

Table 1. Demographic characteristics and means of laboratory parameters of participants.

Parameters	Mean ± Standard Deviation
Age (years)	39.39±10.72
Height (meter)	1.72±0.10
Weight (kilograms)	81.15±15.46
Body mass index (kg/m^2)	27.39±5.02
Glucose (mg/dL)	96.23±15.94
Hemoglobin (g/dL)	14.73±1.71
Mean Platelet volume (μm^3)	10.25±0.88
Monocytes (x10^9/L)	0.57±0.18
Erythrocyte sedimentation rate (mm/h)	13.55±10.38
Total Cholesterol (mg/dL)	184.59±40.49
Low density lipoprotein (mg/dL)	109.09±35
High density lipoprotein (mg/dL)	49.75±19.76
Triglycerides (mg/dL)	139.08±93.43
Non HDL Cholesterol (mg/dL)	134.84±42.60
Triglyceride/High density lipoprotein ratio	3.27±2.99
Monocyte/High density lipoprotein ratio	0.125±0.052
Non HDL Cholesterol/HDL ratio	3.00±1.40

Table 2. Comparison of demographic characteristics and laboratory parameters of participants according to BMI.

Parameter	Normal weight (n=247)	Overweight (n=248)	Obese (n=194)	p value
Age (years)	38.32±11.54	40.10±9.36	43.98±11.19	0.142
Height (meter)	1.74±0.09	1.72±0.09	1.70±0.10	<0.001
Weight (kilograms)	69.92±10.23	79.84±9.24	97.11±13.79	<0.001
Mean Platelet volume (μm^3)	10.26±0.85	10.21±0.91	10.30±0.88	0.543
Monocyte count (x10^9/L)	0.55±0.18	0.58±0.16	0.60±0.19	0.009
Erythrocyte sedimentation rate (mm/h)	9.85±9.09	13.80±7.66	17.95±12.92	<0.001
Glucose (mg/dL)	93.29±10.03	95.61±14.10	100.74±22.17	<0.001
Total Cholesterol (mg/dL)	185.26±37.70	188.81±42.59	178.34±40.60	0.025
Low density lipoprotein (mg/dL)	109.81±32.77	113.06±36.88	103.10±34.63	0.011
High density lipoprotein (mg/dL)	51.26±27.74	48.40±12.66	49.54±14.19	0.270
Triglycerides (mg/dL)	132.24±73.98	148.23±114.35	136.09±85.01	0.142
Monocyte/High density lipoprotein ratio	0.116±0.0047	0.127±0.0050	0.131±0.0061	0.009
Non-HDL Cholesterol (mg/dL)	134±41.31	140.42±43.71	128.79±42.10	0.016
Triglyceride/HDL ratio	3±2.29	3.5±3.41	2.92±1.63	0.165
Non-HDL Cholesterol/HDL ratio	2.91±1.17	3.16±1.41	2.92±1.63	0.085

There were significant correlations between BMI and ESR (r=0.326, p=0.001), glucose levels (r=0.239, p=0.001) and monocyte count (r=0.096, p=0.013) but there were no correlation between BMI and MHR (r=0.055, p=0.204). Correlations were shown in Figure 1a, 1b, 1c.

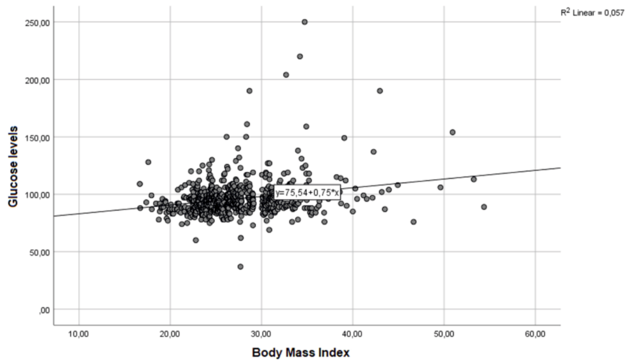

Figure 1a. Correlations between BMI and glucose levels.

Figure 1b. Correlations between BMI and monocyte counts.

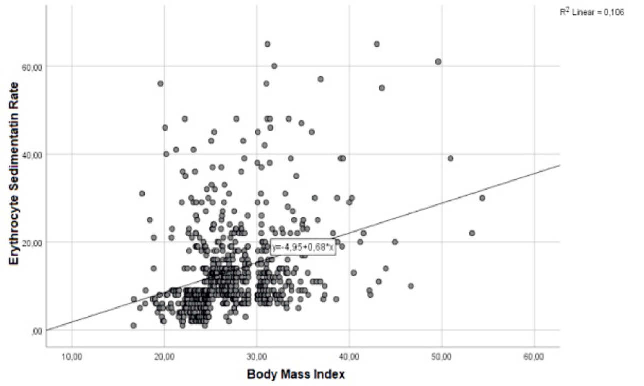

Figure 1c. Correlations between BMI and ESR, glucose levels and monocyte counts.

Discussion

In this study, as BMI increased, glucose, monocyte counts, ESR, and monocyte/HDL ratios were also found to be increasing. There were significant correlations between BMI and ESR, glucose, and monocyte count levels. When effects of age and gender are negated, increase in BMI was most associated with increased ESR levels.

It has been reported that obesity causes a low level but persistent inflammation (15). ESR is a general tool for evaluating the acute phase; it may help predict the magnitude of inflammation and may be used in many conditions, including rheumatic diseases (16). An association between ESR and enhancement in erythrocyte aggregation in obese patients was reported before, and this association was found to be independent of cholesterol levels (17). Obesity, with increased adipose tissue, results in a pro-inflammatory condition because of secreted cytokines and adipokines from activated immune system cells such as macrophages and lymphocytes (18). Cytokines, tumor necrosis factor-alpha, and interleukin-6 secreted from adipocytes were accused of the pro-inflammatory condition in adipose tissue (19). As a result of inflammatory cytokines, acute phase reactants such as ESR will increase (20). In a study with 10745 patients, ESR and inflammatory markers were elevated, related to increasing BMI (21). Interestingly, when obese people lose weight, inflammatory cytokine levels decrease (22). In this study, ESR values of participants were found to be increased with increasing BMI values, and the highest ESR values were recorded in the obese group, and these participants are expected to have concomitant inflammation. This finding is concordant with previous studies (15-19).

In a study, the relationship between erythrocyte aggregation and insulin resistance and glucose levels was reported. This relationship was found to be resulted from emerging acute phase reactants in response to inflammation (23). Similarly, this study also reveals the highest glucose levels in obese participants, and there is a significant correlation between BMI and glucose levels.

Monocytes are activated with inflammatory conditions, and by releasing cytokines, they aggravate inflammation (24). A study from Germany reported that monocyte counts were increasing in obese people (10). MHR is increased in inflammatory conditions like polycystic over syndrome (12). Also, the ratio of MHR was previously reported to be related to metabolic syndrome and obesity (25). In this study, there was an association between monocyte counts and MHR, but there was no association between BMI and HDL.

ESR was reported to be higher in females compared to males. Thus, laboratory normal values were determined differently according to gender, higher in females (26). This study is congruous and female participants had higher ESR values.

A study reported that non-HDL levels increase with increasing BMI values (14). In a study with diabetic patients, LDL and total cholesterol levels were higher in overweight patients than patients with normal weight and obese patients (27). This study also reports highest non-HDL, LDL, and total cholesterol levels in the overweight group, similarly. Lipid profiles of overweight were worse than obese patients, which reminds obesity paradox. In previous studies, the obesity paradox was explained by the uneven distribution of fat throughout the body; for this reason, lean body mass and fat mass may be considered for better evaluation of BMI (28).

This study has some limitations. It has a retrospective design. In all participants, inflammatory parameters other than ESR, monocyte counts, MPV, and MHR were not evaluated. Confounding factors, such as diet and socioeconomic status of participants, were not considered in the evaluation of hyperlipidemia and obesity. Also, waist circumference and waist to hip circumference ratios were not available in every participant. Thus metabolic syndrome could not be evaluated.

Conclusion

This reported study reveals associations between BMI and ESR, glucose, monocyte counts, and MHR. BMI was most associated with increased ESR. As the oldest and widely used one of these parameters, ESR is correlated with BMI and is an effective tool to evaluate inflammation. In people who do not have concomitant diseases, there is a need for further studies about factors affecting erythrocyte aggregation and changes in ESR value.

Yazarlık katkısı: Fikir/Hipotez: RA Tasarım: RA, MBK, KSY Veri toplama/Veri işleme: RA, MBK, KSY Veri analizi: RA, MBK, KSY Makalenin hazırlanması: RA, MBK, KSY Makalenin kontrolü: RA, MBK, KSY.

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