**THE RELATIONSHIP BETWEEN WAIST CIRCUMFERENCE, BODY MASS INDEX AND CORONARY ARTERY DISEASE IN PATIENTS WITH METABOLIC SYNDROME**

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|  | ***Abstract*** |
| ***Keywords:*** *Abdominal obesity, Waist circumference, Metabolic syndrome, Body mass index.* | **Objective:** Nowadays, with increasing incidence, metabolic syndrome has become an important health problem, because of high morbidity and mortality related to a strong relationship with coronary artery disease. Body mass index and waist circumference are anthropometric measurements that are being used to define obesity; a component of the metabolic syndrome. In this study, we aimed to investigate the relationship between body mass index, waist circumference and coronary artery disease and also diabetes mellitus and dyslipidemia which are accepted as major coronary artery disease risk factors in patients with metabolic syndrome.  **Design, Setting, Subjects:** There were 316 metabolic syndrome patients. We registered patients’ age, sex, waist circumference, body mass index, fasting glucose, triglyceride, HDL, LDL levels, history of diabetes mellitus and coronary artery disease and also ECG findings. We analyzed these findings using four different metabolic syndrome diagnostic criteria that are published by: NCEP ATPIII (2001), IDF (2005), WHO (1999), and Society of Endocrinology and Metabolism in Turkey(2009).  **Results:** Coronary artery disease was found in 66 (%20, 8) of our patients. We analyzed the relationship between coronary artery disease and metabolic syndrome parameters. There was a positive correlation between coronary artery disease and patients’ age (p:0,033), body mass index (p:0,050), waist circumference(p:0,048), diabettes mellitus (p:0,023), fasting glucose levels (p:0,004) and LDL levels (p:0,019). In addition, we showed the positive correlation between waist circumference, body mass index and diabetes mellitus; and a negative correlation between dyslipidemia.  **Conclusions:** We found a correlation between the two anthropometric indices and diabetes mellitus and dyslipidemia and also coronary artery disease directly and indirectly. In addition, the relationship between waist circumference and CAD was more powerful according to the relationship power. Also the relationship between waist circumference and coronary artery disease is much powerful according to the relationship power. |
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**Introduction**

Metabolic syndrome(MS) is a metabolic disorder which is observed a variety of cardiovascular risk factors together such as obesity, insulin resistance and or impaired glucose tolerance, coexistence abdominal fatty deposition, dyslipidemia and hypertension.

Metabolic syndrome affects approximately one fourth of the population in the United States(USA). The third National Health and Nutrition Examination Survey(NHANES III) made an investigation includes incidence and prevalence and also epidemiological and demographic features of over eight thousand volunteer participants in the USA. According to data prevalence of the MS were denoted %6,7-%43,5 and %42 with regard to age 20-29, 60-69 and over 70 respectively. Common prevalence was found %22 and showed an increase affair with age.

TEKHARF study, Onat et al(3,4) investigated the prevalence of the MS in our country using National Cholesterol Education Program (NCEP-ATPIII) Diagnostic criteria. According to this study Prevalence of the MS were calculated %24,4 in 1990 and %36,2 in 2000. In addition the study emphasized that MS was observed %37 of over 30 age population in Turkey. That is about 9,1 million adult were predicted. Baltalı et al(5) researched prevalence of the MS after coronary artery by-pass grafting procedure, and reported that MS prevalence were %41,3for man, %55 for woman.

There are more than one diagnostic criteria for MS prepared by different authorities. First one of them were suggested by World Health Organization(WHO) in 1990(6)According to WHO’s MS diagnostic criteria there was an obligation of being diabetes mellitus(DM) and or insulin resistance(İR) for diagnosis of MS. In 2001 NCEP-ATPIII made a new perspective of diagnostic criteria; DM and or İR were one of the component of Diagnostic criteria rather than an obligation unlike WHO’s criteria (7). However in 2003 American Association of Clinical Endocrinologist (AACE) modified the NCEP-ATPIII criteria (8). They emphasized the IR was the first and necessary criteria for diagnosis of MS like WHO. In 2005 International Diabetes Foundation(IDF)(9) made a new diagnostic criteria for MS. According to this criteria there must be an abdominal obesity(Waist circumference ≥94cm in man, ≥80cm in women in European population) and accompanied two more components which are hypertriglyceridemia(≥150mg/dl), hypertension(≥130/85mmHg), low HDL levels(<40mg/dl in man, <50mg/dl in women), DM or high fasting blood glucose levels(≥100mg/dl). Finally in our country, Türkiye Endokrinoloji ve Metabolizma Derneği(TEMD) made a proposal of MS diagnostic criteria in the light of the former authorities in 2009(10). According to TEMD guideline For MS diagnosis there must be DM or İR or impaired glucose tolerance also accompanied two more criteia; hypertension(≥130/85mmHg or using antihypertensive drugs), dyslipidemia(triglyceride≥150mg/dl and or HDL(<40mg/dl in man, <50mg/dl in women), abdominal obesity(Body mass index>30kg/m² or waist circumference≥94cm in man, ≥80cm in women).

Although the etiology of the MS cannot be completely elucidated, it is suggested that besides especially fat tissue disorders like insulin resistance and obesity; hepatic vascular and immunological factors cause the syndrome and also affects the progress of the syndrome(4,11-13)

**Materials and Methods**

We scanned the clinic charts of the follow up patients with hypertension diagnosis in 1998-2013 retrospectively. We found 2000 follow up patients’ file data. We noted body mass index(BMI), waist circumference(WC), sex, fasting blood glucose, HDL, triglyceride, microalbuminuria levels, diagnosis of DM on the files. According to this data, first of all we found diagnosed MS patients with regard to four different MS diagnostic criteria; WHO(16), NCEP-ATPIII(17), IDF(19) and TEMD(5). We found 340 MS patients and included to the study. Then we saved; age, sex, fasting blood glucose(FBG) (mg/dl),BMI(kg/m²), WC(cm),HDL(mg/dl), triglyceride(mg/dl), LDL(mg/dl), microalbuminuria, diagnosis of DM, date of diagnosis, history of coronary artery disease(CAD) and file numbers in the files, except name and surname for protecting the privacy. The patients with history of myocardial infarction, history of by-pass grafting operation, history of CAD diagnosed by coronary angiography and or signs of coronary ischemia like broad T wave negativity on ECG were accepted CAD patient. We exclude the patients’ files couldn’t be reached whole parameters. Also we exclude microalbuminuria levels in the study because of discrepancy of the data. Thus total 316 patients’ files were included in the study. In consequence of check upon the aim, material and methods of study protocol and voluntary information form, we get ethic committee approval from the local ethic committee of the Trakya University with 18/04 number and 01.10.2014 date.

**Statistical Analysis**

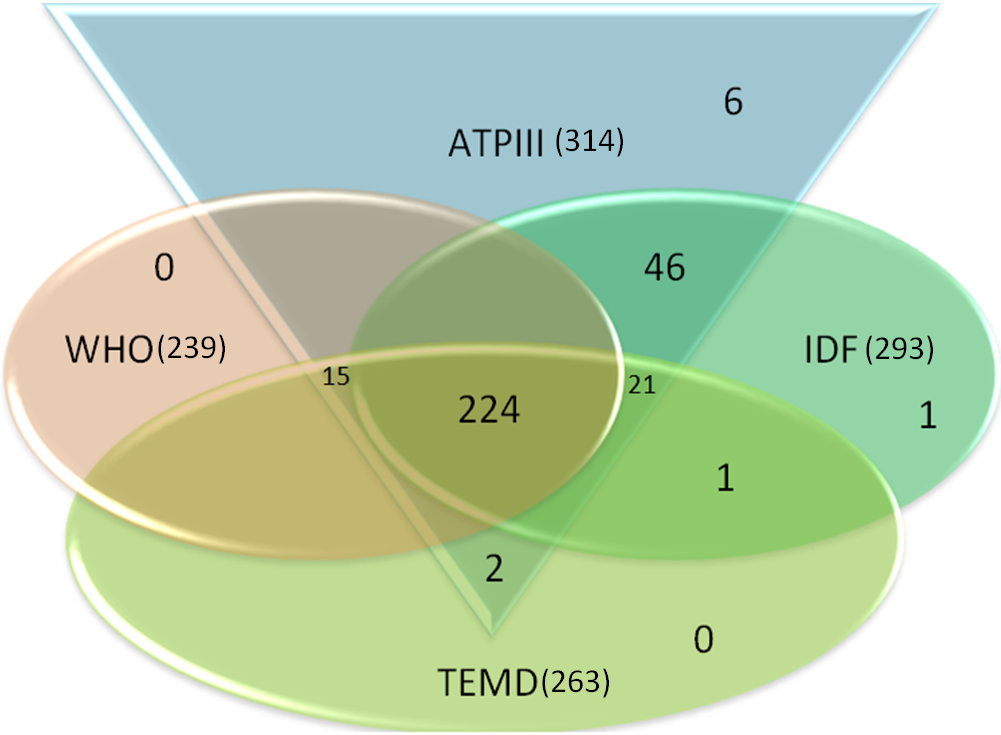
In our study sample size was calculated by GPower© for %80 power, 0,5 effect size and α:0,5. All statistical analyses were performed by SPSS PC Ver. 22(IBM© SPSS Inc. USA). Mean and ± Standard deviations of data were calculated. A value of p<0,05 was considered to be statistically significant for two tailed probabilities. Kolmogorov-Smirnow test was used to test normal distribution. Pearson correlation analysis was used for parametric values with normal distribution and Spearman correlation coefficient was used for parametric values without normal distribution. Also we used MannWhitney-U test for nonparametric values. ROC and AUC analysis were used to evaluate power of the correlation between CAD and other related parameters. In addition Kaplan-Meier survival analysis was performed for analyzing the correlation between CAD and parameters.

**Results**

A hundred(%31) of the 316 patients included the study were male and 216(%68,3) patients were female. According to NCEP ATPIII criterias 314(%99,3) ; for WHO criterias 239(%75,6); for IDF criterias 293(%92,7) and for TEMD criterias 263(%82,2) patients were diagnosed metabolic syndrome. Distributions of the patient counts according to the different guides were showed on the table1 and figure 1. All the patients had hypertension diagnosis. 102(%32,2) patients were DM.204(%64,5) patients were hypertriglyceridemia and 196(%62) patients had low HDL levels. Thus totally 271(%85,7) patients were determined dyslipidemia. According to measured BMI, 186(%58,8) patients had obesity(51of male;135 of female). Fasting blood glucose level was found 100md/dl and above in 254(%80) patients. 292(%92) (90 of male;202 of female) patients had obesity according to measured WC. Total 66(%20,8) patients had CAD(table 1). Highest, lowest and mean values of parameters showed on table 2.

***Table 1:Distribution of the patients according to MS guidelines and parameters.***

|  |  |  |
| --- | --- | --- |
|  | n | % |
| M/F | 100/216 | 31,6/68,3 |
| MS | 316 | 100 |
| NCEP ATP-III | 314 | 99,3 |
| IDF | 293 | 92,7 |
| WHO | 239 | 75,6 |
| TEMD | 263 | 83,2 |
| HT | 316 | 100 |
| DM | 102 | 32,2 |
| Dyslipidemia | 271 | 85,7 |
| TRG≥150 | 204 | 64,5 |
| HDL<40-50 (M/F) | 196 | 62 |
| BMI >30 | 186 | 58,8 |
| WC>94-80 (M/F) | 292 | 92 |
| FBG>100 | 254 | 80 |
| CAD | 66 | 20,8 |



***Figure 1: Distribution of patients according to guidelines.***

***Table 2: Distribution of parameters***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Lowest | Highest | Mean | SD |
| Age | 31 | 90 | 53,1 | 8.945 |
| Triglycerid | 38 | 1192 | 183,29 | 104,551 |
| LDL | 50 | 249 | 135,7 | 36,831 |
| HDL | 21 | 77 | 46,24 | 10,310 |
| BMI | 18 | 55 | 31,8 | 4,872 |
| WC | 68 | 140 | 101,55 | 14,008 |
| FBG | 79 | 241 | 113,48 | 21,838 |

The patients were grouped according to the guidelines they had been diagnosed with. Next the relationship between CAD and this groups were evaluated by Speraman correlation coefficient(table 3). We found only possible correlation between TEMD guideline group and CAD(*p:0,025*).

***Table 3: Correlations between CAD and different guideline groups.***

|  |  |
| --- | --- |
|  | CAD |
| TEMD (*r*)  Sig. (2-tailed) (*p*) | 0,126  0,025 |
| WHO (*r*)  Sig. (2-tailed) (*p*) | 0,092  0,102 |
| ATP III (*r*)  Sig. (2-tailed) (*p*) | 0,041  0,468 |
| IDF (*r*)  Sig. (2-tailed) (*p*) | 0,024  0,670 |

Correlation between CAD and MS parameters were calculated by Spearman correlation analysis(table 4). We found a positive correlation between CAD and FBG(*p:0,004*), age(*p:0,033*), DM(p:0,05) and also WC(*p:0,048*). On the other hand we found no correlation between CAD and HDL, TRG levels.

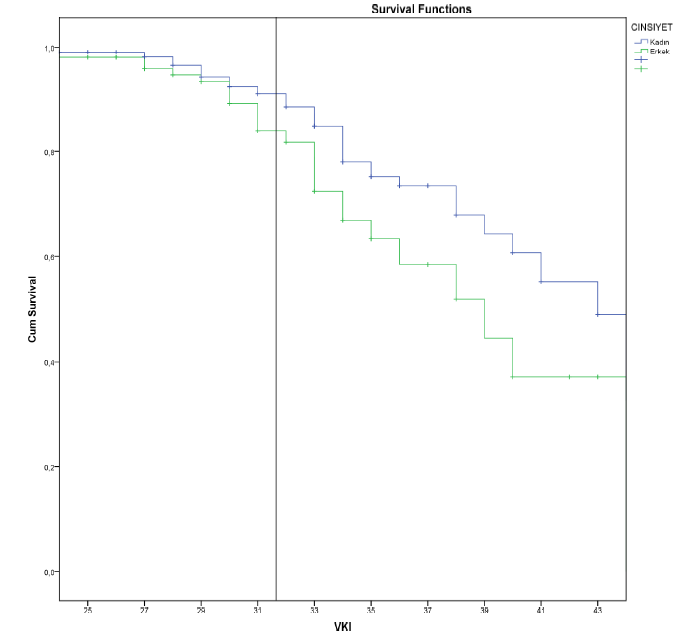
***Table 4: correlation analysis between parameters and CAD***

|  |  |
| --- | --- |
|  | CAD |
| Age Spearman Correlation(*r*)  Sig. (2-tailed) (*p*) | 0,120  0,033 |
| DM Spearman Correlation(*r*)  Sig. (2-tailed) (*p*) | 0,128  0,023 |
| BMI Spearman Correlation(*r*)  Sig. (2-tailed) (*p*) | 0,110  0,050 |
| WC Spearman Correlation(*r*)  Sig. (2-tailed) (*p*) | 0,112  0,048 |
| FBG Spearman Correlation(*r*)  Sig. (2-tailed) (*p*) | 0,160  0,004 |
| TRG Spearman Correlation(*r*)  Sig. (2-tailed) (*p*) | -0,049  0,389 |
| HDL Spearman Correlation(*r*)  Sig. (2-tailed) (*p*) | 0,012  0,831 |

Kaplan Meier estimator was used to estimate the survival function between CAD and parameters. We found a possible correlation between CAD and BMI, LDL levels in a short and long period of time(table 5). According to Kaplan Meier estimator CAD risk increased when BMI become above 30kg/m² for male and female(figure 2). In addition the relationship between CAD and WC, FBG were performed by Cox-regression analysis. According to results CAD risk seemed increased when WC became above 103cm and FBG became above 124mg/dl.

***Table 5: Kaplan Meier analysis between CAD and BMI, LDL***

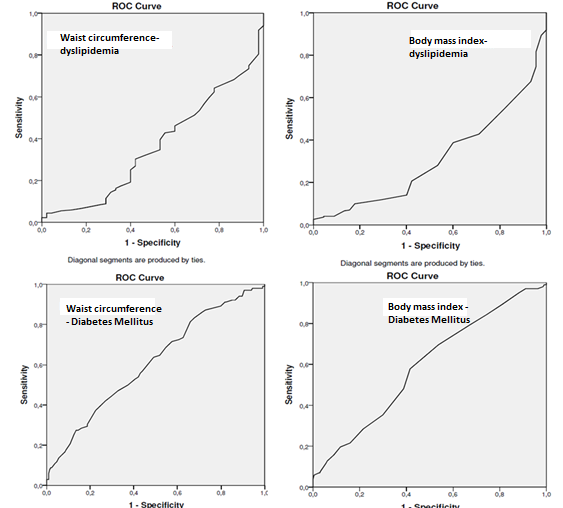
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | BMI and CAD | | LDL and CAD | |
|  | Chi-Square | Sig(*p*) | Chi-Square | Sig(*p*) |
| Mantel Cox | 4,394 | 0,036 | 5,493 | 0,019 |
| Breslow | 2,985 | 0,084 | 6,425 | 0,011 |
| Tarone | 3,699 | 0,054 | 6,292 | 0,012 |



***Figure 2: Survival test for BMI and CAD***

The relationship between BMI, WC and DM, dyslipidemia which are important parameters for pathogenesis of CAD performed by Spearman correlation analysis. We found a positive possible correlation between DM and both BMI and WC(*p:0,04; p:0,001*). On the other hand possible negative correlation between dyslipidemia and anthropometric parameters(*0,001;0,003*). We also performed ROC analysis for the relationship between anthropometric parameters and DM, dyslipidemia. The correlation between DM and anthropometric parameters found significant(AUC:0,610 *p:0,002* for WC; AUC:0,590 *p:0,01* for BMI)(table 6).

***Table 6: ROC analysis between anthropometric measures and DM, dyslipidemia***



**Discussion**

Nowadays MS become an important health problem because of an increase prevalence and also endpoint cardiovascular complications. Pathogenesis of MS couldn’t completely explained nevertheless it is suggested that main reason is insulin resistance and the complications caused by insulin resistance(1,12-15). The reason of insulin resistance is considered multifactorial. Abdominal obesity caused by genetic factors, altered dietary habits in time, high carbohydrate diets and sedentary life is blamed(16,17). As a consequence of all this factors, MS come up with DM, hypertension and dyslipidemia. Each subdiagnoses under MS induce CAD one by one(18-21). Metabolic syndrome has a high morbidity and mortality risk due to strong relationship with CAD. Major aim is to reduce mortality and morbidity risk with taking early precautions and to diagnose MS in clinical practices exact and easy(6-9,10).

In 2006 Meigs et al(22) made a study on MS positive and negative patient groups. They subgrouped the patients according to their BMI and performed relationship between groups and DM, CAD. They reported that there was no possible relationship between BMI increase and CAD in non-MS group. On the other hand they showed an increased incidence on CAD depending on BMI increase in MS positive group. CAD ratio for BMI above 30kg/m² and MS positive group was calculated %13-44. In another study Sinaiko et al(23) investigated on two group patients, insulin resistance positive and negative. Firstly they subgrouped patients depending on their BMI scales. Then they evaluated relationship between groups and CAD major risk factors dyslipidemia and hypertension. According to results they showed significant relationship between CAD risk factors and insulin resistance and obesity positive group. In our study we detected %20,8 of all MS patients CAD diagnosis depending on only their medical history and available ECG changes. We found significant relationship in a short and long term between BMI and CAD(table 5). Besides we showed a rise on CAD risk when BMI increase above 31(figure 3).

Correlation between LDL levels and CAD has known since ancient times. Dagenais et al in 1990(24), Genest et alin 1991(25), Gardner et al(26) in 1996 and Lamarche et al(27) in 1999 worked on relationship between CAD and CAD risk factors. So they showed LDL alone was one of independent risk factor. Furthermore we studied LDL parameters whereas it is not a MS diagnostic parameter. We found a significant correlation between LDL and CAD (*p:0,01*)(Table 5).

A prospective cohort study, Rexrode et al(28) investigated on possible relationship between abdominal obesity parameters WC, waist/hip ratio(W/H R) and CAD. Moreover they subdivided groups according to their BMI which is an indicator of totally body obesity. They showed that correlation between CAD and abdominal obesity parameters was dependent BMI levels. That is to say they demonstrated abdominal obesity was not an independent risk factor for CAD unlike total body obesity. We couldn’t study on correlation between W/H R and CAD due to lack of values on files. But we found significant correlation between WC and CAD(p:0,04)(table 3). Furthermore CAD risk increased when WC become above 103(figure3).

In a study, Kato et al(29) demonstrated correlation between WC and HT, HDL levels in women; WC and TRG in men; BMI and HDL, TRG in men. On contrast they did not find any correlation. In one another study Han et al(30) worked on anthropometric parameters and major CAD risk factors, showed a significant correlation between anthropometric measures and HT and cholesterol levels. Also they showed negative correlation with HDL. However they did not mentioned DM relationships. In summary of two studies it can be said that dyslipidemia and HT prevalence will be increased regarding to BMI and WC rise. Yet they did not have a significant effect on DM prevalence. In contrast we found correlation between anthropometric measures end both DM and dyslipidemia(figure 3). But correlation with dyslipidemia was negative. To sum up we can say that BMI and WC rise will be a predictor for DM on the contrary will not be a certain predictor for dyslipidemia.

In a cross sectional study on55563 case, Lin et al(31) investigated correlation between CAD risk factors and anthropometric measures WC, BMI W/H R, and waist/height ratio. They showed waist/height ratio was the best indicator for CAD caused by obesity. In addition they evaluated that WC was better predictor than BMI for CAD. Also in this study they calculated BMI and WC cut off values were lower than the values used in western countries in Taiwan. In a different study Mirmiran et al(32) worked on relationship between WC,BMI,W/H R,waist/height ratio ; dyslipidemia, HT, DM presumed major CAD risk factors in Tahran. They demonstrated significant relationship between anthropometric measures and CAD risk factors. But they did not compare power of the anthropometric measures. Aekplakorn et al(33) made a study with 5305 patients in 2006 and compared anthropometric measures and DM, HDL, LDL, FBG, TRG and blood pressures. They emphasized WC and W/H R are superior than BMI according to indicate CAD risk factors. Likewise in an another study Schneider et al said WC and waist/height ratio are superior than BMI as an indicator of CAD(34). Also Sargeant et al (35) showed WC is more useful anthropometric measure than BMI. We analyzed anthropometric measures and DM, dyslipidemia. We found WC was more valuable parameter for determining DM and dyslipidemia than BMI same as other studies(*p:0,003*). According to correlation analysis results we found significant direct relationship between CAD and BMI, WC(p:0,031; p:0,003). In summary we found correlations between anthropometric measures and CAD in a direct and indirect way. Correlation power between CAD and WC was evaluated superior than BMI and CAD. But the power gap was not statistically significant as indirect correlations. According to ROC analysis correlations between anthropometric measures and dyslipidemia was nonsense. On the other hand correlation between WC and DM was more significant than BMI and DM but the difference was not statistically significant. In summary we did not find any significant difference according to each three analysis. This was because we studied on a limited small number of groups we thought.

In conclusion Spreading usage of WC as well as BMI on MS patient follow-up is important for new analysis in the future. According to other studies WC could be important anthropometric measure for predicting CAD. But we recommended both BMI and WC usage together in clinical practices.

**References**

1. Dağdelen, S., Yıldırım, T., Erbaş, T. (2008). Metabolik sendrom tanı kriterleri.Anadolu Kardiyoloji Dergisi, 8: 149-53.
2. Ford, E.S., Giles, W.H., Dietz, W.H. (2002). Prevalence of the metabolic syndrome among US adults: Findings from the Third National Health and Nutrition Examination Survey. JAMA; 287: 356-59.
3. Onat, A. (2009). Metabolik Sendrom: Hekimlerimiz için odak. Türk eriskinlerinde kalp sağlığı. Yelken Basim. s. 104-110, İstanbul.
4. Onat, A., Sansoy, V. (2002) Halkımızda koroner hastalığın başsuçlusu metabolik sendrom: sıklığı, unsurları, koroner risk ile ilişkisi ve yüksek risk kriterleri. Türk Kardiyoloji Dern Araş;30:8-15.
5. Baltalı, M., Kızıltan, H.T., Korkmaz, M.E., Topçu, S., Demirtaş, M., Müderrisoğlu, H. ve diğerleri. (2004). Koroner baypas sonrası hastalarda metabolik sendrom sıklığı ve tedaviye uyum oranları. Anadolu Kardiyol Derg ;4:10-6.
6. Alberti, K.G., Zimmet, P.Z. (1998). Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: diagnosis and classification of diabetes mellitus provisional report of a WHO consultation. Diabet Med.;15:539-53.
7. National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults(Adult Treatment Panel III) Third Report of the National Cholesterol Education Program(NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults(Adult treatment Panel III) final report (2002). Circulation;106:3143-3152.
8. Einhorn D, Reaven GM, Cobin RH, Ford, E.,Ganda, O.P., Handelsman, Y.ve diğerleri. (2003). American College of Endocrinology position statement on the insulin resistance syndrome. Endocr Pract.;9:237–252.
9. International Diabetes Federation.(2005).24.08.2005,Ağ sitesi:Worldwide definition of the metabolic syndrome.http://www.idf.org/webdata/docs/IDF\_Metasyndrome\_definition.pdf
10. Türkiye Endokrinoloji ve Metabolizma Derneği’nin (TEMD) Metabolik Sendom Kılavuzu 2009
11. Samur, G. Metabolik sendrom ve sağlıklı zayıflama diyeti, Sendrom, 17 (10):78-86, 2005.
12. Işıldak, M., Güven, G.S., Gürlek A. Metabolik Sendrom ve İnsülin Direnci, Hacettepe Tıp Dergisi, 35, 96-99, 2004.
13. Grundy, S. M., Hansen, B., ve ark., Clinic Management of the Metabolic Syndrome, Report of the American Heart Association/National Heart, Lung and Blood Institue/American Diabetes Association Conference on Scientific Issues Related to Management, Circulation, 109: 551-556, 2004.
14. Ford, E.S., Giles, W.H., Mokdad, A.H. (2004). Increasing prevalence of the metabolic syndrome among U.S. adults. Diabetes Care; 27 (10): 2444-9.
15. Soysal,A., Demiral, Y., Soysal, D., Uçku, R., Köseoğlu, M., Aksakoğlu, M. (2005). İzmir ilinde genç erişkinlerde metabolik sendrom prevalansı. Anadolu Kardiyoloji Derg., 5: 196-201.
16. Bergman, R. N. et al. Why visceral fat is bad: mechanisms of the metabolic syndrome. Obesity (Silver Spring) 14 (Suppl. 1), 16S–19S (2006).
17. Mittelman, S. D., Van Citters, G. W., Kirkman, E. L. & Bergman, R. N. Extreme insulin resistance of the central adipose depot in vivo. Diabetes 51, 755–761 (2002).
18. Abate, N., Obesity and Cardiovascular Disease, Pathogenetic Role of the

Metabolic Syndrome and Therapeutic Implications, Journal of Diabetes and

Its Complications, 14: 154-174, 2000.

1. Pua YH, Ong PH. Anthropometric indices as screening tools for cardiovascular risk factors in Singaporean women. Asia Pac J Clin Nutr 2005;14:74e9
2. Nesto, R.W., The Relation of Insulin Resistance Syndromes to Risk of Cardiovascular Disease, Rev. Cardiovasc. Med., 4(suppl 6): 11-18, 2003
3. Sowers, J.R., Frohlich, E.D., Insulin and Insulin Resistance: Impact on Blood Pressure and Cardiovascular Disease, Med. Clin. N. Am., 88: 63-82, 2004.
4. Meigs,J.B.,Wilson,P.W.F.,Fox,C.S. Body Mass İndex, Metabolic Syndrome, and Risk of Type 2 Diabetes or Cardiovascular Disease,The Journal of CliNical Endocrinology and Metabolism 91(8):2906-2912, 2006
5. Sinaiko AR, Steinberger J, Moran A, Prineas RJ, Vessby B, Basu S, Tracy R,Jacobs Jr DR 2005 Relation of body mass index and insulin resistance to cardiovascular risk factors, inflammatory factors, and oxidative stress during adolescence. Circulation 111:1985–1991
6. Dagenais GR, Robitaille NM, Lupien PJ, et al. First coronary heartdisease event rates in relation to major risk factors: Québec cardiovascu-lar study.Can J Cardiol.1990;6:
7. Genest JJ, McNamara JR, Salem DN, et al. Prevalence of risk factors inmen with premature coronary heart disease.Am J Cardiol. 1991;67:1185–1189
8. Gardner CD, Fortmann SP, Krauss RM. Association of small low-densitylipoprotein particles with the incidence of coronary artery disease in menand women.JAMA. 1996;276:875–881
9. Lamarche B, Lemieux I, Despres JP. The small, dense LDL phenotypeand the risk of coronary heart disease: epidemiology, patho-physiologyand therapeutic aspects.Diabetes Metab. 1999;25:199–211
10. Rexrode KM, Buring JE, Manson JE Abdominal and total adiposity and risk of coronary heart disease in men Int J Obes Relat Metab Disord 25(7):1047-1056 2001
11. Kato MM, Currier BM, Villaverde O, Blanco MG The relation between body fat distribution and cardiovascular risk factors in patients with schizophrenia:a cross-sectional pilot study Prim Care Companion J Clin Psychiatry 7(3)114-118 2005
12. Han TS, van Leer EM, Seidell JC, Lean MEJ Waist Circumference action levels in the identification of cardiovascular risk factors: prevalance study in random sample BMJ 311:1401 1995
13. Lin WY, Lee LT, Chen CY, Lo H, Hsia HH, Liu IL, et al. Optimal cut-off values for obesity: using simple anthropometric indices to predict cardiovascular risk factors in Taiwan. Int J Obes 2002;26: 1232e8.
14. Mirmiran P, Esmaillzadeh A, Azizi F. Detection of cardiovascular risk factors by anthropometric measures in Tehranian adults: receiver operating characteristic (ROC) curve analysis. Eur J Clin Nutr 2004;58:1110e8.
15. Aekplakorn W, Kosulwat V, Suriyawongpaisal P. Obesity indices and cardiovascular risk factors in Thai adults. Int J Obes 2006;30:1782e90.
16. Schneider HJ, Glaesmer H, Klotsche J, Bohler S, Lehnert H, Zeiher AM, et al. Accuracy of anthropometric indicators of obesity to predict cardiovascular risk. J Clin Endocrinol Metab 2007;92:589e94.
17. Sargeant LA, Bennett FI, Forrester TE, Cooper RS, Wilks RJ. Predicting incident diabetes in Jamaica: the role of anthropometry. Obes Res 2002;10:792e8.