Section: Miscellaneous

Original Research Article

SERUM ADIPONECTIN LEVELS IN RELATION TO METABOLIC SYNDROME

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ABSTRACT

Background: Metabolic Syndrome (MetS) is defined by a cluster of interconnected factors that increase the risk of coronary heart disease (CHD), other forms of atherosclerotic cardiovascular diseases (ASCVD) and type 2 diabetes mellitus (T2DM). Adipose tissue secretes bioactive adipocytokines. Adiponectin is the most prevalent adipocytokine that regulates glucose and lipid homeostasis by promoting a strong insulin sensitizing effect, fatty acid oxidation and mediating anti-inflammatory effects. Thus, adiponectin may serve as a biomarker in MetS. **Aim**: To determine the serum adiponectin levels in patients with and without MetS and also to see the correlation of adiponectin with various parameters of MetS. **Materials and Methods:** A cross-sectional study was carried out in the Department of Biochemistry in collaboration with Department of Medicine, Regional Institute of Medical Sciences (RIMS), Imphal, Manipur, India from January 2021 to October 2022. Fifty diagnosed cases of MetS and fifty individuals without MetS were included in this study. Serum adiponectin and parameters of MetS {Body mass index (BMI), weight, waist circumference (WC), skinfold thickness, High-density Lipoprotein (HDL), Triglycerides (TG), and Blood Pressure (BP)} were assessed in the study. The data were statistically analysed using Independent Sample t-test and Pearson's correlation test. **Result:** The mean age was found to be 61.10±12.52 years in cases and 57.08±10.67 years in controls. Serum adiponectin levels were significantly decreased in cases (7.16±4.19 µg/mL) compared to controls (12.18±9.4 µg/mL). MetS patients had significantly higher levels of triglyceride, fasting blood glucose and BMI. Serum Adiponectin levels show significant positive correlation with HDL and significant negative correlation with triglyceride, weight, BMI and fasting blood glucose ($p<0.05$). **Conclusion:** Lower adiponectin levels were associated with an increased incidence of MetS. Adiponectin can be a potential biomarker for early detection of MetS to prevent further complications.

INTRODUCTION

Metabolic Syndrome (MetS) is defined by a cluster of interconnected factors that increase the risk of coronary heart disease (CHD), other forms of atherosclerotic cardiovascular diseases (ASCVD) and type 2 diabetes mellitus (T2DM). Its main components are dyslipidemia (i.e., elevated triglycerides (TG) and apolipoprotein B-containing lipoproteins), elevated arterial blood pressure and dysregulated glucose homeostasis. Abdominal obesity and/or insulin resistance (IR) have gained increasing attention as core manifestations of the syndrome.[1]

According to International Diabetes Federation (IDF), MetS is diagnosed in the presence of: central obesity (WC ≥ 90 cm for men and ≥ 80 cm for women), with ethnicity-specific values assumed if BMI is > 30 kg/m2 in addition to any two of the following four factors: 1) raised TG (≥150 mg/dL) or specific treatment for this lipid abnormality (2) reduced HDL cholesterol (< 40 mg/dL in males, < 50 mg/dL in females) or specific treatment for this lipid abnormality (3) raised BP (BP ≥ 130/85 mmHg) or treatment of previously identified hypertension and

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(4) raised fasting plasma glucose (≥ 100 mg/dL) or previously diagnosed T2DM.[2]

The contributing factors of MetS include insulin resistance, adipose tissue dysfunction, chronic inflammation, oxidative stress, circadian disruption, microbiota, genetic factors, maternal programming, etc.[3]

Adiponectin is a 30kDa glycoprotein of 244 amino acid residues composed of N-terminal signal sequence, a non-homologous or hypervariable region, a collagen-like sequence and a C-terminal globular region.[4] It is an adipocytokine, which modifies glucose homeostasis, inhibits renin-angiotensin system activation and exhibits both anti-inflammatory and anti-atherogenic effects in regulating insulin sensitivity, glucose and lipid metabolism.[5]

Adiponectin exerts its effect via binding to its receptors: AdipoR1, AdipoR2 and T-cadherin. Binding of adiponectin to its receptors can regulate glucose and lipid homeostasis. AMP-activated protein kinase (AMPK) and peroxisome proliferative–activated receptor-α (PPARα) are primary targets activated by AdipoR1 and AdipoR2, respectively.[6] Its binding increases glucose uptake through GLUT4 translocation.[7]

Several studies have shown the effect of Adiponectin and its role in lipid metabolism and metabolic disorders. So, it may be considered a possible treatment target for metabolic syndrome to reduce its global burden.

Aims and Objectives: To determine the serum adiponectin levels in patients with and without MetS and also to see the correlation of adiponectin with various parameters of MetS.

MATERIALS AND METHODS

Study setting: The study was conducted in Department of Biochemistry in collaboration with Department of Medicine, Regional Institute of Medical Sciences, Imphal, Manipur, India. The study was approved by the Research Ethics Board, RIMS, Imphal (Ref. No. A/206/REB-Comm(SP)/RIMS/2015/680/22/2020).

Study design: Cross- sectional study

Study duration: The study was carried out from January 2021 to October 2022.

Study population: The study participants consisted of 50 diagnosed cases of MetS fulfilling the IDF criteria [2] for MetS attending Emergency department, Medicine OPD and wards of RIMS, Imphal and 50 age and sex matched individuals without MetS were included.

Inclusion Criteria

- Individuals who are 30 years and above, irrespective of sex, caste and creed
- Diagnosed cases of MetS who gave written consent to participate voluntarily
- Age and sex matched apparently healthy individuals without metabolic syndrome were taken as controls

Exclusion Criteria

- Individuals with the following disorders - Type I diabetes mellitus (T1DM), chronic kidney disease, cardiovascular disease (Rheumatic heart disease), liver disorders (primary dyslipidemia, hepatitis B & C, alcoholic liver disease, carcinoma), immune deficiency (malignancy, renal failure, connective tissue disease, liver cirrhosis, congestive heart failure, pregnancy, steroid therapy and Anti-Retroviral Therapy (ART) were excluded from the study.

Sample Collection

Eligible participants with or without MetS were identified using IDF (2023) criteria. A sample of about 4 ml venous blood was collected under aseptic precautions after 8-10 hrs overnight fasting and after taking informed consent from the participants. About 2ml of blood was collected in fluoride vial for blood glucose estimation and the remaining blood was collected in plain vial, centrifuged at 3000 rpm for 10 minutes to obtain serum, which was used for estimation of adiponectin, triglyceride and HDL.

Measurement of serum Adiponectin:

Serum adiponectin was estimated by ELISA using Mediagnost Adiponectin ELISA kit, Germany.[8]

Measurement of blood glucose:

Blood glucose was estimated using "Randox Glucose kit Cat. No. GL 3815, United Kingdom" by GOD/PAP (Glucose oxidase-phenol 4 amino phenazone) method.[9]

Measurement of serum triglycerides:

Serum triglyceride was estimated by the Enzymatic colorimetric test by Human Gessellschaft fur Biochemica und Diagnostica mbH.[10]

Measurement of serum HDL:

Serum HDL cholesterol was estimated using the Human Gessellschaft fur Biochemica und Diagnostica mbH HDL kit.[11]

Statistical Analysis

The data collected were analyzed using IBM SPSS version 21 for windows. To compare the serum levels of adiponectin between patients with and without MetS, independent sample t-test was used. Pearson's correlation analysis was used to find the correlation between dependent variables. P value <0.05 was considered statistically significant

RESULTS

A total of 100 individuals (50 individuals with MetS and 50 individuals without MetS) were included in this study. Table 1 shows that there were 44 males and 56 females in both the cases and controls.

Table 2 shows that the mean (±SD) levels of weight, BMI, waist circumference (WC), pulse rate, blood pressure (both systolic and diastolic) and skin fold thickness (SFT) shows significant differences between controls and cases but there was no

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significant difference in the mean (±SD) level of age and height among controls and cases.

The mean (±SD) levels of fasting blood glucose (FBG) and triglycerides (TG) were significantly increased in cases compared to controls($p<0.01$), and the levels of adiponectin, high-density lipoprotein (HDL) cholesterol and haemoglobin (Hb) were lower in cases than in controls (Table 3)

There was a significant difference in the mean (±SD) of BMI, height, Triglycerides and Hemoglobin between males and females among the cases when different clinical and metabolic parameters were compared between males and females. (Table 4)

Table 5 shows that serum adiponectin has a significant positive correlation with HDL and a statistically significant negative correlation with serum TG, Weight, BMI, WC, blood pressure and SFT among the various parameters of MetS.

In Figure 1 and Table 6, the Receiver operating characteristic (ROC) curve of adiponectin was constructed to determine its diagnostic ability for metabolic syndrome. It has an area under curve (AUC) value of 0.679 by using the study-specific cut-off value 8.4 (sensitivity 0.521, specificity 0.771).

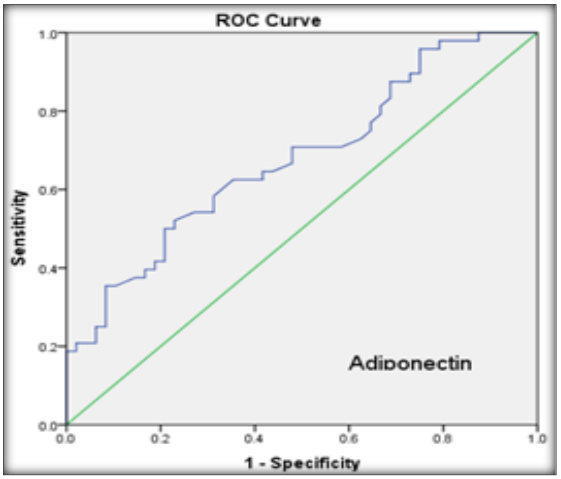

Figure 1: Receiver operating characteristic (ROC) curve of adiponectin

Table 1: Sex wise distributions of study participants

Gender	Control (N=50)	Cases (N=50)	p-value
Male	21	23	0.43
Female	29	27	

Table 2: Distribution of respondents by clinical and metabolic parameters between controls and cases

Parameter	Control (N=50) Mean ±SD	Cases (N=50) Mean ±SD	P value
Age (years)	57.08 ± 10.67	61.10 ± 12.52	0.07
Height (cm)	161.33 ±6.69	159.65 ± 6.18	0.20
Weight (kg)	52.21 ± 5.40	74.21 ± 8.66	<0.01
BMI (kg/m^2)	20.42 ± 1.82	29.14 ± 3.20	<0.01
WC (cm)	75.23 ± 4.90	91.81 ± 5.0	<0.01
Pulse (per min)	75.58 ± 5.68	79.312 ± 7.52	<0.01
BP-Systolic (mmHg)	112.83 ± 9.19	138.65 ± 11.99	<0.01

Table 3: Distribution of respondents by other metabolic parameters among controls and cases

Variables	Control (N=50) Mean ±SD	Cases (N=50) Mean ±SD	P value
Adiponectin (µg/ml)	12.18 ± 9.4	7.16 ± 4.19	<0.01
FBG (mg%)	94.33 ± 10.16	194.06 ± 66.2	<0.01
HDL (mg%)	47.42 ± 4.91	26.54 ± 7.91	<0.01
TG (mg%)	125.75 ± 35.07	198.56 ± 88.68	<0.01
Hb (g/dl)	13.94 ± 11.98	11.66 ± 1.7	0.20

Table 4: Distribution of respondents by clinical and metabolic parameters between males and females among cases

Parameter	Female (N=27) Mean ±SD	Male (N=23) Mean ±SD	P value
Age (years)	64.08 ± 12.30	57.59 ± 12.11	0.05
Height (cm)	155.77 ± 4.32	164.23 ± 4.76	<0.01
Weight (kg)	73.31 ± 10.51	75.27 ± 5. 86	0.44
BMI (kg/m^2)	30.16 ± 3.74	29.93 ± 1.86	0.01
WC (cm)	91.38 ± 6.34	92.32 ± 2.50	0.52
WHR	1.09 ± 0.09	1.10 ± 0.04	0.86
Pulse (per min)	80.46 ± 8.38	77.95 ± 6.28	0.25
BP-Systolic (mmHg)	136.62 ± 12.77	141.05 ± 10.80	0.20
BP-Diastolic (mmHg)	88.92 ± 10.28	90.45 ± 6.62	0.55
SFT (mm)	9.12 ± 2.96	8.18 ± 1.44	0.18
Adiponectin (µg/ml)	10.74 ± 9.61	8.56 ±4.73	0.17
FBG (mg%)	195.0 ± 63.7	193.13 ± 69.98	0.92
HDL (mg%)	25.58 ± 9.20	27.50 ± 6.43	0.41
TG (mg%)	226.42 ± 110.3	170.71 ± 47.77	0.03
Hb (g/dl)	10.60 ± 1.34	12.72 ± 1.34	<0.01

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Table 5: Pearson's correlation of adiponectin with parameters of metabolic syndrome Correlation is significant at the 0.01 level (2-tailed)

Parameter	Correlation coefficient	P value
FBG (mg%)	-0.197	0.06
TG (mg%)	-0.216	0.03
HDL (mg%)	0.363	<0.01
Weight (kg)	-0.250	0.01
BMI (kg/m^2)	-0.230	0.02
WC (cm)	-0.282	<0.01
BP-Systolic (mmHg)	-0.269	<0.01
BP-Diastolic (mmHg)	-0.243	0.02
SFT (mm)	-0.235	0.02

Table 6: Area under ROC curve

Variable	AUC	SE	PPV	NPV	Sig
Adiponectin	0.679	0.054	61.7	69.4	0.006

DISCUSSION

Metabolic syndrome is a cluster of metabolic abnormalities with interrelated risk factors that is considered a major health concern. MetS is associated with coronary heart disease, T2DM and all-cause mortality in elderly.[12] Over the last few years, there has been increasing evidence of association between metabolic syndrome and adipokines. The importance of adiponectin in the development of metabolic syndrome has been demonstrated in many studies.[13,14] This study adds additional information on the association between adiponectin with metabolic syndrome.

There were significant gender differences seen in the distribution of components of MetS regarding BMI, height, Hb and triglycerides. The reason for the prevalence of some components of metabolic syndrome among females may be due to less physical activity, sedentary lifestyle and higher adiposity. Gender difference in the MetS components was also seen in the study done by Beigh SH et al,[15] and Lee S et al.[16]

The mean (±SD) blood pressure seemed paradoxically low since almost all the patients were on anti-hypertensive medication. Blood pressure showed significant negative correlation with serum adiponectin levels which is consistent with the findings of Senarathne R et al.[17] The triceps skin fold thickness was measured by a standard caliper. The mean (±SD) level of SFT of cases were significantly higher than controls. Among MetS cases, the mean level of SFT was higher in females than males which is consistent with the findings of the study by Vasan SK et al.[18] The mean (±SD) levels of BMI and WC showed significant difference between control and cases. Among the cases, BMI was significantly higher in female as compared to male. The study done by Alamgir MA et al,[19] found that females had higher BMI, hypertension, hyperglycemia and hyperlipidemia as compared to male counterparts.

There was negative correlation between TG and adiponectin, while positive correlation existed between HDL and adiponectin. According to the study conducted by Tao LX et al,[20] the longitudinal correlation between TG and BMI with MetS was the largest among other components. Low HDL level is an independent risk factor for MetS and in this study female have lower levels of HDL than males but the difference was not statistically significant. A study done by Mani P et al,[21] demonstrated a clear association between low HDL-cholesterol and incident of MetS that is independent of traditional risk factors and visceral adiposity.

Adiponectin encoded by the ADIPO-Q gene is involved in regulation of glucose levels as well as fatty acid breakdown by its insulin sensitizing and anti-inflammatory effects.[22] In our study serum adiponectin levels were significantly lower in MetS and showed significant positive correlation with HDL and negative correlation with TG, weight, BMI, WC, SFT and blood pressure. The study done by Marsche G et al,[23] said that hypoadiponectinemia is an effective predictor for decreased cholesterol efflux capacity and variation in adiponectin production may be a crucial modulator of the functionality of HDL, representing a mechanism for increased cardiovascular risk. High adiponectin values have prognostic value in terms of cardiovascular diseases by its anti-inflammatory effect through activation of its receptors in target cells which results in increased hepatic and skeletal muscle fatty acid oxidation, increased skeletal muscle lactate production, reduced hepatic gluconeogenesis, increased cellular glucose uptake, inhibition of inflammation and oxidative stress.[24] Insulin receptor dysfunction is associated with increased circulating adiponectin. Insulin directly suppresses adiponectin secretion from the adipose tissue.[25] The AUC value determined from ROC curve was 0.6 for diagnosis of MetS by using the study specific cut off value (sensitivity 0.521, specificity 0.771) which is consistent with the findings of Yosaee S et al.[26]

Limitation: Our study was limited by the small sample size and cross-sectional methodology, which is inappropriate for examining the link between MetS and adiponectin as a causative factor.

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CONCLUSION

Lower adiponectin levels were associated with increased incidence of metabolic syndrome. The study results showed that adiponectin can be a potential biomarker for early detection of metabolic syndrome. However, similar studies which include a substantial study group of metabolic syndromes are required to demonstrate their value as an accurate and affordable metabolic syndrome biomarker.

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Conflict of interest

The authors declare no conflict of interest.

REFERENCES

1. Kassi E, Pervanidou P, Kaltsas G, Chrousos G. Metabolic syndrome: Definitions and controversies. BMC Med. 2011;9(1):48.
2. International Diabetes Federation [Internet]. Brussels. International Diabetes Federation [cited 2025 Mar] Available from: https://idf.org/about-diabetes/resources/idf-consensus-definition-of-metabolic-syndrome-in-children-and-adolescents/
3. Xu H, Li X, Adams H, Kubena K, Guo S. Etiology of metabolic syndrome and dietary intervention. Int J Mol Sci. 2018;20(1):128-51.
4. Okada-Iwabu M, Iwabu M, Yamauchi T, Kadowaki T. Structure and function analysis of adiponectin receptors toward development of novel antidiabetic agents promoting healthy longevity. Endocr J. 2018;65(10): 971-7.
5. Singhal A, Punia VS, Bharti A, Mittal S, Mishra PR, Kumar P. A study of correlation of adiponectin levels in metabolic syndrome. Diabetes. 2022 Nov.
6. Kim Y, Park CW. Mechanisms of adiponectin action: Implication of adiponectin receptor agonism in diabetic kidney disease. Int J Mol Sci. 2019;20(7):1782-96.
7. Han Y, Sun Q, Chen W, Gao Y, Ye J, Chen Y, Wang T, Gao L, Liu Y, Yang Y. New advances of adiponectin in regulating obesity and related metabolic syndromes. Journal of pharmaceutical analysis. 2024 May 1;14(5):100913.
8. Risch L, Hoefle G, Saely C, Berchthold S, Weber M, Gouya G, et al. Evaluation of two fully automated novel enzyme-linked immunosorbent assays for the determination of human adiponectin in serum. Clin Chim Acta. 2006 Nov;373(1-2).
9. Dumitriu IL, Gurzu B, Cojocaru E, Slătineanu SM, Enea M. COURSE NOTES Validation of GOD/PAP method for quantitative determination of glucose concentration in human serum. Revista Română de Medicină de Laborator Vol. 2011;19(1/4).
10. Bucolo G, David H. Quantitative determination of serum triglycerides by the use of enzymes. Clin Chem. 1973;19(5):476-82.
11. Portela RD, Neto EM, Júnior FJ, Ferreira JM, de Sousa Alves R, Carvalho TM, Holanda BA. Comparative analysis of two methodologies for determination of HDL cholesterol. Journal of Young Pharmacists. 2018;10(3):308.
12. Powell-Wiley TM, Poirier P, Burke LE, Després JP, Gordon-Larsen P, Lavie CJ, Lear SA, Ndumele CE, Neeland IJ, Sanders P, St-Onge MP. Obesity and cardiovascular disease: a scientific statement from the American Heart Association. Circulation. 2021 May 25;143(21):e984-1010.
13. Albarracin ML, Torres AY. Adiponectin and leptin adipocytokines in metabolic syndrome: What is its importance? Dubai Diabetes Endocrinol J. 2020 Sep:1-0.
14. Cao H. Adipocytokines in obesity and metabolic disease. J Endocrinol. 2014 Feb;220(2):T47-59.
15. Beigh SH, Jain S. Prevalence of metabolic syndrome and gender differences. Bioinformation. 2012;8(13):613.
16. Lee S, Ko Y, Kwak C, Yim ES. Gender differences in metabolic syndrome components among the Korean 66-year-old population with metabolic syndrome. BMC Geriatr. 2016 Dec;16(1):1-8.
17. Senarathne R, Hettiaratchi U, Dissanayake N, Hafiz R, Zaleem S, Athiththan L. Metabolic syndrome in hypertensive and non-hypertensive subjects. Health Sci Rep. 2021 Dec;4(4):454.
18. Vasan SK, Thomas N, Christopher S, Geethanjali FS, Paul TV, Sanjeevi CB, et al. Anthropometric measurements for the prediction of the metabolic syndrome: a cross-sectional study on adolescents and young adults from southern India. Heart Asia. 2011 Jan;3(1):2-7.
19. Alamgir MA, Javid RA, Hammed A, Mustafa I. Gender difference in components of metabolic syndrome among patients of type 2 diabetes. Pak J Med Sci Q. 2015 Jul;31(4):886.
20. Tao LX, Yang K, Liu XT, Cao K, Zhu HP, Luo YX et al. Longitudinal associations between triglycerides and metabolic syndrome components in a Beijing adult population, 2007-2012. Int J Health Sci. 2016;13(6):445.
21. Mani P, Ren HY, Neeland IJ, McGuire DK, Ayers CR, Khera A, et al. the association between HDL particle concentration and incident metabolic syndrome in the multi-ethnic Dallas Heart Study. Diabetes Metab Syndr. 2017 Nov;11:S175-9.
22. Tang YH, Wang YH, Chen CC, Chan CJ, Tsai FJ, Chen SY. Genetic and functional effects of adiponectin in type 2 diabetes mellitus development. International Journal of Molecular Sciences. 2022 Nov 4;23(21):13544.
23. Marsche G, Zelzer S, Meinitzer A, Kern S, Meissl S, Pregartner G et al. Adiponectin predicts high-density lipoprotein cholesterol efflux capacity in adults irrespective of body mass index and fat distribution. J Clin Endocrinol Metab. 2017;102(11):4117-4123.
24. Lopez-Jaramillo P, Gomez-Arbelaez D, Lopez-Lopez J, Lopez-Lopez C, Martinez-Ortega J, Gomez-Rodriguez A et al. The role of leptin/adiponectin ratio in metabolic syndrome and diabetes. Horm Mol Biol Clin Investig. 2014 Apr;18(1):37-45.
25. Aksu NM, Aksoy DY, Akkas M, Cinar N, Ucar F, Yildiz OB et al. adiponectin levels decrease independently of body mass index and diabetes type after normalization of hyperglycemia. Turk J Med Sci. 2020 Apr;50(2):312-5.
26. Yosaee S, Khodadost M, Esteghamati A, Speakman JR, Djafarian K, Bitarafan V et al. Adiponectin: an indicator for metabolic syndrome. Iran J Public Health. 2019 Jun;48(6):1106.

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