AMERICAN JOURNAL OF PREVENTIVE MEDICINE AND PUBLIC HEALTH, 2020
VOL 6, NO. 1, PAGE 9–15
10.5455/ajpmph.20190904102759

ORIGINAL RESEARCH

Open Access

Evaluation of serum adipokines with the development of metabolic syndrome among industrial workers

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ABSTRACT

Background: Most of the studies were reported serum adipokines with the presence of metabolic syndrome (MetS) in population-based studies.
Objective: The present study assessed the levels of serum adipokines, i.e., leptin, adiponectin, leptin:adiponectin ratio (LAR), and adiponectin:leptin ratio (ALR), and the development of MetS among industrial workers.
Methods: Eighty-eight workers were recruited in the study. MetS was diagnosed using the definition of the International Diabetes Federation. Serum leptin and adiponectin levels were done using enzyme linked immunosorbent assay methods. LAR and ALR values were calculated using the serum leptin and adiponectin. The data was analyzed using statistical package for the social sciences software. Mann–Whitney U test was used to find out the differences of adipokines among workers with or without MetS. Kruskal–Wallis test was used to find out the effect of the number of metabolic components (0, 1, 2, 3, and >4) on serum adipokines among workers.
Results: 37.5% of workers had MetS. The levels of serum leptin ($p < 0.01$) and LAR ($p < 0.01$) were significantly increased and serum adiponectin ($p = 0.104$) and ALR ($p < 0.01$) were decreased in workers with the presence of MetS. The effect of the number of metabolic components was demonstrated a significant increase of serum leptin ($p = 0.018$) and LAR ($p = 0.026$) and significant decrease of ALR ($p = 0.046$).
Conclusion: The levels of serum leptin and LAR were increased and adiponectin and ALR were decreased in workers with the presence of MetS and the number of metabolic components. The data of the present study support the role of adipokines and development of MetS. It could be used as specific indicators for the diagnosis and management of MetS.

ARTICLE HISTORY

Received September 04, 2019
Accepted December 27, 2019
Published February 29, 2020

KEYWORDS

Metabolic syndrome; industrial workers; leptin; adiponectin; leptin:adiponectin ratio; adiponectin:leptin ratios

Introduction

Metabolic syndrome (MetS) is the risk of obesity, reduced high-density lipoprotein-cholesterol (HDL-C), hypertriglyceridemia, hypertension, and elevated glucose. It is characterized by proinflammatory, prothrombotic state, and atherogenic dyslipidemia [1]. It is a global public health problem and linked with a three-fold risk of type 2 diabetes mellitus and a two-fold risk of cardiovascular disease (CVD) [2]. The potential health problems such as insulin resistance, obesity, and CVD were positively associated with the presence of MetS [3]. Industrial workers with privileged access to healthcare facilities typically reported a high prevalence of MetS [4]. Physical inactivity, worse lifestyle factors, unhealthy dietary intake, and overweight were positively related to the risk of MetS [5]. A high prevalence of MetS was reported in industrial workers from Poland [6] and adults from Jordan [7]. A significant number of the metabolic component score was reported in gas refinery workers as compared to non-industrial workers [8]. Work places of manufacturing, transport, finance, and cooperative association reported a high prevalence of MetS [9]. The self-reporting health complaints were positively associated with the risk of MetS [10]. The cost of medical treatment is 3.6 times higher for those with MetS and disease [11]. Employees with

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abdominal obesity [12], high workload [13], short duration of sleep and shift [14], and high job stress [15] are the potential predictors of MetS.

Adipose tissue is an endocrine gland, which produces different kinds of biologically active compounds, namely -α Tumor necrosis factor (TNF-α), IL-6, leptin, adiponectin, and retinal binding protein-4 [16]. Adipokines, in particular, leptin and adiponectin modulate the MetS [17]. Adiponectin regulates the metabolism of glucose and lipids and has the property of antiatherogenic and anti-inflammatory. It is served as an eradicating marker of MetS [18]. A negative tendency was noted between adiponectin and the presence of MetS [19]. Subjects with the existence of MetS observed lower levels of adiponectin [20]. Leptin regulates the appetite, carbohydrate, lipid, energy metabolism, arterial pressure, neuroendocrine, and etiopathogenesis of MetS [21]. Leptin was positively correlated with MetS [22]. The existence of MetS in older adults has noted higher leptin and lower adiponectin [23,24]. Jung et al. [25] reported a significant relationship between ALR and the presence of MetS and the number of metabolic components in the population. A recent study also established that the ALR was a better marker for the assessment of acute metabolic stress [26]. LAR was served as a sensitive marker for the early detection of MetS [27,28]. LAR is a better predictor for MetS as compared to alone measurements of adiponectin and leptin [29].

Most of the studies were reported serum adipokines and the presence of Mets in population-based studies. However, the interactions between adipokines (adiponectin, leptin, LAR, and ALR) and the presence of MetS among industrial workers were not explored. This study was undertaken to find out the interaction between adipokines and the presence of MetS among industrial workers.

Material and methods

This study enrolled eighty-eight industrial workers from establishments located in Karnataka, India. The study subjects were enrolled in the study by visiting the industry. These subjects were chosen from the industries which manufactured bearings components and food flavors and fragrances. Subjects with a history of diabetes, thyroid, pituitary, hypogonadism, chronic liver, or chronic renal diseases were excluded from the study to avoid the influences of adipokine secretions on metabolic syndrome among industrial workers. The Institutional Ethics Committee has approved the study with protocol number: 142 dated 13-12-2018. A diagnosis of MetS among industrial workers was done using the definition of the International Diabetes Federation (IDF). Serum adiponectin and leptin concentration among subjects were analyzed using enzyme linked immunosorbent assay (ELISA) methods.

Clinical examination

Clinical examination and lifestyle factors data were collected from industrial workers using a pre-validated questionnaire, which was validated using a small sample population from the center. Subjects' height in centimeters and weight in kilograms were measured using measuring tape and weighing machine with lightly clothed and without shoes. For waist circumference (WC), we measured in accordance with the World Health Organization diagnostic criteria for abdominal obesity. Blood pressure [systolic blood pressure (SBP) and diastolic blood pressure (DBP)] was monitored in subjects using the HEM-7112 monitor after resting for 4 minutes while sitting.

Blood collection

Four milliliters of whole blood was collected into Vacuurate easy clot activator tubes (manufactured by Labtech Disposables, India) and centrifuged at 4,000 rpm for 10 minutes at 4°C to separate the serum and used for the measurement of fasting serum glucose, triglyceride, and HDL-C among subjects.

Fasting serum glucose (FSG)

The FSG estimation was performed using glucose oxidase and peroxidase (GOD-POD), an endpoint kit method developed by Trinder [30]. In this method, the GOD enzyme converts the glucose into gluconate. The hydrogen peroxide is produced in the reaction, is degraded by POD, and gives a colored product phenol and 4-aminoantipyrine, which is measured using the Trinder indicator reaction at 505 nm. The absorbance increase was correlated with the glucose concentration of the sample. The limit of detection (LOD) of the method is 1 mg/dl.

Serum triglycerides

The level of serum triglyceride estimation was done using enzymatic (glycerol 3-phosphate oxidase peroxidase) kit method developed by Fossati et al. [31] and coupled the reaction of classical Trinder [30]. In this approach, triglycerides are hydrolyzed by lipase into glycerol and fatty acids. Glycerol is phosphorylated by ATP in the presence of glycerol kinase to glycerol-3-phosphate, which is oxidized by the glycerol-3-phosphate oxidase and produces hydrogen peroxide. It reacts with 4-aminoantipyrine and 4-chlorophenol in the presence of POD to produce red quinoneimine. The intensity of color developed is proportional to the triglyceride concentration. The LOD of the method is 1 mg/dl.

Serum HDL-cholesterol

The levels of serum HDL-C were measured using phosphotungstic acid and magnesium ion precipitate method as described by Lopes et al. [32]. In this approach, chylomicrons, very low density lipoprotein, and low density lipoprotein are precipitated by phosphotungstic acid and magnesium ions. After centrifugation, HDLs are present in the supernatant. Cholesterol is measured by an enzymatic kit method. In which, the determination of cholesterol after enzymatic hydrolysis and oxidation in the above, the colorimetric indicator quinoneimine is formed, which is generated from 4-aminoantipyrine and phenol by hydrogen peroxide under the catalytic action of POD. This is measured using Trinder indicator reaction at 510 nm. The increase in absorbance correlates with the HDL-C concentration of the sample. The LOD of the method is 4 mg/dl.

Serum adiponectin

The levels of serum adiponectin were measured using the sandwich ELISA kit method (Diagnostics Biochem Canada Inc., CAN-APN-5000). The LOD of the method is 0.06 ng/ml and detection range is 0–50 ng/ml.

Serum leptin

The level of serum leptin was measured using sandwich ELISA kit method (Diagnostics Biochem Canada Inc., CAN-L-4260). The LOD of the method is 0.50 ng/ml and detection range is 0–100 ng/ml.

Leptin:adiponectin ratio (LAR)

It was a calculated value from serum leptin and serum adiponectin of individual subjects.

Adiponectin:leptin ratio (ALR)

It was a calculated value from serum adiponectin and serum leptin of individual subjects.

Statistical analysis

The Statistical package for the social sciences version 20 was used for data analysis. Shapiro–Wilk test was used to find the normality of serum adipokine levels (adiponectin, leptin, LAR, and ALR) among industrial workers. The distribution of serum adipokine levels was found in non-normal (skewed). The data of serum adipokines (adiponectin, leptin, LAR, and ALR) were presented in median levels and compared using the Mann–Whitney U test in industrial workers with and without MetS. Kruskal–Wallis test was used to find the effect of the number of metabolic components (0, 1, 2, 3, and >4) on serum adipokines (adiponectin, leptin, LAR, and ALR) among industrial workers. Probability of less than 0.05 was considered as significant.

Result

Table 1 represents the criteria for MetS using the IDF that is WC plus the presence of any two of the risk factors such as elevated triglyceride, low HDL-C, increased blood pressure(SBP or DBP) and elevated levels of fasting glucose. The baseline data of the industrial workers are presented in Table 2. Individuals with a mean and standard deviation of age, height, weight, BMI, WC, blood pressure (SBP and DBP), and lipid profile (serum triglycerides and HDL-C); serum fasting glucose; and adipokines (leptin, adiponectin, LAR, and ALR) were reported.

Table 3 shows the median levels of serum adipokines (adiponectin, leptin, LAR, and ALR) among industrial workers with and without MetS. The non-parametric test such as the Mann–Whitney U test was used to find the differences of adipokine levels among industrial workers with and without MetS. The levels of serum leptin ($p < 0.01$) and LAR ($p < 0.01$) were significantly increased and ALR ($p < 0.01$) was significantly decreased in industrial workers with the presence of MetS. The level of serum adiponectin was decreased ($p = 0.104$) in workers with MetS, but it was not significantly altered.

Table 1. IDF criterion for MetS .

Parameters	Defining level
Serum triglycerides	≥150 mg/dl
Serum HDL-C	<40 mg/dl in males <50 mg/dl in females
Blood pressure (SBP or DBP)	Systolic BP ≥ 130 or Diastolic BP ≥ 85 mm Hg
Serum fasting glucose	≥ 100 mg/dl
Waist circumference	Male ≥ 90 cm Female ≥ 80 cm

Diagnosis of MetS: WC plus any two of four parameters.

Table 2. Baseline data of the industrial workers.

Parameters	Mean ± SEM (n = 88)
Age (years)	33.65 ± 1.0
Height (cm)	162.76 ± 0.9
Weight (kg)	63.50 ± 1.1
BMI (kg/m^2)	24.03 ± 0.4
WC (Cm)	86.04 ± 1.0
SBP (mm Hg)	125.22 ± 1.8
DBP (mm Hg)	74.84 ± 1.2
Glucose (mg/dl)	93.91 ± 3.5
Triglyceride (TG) (mg/dl)	167.42 ± 9.9
HDL-C (mg/dl)	34.51 ± 0.8
Leptin (ng/ml)	1.30 ± 0.05
Adiponectin (μg/ml)	4.76 ± 0.4
Leptin:adiponectin ratio (LAR)	0.52 ± 0.2
Adiponectin:leptin ratio (ALR)	6.01 ± 0.8

Table 3. Median levels of serum adipokine among workers with and without MetS.

(MetS)	n = 88	Leptin (ng/ml)	Adiponectin (μg/ml)	LAR	ALR
(–)	55	1.01	4.51	0.19	5.02
(+)	33	1.49**	3.16	0.48**	2.27**

**$p < 0.01$.

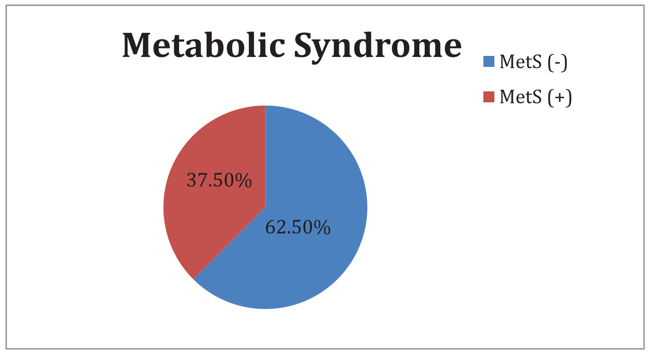

Figure 1. Prevalence of metabolic syndrome among industrial workers.

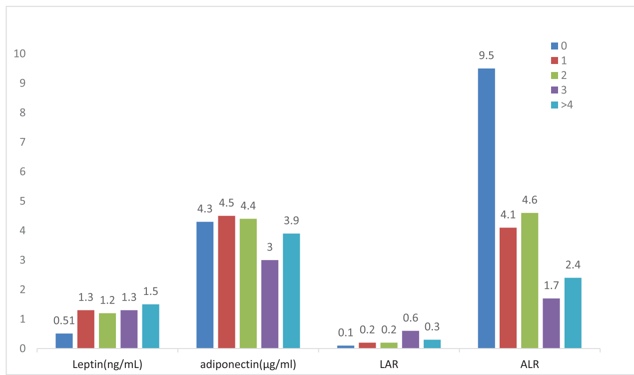

Figure 2. Effect of the number of metabolic components on serum adipokines among workers.

The prevalence of MetS among industrial workers is presented in Figure 1. The prevalence of MetS among industrial workers was assessed using the definition of IDF, i.e., WC plus any two of the following four factors: increased triglycerides, reduced HDL-C, increased blood pressure (SBP or DBP), and elevated levels of fasting glucose. In this study, it was noted that 37.5% of workers had MetS and 62.5% of workers without MetS.

Figure 2 shows the effect of metabolic components on serum adipokines (adiponectin, leptin, LAR, and ALR) among industrial workers. Kruskal–Wallis test was used to find the effect of the number of metabolic components (0, 1, 2, 3, and >4) on serum adipokines (adiponectin, leptin, LAR, and ALR) among industrial workers. The results of the study shown that the serum leptin (p = 0.018) and LAR (p = 0.026) were significantly increased and ALR (P=0.046) was significantly decreased with the increase of the number of metabolic components.

Discussion

This study assessed the interaction between serum adipokines and the presence of MetS among industrial workers. Nair et al. [33] reported the presence of MetS ranged from 11.11% to 30.7% as per the International Standard Classification of Occupations (ISCO-88); the highest prevalence of MetS was reported in managers and senior officials. Sarang et al. [34] identified the MetS ranged from 9.4% to 52.9% in mining workers. During the present study, it was noted that 37.5% of workers had the MetS. A similar prevalence of MetS was noted in adults from Jordan [7] and gas refinery workers [8]. A study from India reported a high prevalence of MetS among industrial workers, who have good access to health care [4]. Review of the literature indicated that the presence of MetS was associated with unhealthy diet patterns, worse lifestyle factors, and low physical activity [35].

MetS was accompanied by increased visceral tissue and adipokine secretion [36]. An inverse association was noted between adiponectin levels and the presence of MetS in population-based studies [37,38]. During the present study, it was observed a similar trend between adiponectin levels and the presence of Mets among industrial workers. The measurement of adiponectin was considered as a therapeutic marker for MetS [39]. Leptin is a hormone derived from adipose tissue and reported a positive correlation with the MetS in population-based studies [40,41]. In this study, we also noted a similar tendency between serum leptin and the presence of MetS among industrial workers. The existence of MetS in older adults reported higher leptin and lower adiponectin levels [23,24]. In the present study, it was observed higher leptin and lower adiponectin levels with the existence of MetS among workers. Leptin was considered as a predictive marker of MetS [42].

LAR was associated with low-grade inflammation [43] and atherosclerotic risk [44]. It is used as a predictive marker for MetS as compared to individual measurements of adiponectin and leptin [45]. Population-based studies have reported a positive association between LAR and the presence of MetS [46,47]. The findings of this study found a similar relationship between LAR and the presence of MetS among workers.

ALR is a marker of adipose tissue inflammation [48]. It is a useful estimator for obesity-associated cardiometabolic risk [49]. Population studies have found the negative link between ALR and the presence of MetS [50,51]. The findings of this study also indicated a decreased ALR with the presence of MetS. Wang et al. [40] reported a positive tendency between leptin and number of metabolic components. This study also evaluated the effect of the number of metabolic components (0, 1, 2, 3, and >4) on serum adipokines (leptin, adiponectin, LAR, and ALR) among industrial workers. The findings of this study were indicated significantly higher serum leptin and LAR concentration with the presence of MetS. Santamiema et al. [52] reported a negative inclination between adiponectin levels with the components of MetS defined by IDF. Jung et al. [16] reported a negative trend between ALR and the presence of MetS and the number of metabolic components in Korean subjects. In this study, it was noted a similar trend between adiponectin and ALR concentrations with the number of MetS components.

Conclusion

The levels of serum leptin and LAR were significantly increased and ALR were significantly decreased in workers with the presence of MetS and the number of metabolic components. The data of this study support the role of adipokines and development of MetS. It could be used as a specific indicator for the diagnosis and management of MetS.

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