Review Article

Metabolic Syndrome and Diabetes: A Review

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ABSTRACT
The prevalence of metabolic syndrome is increasing worldwide. Several factors such as hyperglycemia are associated with risk of developing metabolic syndrome. Metabolic syndrome is a clinical tool for identification of subjects at risk of diseases such as type 2 diabetes mellitus, which could be a predictor of metabolic syndrome. There may be an association between diabetes, metabolic syndrome and cardiovascular morbidity and mortality. This study aimed to review the literature on diabetes, as a component of metabolic syndrome.

KEYWORDS: Metabolic syndrome; Diabetes; Diseases

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INTRODUCTION
Metabolic syndrome (MetS) is a major public-health problem worldwide. It increases the risk of developing type 2 diabetes mellitus (T2DM) and cardiovascular disease (CVD) by 5- and 2-fold, respectively [1]. Many studies have shown that patients with MetS are at greater risk of stroke (2-4 fold), myocardial infarction (3-4 fold) and mortality (2-fold) compared to those without the syndrome [2]. In 1920, Kylin, a Swedish physician, showed the association of hypertension, hyperglycemia and gout [3]. In 1947, Vague indicated that visceral obesity is associated with metabolic disorders in patients with CVD and T2DM [4]. In 1965, Avogaro and Crepaldi revealed a syndrome that included hypertension, hyperglycemia and obesity [5]. In 1988, Reaven demonstrated “Syndrome X” as a concept of insulin resistance [6]. In 1989, Kaplan introduced the syndrome “The Deadly Quartet”, which is due to upper body obesity, glucose intolerance, hypertriglyceridemia, and hypertension [7]. In 1992, Haffnerre introduced “The Insulin Resistance Syndrome” [8].


It has believed that high prevalence of MetS is the reason for more recent study. Many studies have shown that the worldwide prevalence of MetS ranges from almost 10% to 84%. The prevalence of MetS is affected by geographic location, sex, age, race, sedentary lifestyle, high body mass index and ethnicity [15, 16]. Study of Cameron et al. indicated that the prevalence of MetS and its components is associated with genetic background, diet, levels of physical activity, smoking, family history of diabetes, and education level [17]. Age-related study of Park et al. have revealed that the prevalence of MetS ranges from 20 to 70 years in males and females [18], while findings of Ponholzer et al. showed that prevalence of MetS ranges from 32.6% to 41.5% among
postmenopausal females [19]. Study of
Marjani et al. showed that the prevalence of
MetS in patients with T2DM is higher in
females (53.27%) than in males (48.71%)
[20]. Marjani et al. also indicated that the
frequency of MetS in T2DM patients was
75.42% and 76.79% according to ATPIII
and IDF diagnostic criteria, respectively. In
addition, females have been affected more
than men according to both criteria [21]. The
frequency of MetS in Fars and Sistani ethnic
groups in Gorgan (Iran) was 20.62% and
23.75%, respectively [22,23]. The
prevalence of MetS in Korean and Chi
nese females was 13.8% [24] and 17.8% [25],
respectively. Studies of Eshtiaghi [26], Ainy
[27], Deilbert [28], Figueiredo Neto [29] and
Heidari et al. [30] indicated that the
prevalence of MetS is 18.3%, 53%, 23%,
24% and 44.9%, respectively. The aim of
this study was to review the literature on the
association of diabetes with MetS.

**Diabetes, a component of MetS**

T2DM is a chronic and fatal disease with an
increasing prevalence worldwide [31]. MetS
is a clinical tool for identification of subjects
at risk of some diseases such as CVD and
T2DM. Several factors may lead to
development of MetS [32]. MetS is
associated with insulin resistance, visceral
adiposity, atherogenic dyslipidemia,
endothelial dysfunction, genetic
susceptibility, hypertension, thrombophilia,
and chronic stress [33]. According to the
WHO, diabetes in defined as fasting plasma
glucose of ≥7.0mmol/l (126mg/dl) or 2-h
venous plasma glucose ≥11.1 mmol/l
(200mg/dl) following ingestion of 75g oral
glucose load [34]. The number of patients
with T2DM worldwide has been estimated
to increase to 300 million by 2025 [35].
High glucose level is a component of MetS
[1, 36]. Many studies have reported insulin
resistance as a risk factor for MetS [37]. It is
well demonstrated that insulin resistance
causes hyperglycemia. A study has shown
that insulin resistant was considered in most
subjects with the MetS [38]. Moreover, there
seems to be an association between MetS
and pre-diabetes. In addition, MetS
increases the risk of developing diabetes by
5-fold [39]. Impaired fasting glucose (IFG)
or impaired glucose tolerance (IGT) in
patients with MetS may also increase the
risk of developing diabetes. Some findings
have indicated that MetS without diabetes
may increase the risk of diabetes by almost
5-fold, whereas in patients with IFG or IGT,
the risk of diabetes is 5- to 7-fold higher
compared to subjects with normal blood
glucose [40]. Thus, there may be an
association between IFG or IGT, MetS and
the increased risk of diabetes. Diabetologists
believe that diabetes is a risk factor for CVD
and microangiopathic disease. CVD is the
most important complication of diabetes. It
is accounted for up to 80% of the
macrovascular complications [41,42].
Diabetic patients also have higher risk of
developing hypertension, dyslipidemia, and
obesity. They may also be at risk of
coronary heart disease, stroke, and
peripheral vascular disease along with
retinopathy, chronic kidney disease, bladder
dysfunction, erectile dysfunction, orthostatic
hypotension, gastroparesis, and skin
disorders [33]. Studies have revealed that
there is an association between increased
glucose level and incidence of
microangiopathy (diabetic nephropathy,
retinopathy, and neuropathy). Many
molecular mechanisms have been suggested
to explain the effect of increased glucose
levels in microangiopathy. These
mechanisms include protein kinase C
activation, formation of advanced glycation
end products, formation of reactive oxygen
species, flux through the hexosamine
pathway, the polyol pathway induction,
overexpression of growth factors and
inflammatory cytokines, and defective
insulin signaling [43, 44]. The prevalence of metabolic disorders is increasing worldwide [45]. Several risk factors are associated with this increase [46]. MetS with or without diabetes, is a predictor of coronary heart disease and premature mortality [47-49]. In diabetic patients, MetS is considered a risk factor for chronic microvascular complications [47-48, 50-52]. Some studies have shown association of MetS and microvascular complications in diabetics [53, 54]. Clinical identification of MetS patients is important for management and treatment to reduce the potential risk of subsequent diseases [55]. Lifestyle changes, primarily weight loss, change in diet, exercise, and pharmacological treatment are effective for controlling the risk of complications [56]. However, the clinical management of patients with MetS is not easy. This may be due to lack of a known method for prevention or improvement of all risk factors (components of MetS) of MetS. Physicians use different methods to treat each component of MetS. For example, drug therapy is used to reduce blood pressure, blood glucose, and triglycerides. Lifestyle modification is another method that can be advised by physicians and dieticians [57]. Although the impact of lifestyle modification is less than that of drug therapy, it can be useful for controlling the metabolic risk factors [58]. Weight loss is also suggested for treatment of patients with MetS, which can be carried out by limiting calorie intake, behavioral change, physical activity and anti-obesity medications [58]. Studies have shown that weight loss can lower blood pressure, affect lipid profile (decrease triglyceride and increase high-density lipoprotein levels), and improve insulin resistance [59-60]. Weight loss could also reduce fasting blood glucose, insulin, hemoglobinA1c levels, and contribute to abdominal fat loss [61, 62]. It seems to improve an unusual component of MetS and limit the progression of diabetes [63]. According to the Finnish Diabetes Prevention Study [64] and the US Diabetes Prevention Program [65], diet and exercise have significant effects on the progression of IGT to T2DM. Some studies have revealed association of hyperlipidemia and hyperglycemia (the components of the MetS) with low glycemic index foods [66], while the prevalence of insulin resistance and MetS is associated with high glycemic index foods [67]. Implementation of treatment guidelines provided by the NCEP [68], the seventh Joint National Commission for treatment of high blood pressure [69], the American Diabetes Association [70], the American Heart Association [36], and the National Institute of Health Obesity Initiative [71] could also be used to prevent risk factors of MetS.

CONCLUSION
Several factors can prevent the development of MetS. T2DM is suggested as a predictor of MetS. There is an association between diabetes, MetS and cardiovascular morbidity and mortality.

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