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Abstract

Background:

Obesity is a chronic health problem which affects large number of individuals. Obesity prevalence has been increased in many countries, it is one of the major causes of co-morbidities. The obesity-related co-morbidities including dyslipidemia, which involves reduced HDL cholesterol, increase in LDL and hypertriglyceridemia.

Aim:

To review the prevalence, risk factors of obesity and dyslipidemia as well as the correlation between them and their management.

Method:

Online scientific websites were used to search for articles related to the current subject using different keywords such as obesity, dyslipidemia, obesity and dyslipidemia.

Result:
30 articles were obtained, 10 of them were included and they were original and review articles.

**Conclusion:**

Obesity is increasing globally as a result of modernization, dyslipidemia is associated with obesity and both can be managed by change lifestyle and pharmacological treatment.

**Keywords:** Obesity, Dyslipidemia, Obesity and dyslipidemia correlation.

**Introduction:**

Obesity affects a large number of individuals, this number is increasing, obesity is a chronic health problem which is now recognized as a global epidemic [1]. Obesity prevalence has been increased in many countries of the world during the 3 past decades and it is defined at 30 or higher BMI [2]. The prevalence of obesity has been increased in several developing and developed countries [3]. It was reported that obesity is one of the major causes of co-morbidities including diabetes, and cardiovascular diseases, also it is a leading cause for morbidity and mortality [4]. It has become a pandemic problem and it is the fifth leading cause of mortality globally [5]. The increase of both overweight and obesity is directly correlated with rising of the obesity-related co-morbidities prevalence such as dyslipidemia, hypertention, cardiovascular disease, metabolic syndrome and type 2 diabetes mellitus [1]. Obesity is associated with rising in plasma triglycerides, dyslipidemia involves reduced HDL cholesterol, increase in LDL and hypertriglyceridemia [6]. In this review we aimed to
highlight the prevalence, risk factors and management of obesity and dyslipidemia as well as the correlation between them.

**Materials and methods:**

Online research via scientific research was used to search for articles related to the current subjects. Several key words were used to obtain the required articles such as obesity, dyslipidemia, obesity prevalence, dyslipidemia prevalence, obesity and dyslipidemia, obesity relation to dyslipidemia. We obtained 30 articles, 20 of them were excluded as they didn’t focus on the subject, whereas 10 articles were included. The included articles published between 2011 to 2017.

**Discussion:**

1. **Obesity definition and prevalence:**

Obesity is excessive abnormal fat accumulation in the adipose tissue resulting in severe adverse effects [7]. Obesity is a major factor for the development of dyslipidemia, hypertension, type II diabetes, cardiovascular diseases, metabolic syndrome and certain cancers [8-11]. Obesity is measured by BMI and waist-to-hip circumference ratio (WHR), however BMI is the most commonly used method to define thinness and fatness and it is the ratio of weight per height (Kg/m²) [12]. WHO recommended cutoffs of BMI as follows; 18.5-24.9 for normal, 25-29.2 for overweight, >30 for obesity [13]. Obesity is a significant public health problem, it was claimed that since 1980, obesity has more than doubled globally [4]. The prevalence increased in the last year in both developing and developed countries [5]. It was reported that there were 1.5 billion adults overweight in 2008 with over 200
million men and 300 million women were obese. The prevalence of obesity differs between different nations, ranging from below 5% to over 75% [14]. In 2014, there were more than 1.9 million overweight adults, and over 600 million were obese [15]. Childhood obesity also is highly prevalent where, it was stated that there were 22 million children under 5 years were overweight [14]. In 2014, the number of obese and overweight children increased to 41 million for those less than 5 years old [15] and in 2016, there were 43 million children under 5 years old were overweight [16]. It was reported by WHO that the rates of obesity were higher among females [17]. Saudi Arabia is one of the highest prevalence rates of obesity and overweight [18] it is of great concern as 7 out of 10 individuals are suffering this problem [19]. This occurred as a result of the economic rise happened and westernization as well as modernization of the dietary habits among Saudi population which led to the sudden rise in overweight and obesity prevalence [20,21]. A study from Dammam which conducted on female nursing students found that 3.8% only were obese and 23.1% were overweight [3]. However in a survey on 10,735 individuals with 5 years old showed that obesity was prevalent in 28.7% of respondents, with more prevalence in females than in males; 33.5% and 24.1% respectively [22]. Higher prevalence of obesity was reported from Hail region, where obesity was prevalent in 63.6%, with prevalence of 71% in females and 56.2% in males [23]. One study on females in KSA, showed that 36.9% of households were overweight, whereas 35.5% were obese [24]. One study was conducted on 5 KSA military regions and it was demonstrated that 42% had central obesity, 29% were obese and 40.9% were overweight [2]. It can be concluded that males tend to be overweight, whereas females tend to be obese [4]. Also, WHO found that the prevalence of obesity in KSA was higher in females (30%) than in males (23%) for those in age range of 18-21 years old [17].
2. Obesity risk factors:

The elevation in obesity and overweight prevalence resulted from combination and interaction of several factors including genetic, environmental, metabolic, and behavioural influences [4]. It was reported that high fat diet is the main cause of both obesity and insulin resistance [26]. It was stated by Horaib et al[2] that obesity is caused by the modernization of society such as less physical activity, faulty dietary habits, unhealthy food, and increased stress. The increase in obesity prevalence in Saudi Arabia returns to increasing in obesity main sources such as many diseases including diabetes, obstructive sleep apnea hypertension, hyperlipidemia, and osteoarthritis [22]. In several developing countries, the risk factors for obesity prevalence including adoption of western lifestyle, decreased physical activity and high caloric intake [22]. In Saudi Arabia, it was found that diabetes, diet, hypertension, hypercholesterolemia and physical activity were risk factors for obesity among men and among women, hypertension, and chronic diseases’ history were the risk factors [22]. A study from Saudi Arabia showed that BMI increased by presence of age, diabetes and family history of hypertension [2].

3. Dislipidemia definition, prevalence and outcomes:

Dyslipidemia is lipoprotein metabolism disorders, including overproduction and deficiency of lipoprotein, it involves increase in the level of LDL, total cholesterol and triglyceride as well as reduction in level of HDL, in case of promotion of insulin resistance this results in metabolic syndrome in obesity [27-30]. Most dyslipidemia is hyperlipidemia which involves high level of triglycerides (TGs), cholesterol or both
or low levels of high density lipoprotein (HDL) in blood [31]. Changes in lifestyle lead to dyslipidemia development [32]. There are three types of dyslipidemia, hypercholesterolemia which involves the elevation of cholesterol level than 100 mg/dl, hypertriglyceridemia when triglyceride level exceeds 150 mg/dl and HDL level became lower than 40 mg/dl in male and 50 mg/dl in female, whereas mixed hyperdislipidemia involves the presence of more than one abnormal lipid content[33]. The prevalence of dyslipidemia varies among different nations based on geographic region, studied population, gender, socioeconomic development, and the presence of metabolic disorders and genetic disorders [34]. The American Heart Association evaluated that more than 34 million adult Americans had cholesterol levels higher than 240 mg/dL indicating that they required treatment, whereas one third of population had moderately high cholesterol levels in excess of 200 mg/dL [35]. It was demonstrated that one third of population of the developed countries have dyslipidemia [36,37]. However, the prevalence of dyslipidemia varies depending on ethnicity of the studied group, cultural and socioeconomic characteristics [32,38]. Globally, dyslipidemia prevalence ranged from 2.7% to 51.9% [39-42]. Recently, dyslipidemia in Saudi Arabia became obvious as a result of changes in dociodemographic, lifestyle and dietary habits [43]. It was reported that dyslipidemia ranges from 20%- 44% in Saudi study [44]. It was reported that hypercholesterolemia and hypertyiglyceridemia are prevalent in 50% of adult Saudi population [45]. Dyslipidemia is one of the main risk factors for many chronic non-communicable diseases resulting in morbidity and mortality [44]. It is responsible for the development of atherosclerosis [46,47], type 2 diabetes [48,49], stroke [50,51], and cardiovascular diseases [52,53]. Dyslipidemia is an important risk factor for Coronary heart disease (CHD) and WHO reported that dyslipidemia is responsible for more
than 4 million deaths/year and more than half of global cases of ischemic heart
disease [54]. Also, diabetes mellitus is associated with dyslipidemia, where diabetic
patients have an average LDL-C levels in excess of 140 mg/dL [55].

4. Correlation between obesity and dislipidemia:

It was stated that obesity is associated with several comorbidities including
dyslipidemia, non-alcoholic fatty liver disease (NAFLD), hypertension and
hyperglycemia [38]. One study reported that the prevalence of dyslipidemia was
increased with increasing BMI, also it was reported that both overweight and obesity
are important risk factors for this disease [56]. In fact obesity is an independent risk
factor for dyslipidemia development [57]. Dyslipidemia of obesity involves increased
free fatty acids and triglycerides, while HCL-C decreased and normal or slightly
increased LDL-C with increased small dense LDL, also there is increase in plasma
apolipoprotein (apo) B [58, 59]. It is thought that the other lipid abnormalities return to
hypertriglyceridemia as it leads to formation of small dense LDL [60, 61] and delayed
clearance of the TG-rich lipoproteins [62-64]. In obesity, the lipolysis process of TG-
rich lipoprotein is impaired as a result of reduction in mRNA expression levels
leading to increase in TG [65]. The levels of free fatty acids rise as postprandial
lipemia increase [66]. TG content of LDL increase by CETP activity, while the
cholesterol-ester content of LDL decreases in the presence of hypertriglyceridemia
[66]. Small, dense LDL particles are formed by the action of hydrolyzation of hepatic
lipase on the TG content of LDL, so the small dense LDL in obesity results from TG
concentration and it is independent of total body fat mass [67]. Metabolism of HDL is
influenced by obesity, CETP activity increases by increasing the number of TG-rich
lipoproteins, which exchanges cholesterolesters from HDL for TG from VLDL and
LDL [68]. Also, the reduction of HDL-C result from the lipolysis of TG-rich HDL by
hepatic lipase producing small HDL with a reduction in its affinity for apo A-I, leading to dissociation of apo A-I from HDL and finally decrease in HDL-C levels [69]. A study from Iran showed that there was significant relation between BMI with TG and LDL, where TG and LDL-C were significantly higher in obese and overweight students [70]. A study in India demonstrated that the mean level of cholesterol, LDL-C and TG were significantly higher in obese individuals, and there was an increased risk for dyslipidemia among obese individuals than in normal ones [57]. Another study from India showed that in individuals with high BMI, total cholesterol, LDL, very LDL and TG were higher compared to normal ones, however HDL showed no significant difference [71]. In Saudi study [72] it was found that dyslipidemia was high in obese patients with more prevalence of hypertriglycerideremia type, where 72.2% of obese patients had cholesterol level more than 200 mg/dl, 75.6% of obese patients had LDL level higher than 100 mg/dl, 77.78% had triglyceride more than 150 mg/dl and 55.6% had lower HDL. A study by Jacob et al [57] revealed that cholesterol level was higher in obese persons. Study in Saudi Arabia [73] showed that all types of dyslipidemia were associated with obesity except HDL.

5. The management of obesity and dislipidemia:

Obesity-associated dyslipidemia treatment should based on changes in lifestyle such as healthy diet, weight loss and physical exercise. Both dyslipidemia and insulin resistance in turn are improved by changing life style [74]. Increasing HDL levels and decreasing LDL can manage both obesity and dislipidemia [1]. It was showed that in patients with low LDL, treatment by statin reduced the cardiovascular events [75]. By loss of weight it is expected to decrease LDL-C which may be attributed to increased LDL receptor activity, it was demonstrated that losing of 4-10 Kg in obese individuals
leads to reduction in LDL-C by 12% and increase in LDL receptor mRNA levels by 27% [76,77]. Weight loss was found to reduce fasting and non-fasting TG concentrations which lead to decrease in CETP activity [78,79], hence increased catabolism of TG-rich lipoproteins [80]. Reduction in intra-hepatic TG content is induced by exercise even in absence of weight loss [81]. 16 weeks of exercise training in NAFLD obese persons result in a small reduction in intra-hepatic TG content, but with no changes in VLDL-TG [82]. In overweight men, intra-hepatic TG content was reduced by ingestion of low fat diet for three weeks [83]. It was confirmed in studies that focused on blood lipids that plasma TG was lowered by exercise and weight loss [84], while the effect of exercise on HDL-C levels is controversial [85]. Dyslipidemia can be affected by other types of food such as ingestion of dietary fiber and resistant starch which has been associated with insulin metabolism and improve nutrient absorption [66]. It was reported in a randomized study that intake of resistant starch supplementation (40 g/day) for 8 weeks improved insulin resistance and subsequently FFA metabolism in insulin resistant individuals. Also the ingestion of resistant starch promoted the lipolysis of TG with increased FFA uptake by skeletal muscle and lowered fasting FFA concentrations [86]. However, TG and cholesterol concentrations weren’t affected by resistant starch supplementation [86,87]. The changes in lifestyle seem to be insufficient to improve dyslipidemia and achieve weight loss [66]. Combination of pharmacological treatment with modification of lifestyle in obese individuals with dyslipidemia is dependent on the calculated cardiovascular risk, the potential underlying primary lipid disorders and co-morbidity [88,89]. In case of high risk individuals who suffer diabetes mellitus, cardiovascular disease, primary lipid disorders like familial hypercholesterolemia or familial combined hyperlipidemia require suitable pharmacological treatment independent
from obesity [89,90]. The first choice of drug is statins among all pharmacological agents to reduce non-HDL-C, LDL-C, and/or apo B, however statins reduce TG only and don’t totally correct the dyslipidemia seen in obesity and this in turn may assist in the risk after initiating statin therapy [91]. Statins perform their action by the inhibition of 3-hydroxy-3-methylglutaryl-coenzyme A (HMG-CoA) enzyme, this is the rate limiting step in the hepatic cholesterol synthesis. This results in increase in the fractional catabolic rate of both LDL and VLDL with a slight reduction in hepatic secretion of VLDL. Hence, statins reduce both LDL-C levels and remnant cholesterol [92]. Combination therapies with statin was investigated, it was found that statins can be combined with ezetimibe, which inhibits the intestinal absorption of cholesterol by interaction with NPC1L1 and this results in reduction of LDL-C by 20%, however there was no impact on TG or HDL-C. Fibrates which are fibric acid derivatives are another agent that primarily indicated in the case of hypertriglyceridemia, they result in increase in HDL-C by 9% as an average and TG reduction by 30% as well as LDL-C reduction by 8% [93]. Fibrates transcriptionally regulate lipid metabolism related genes as they are peroxisome proliferator-activated receptor-α agonists [66]. Nicotinic acid inhibits the lipolysis of adipocytes, which results in reduction in VLDL synthesis, decreased FFA levels, decreased catabolism of HDL and a slight rise in HDL production rate [92]. These events lead to reduction in TG levels by 15%–35% and increase in HDL-C concentration by 10%–25% [88,92]. There is no clinical benefit by adding niacin to patients with typical dyslipidemia, known history of cardiovascular disease, and intensively controlled LDL-C levels with statin therapy, only fasting TG is reduced and HDL-C is increased [94]. Data about combination of statins with niacin in obesity is scarce [66]. Omega-3 fatty acids decrease the accumulation and hepatic synthesis of TG [95], and it was
found that reduce plasma TG by 25%–30% by lowering the hepatic secretion of VLDL in insulin resistant persons [92,96]. Omega-3 fatty acids also were found to increase the conversion of VLDL into IDL, and this enhance the benefit for combining omega-3 fatty acids with statins by increasing the catabolism of VLDL, IDL and LDL [159of05].

**Conclusion:**

The current review concluded that obesity was increasing globally including developing countries as developing countries started in changing the lifestyle and their dietary habits. Obesity results in dyslipidemia development, dyslipidemia of obesity involves decreased in HDL-C level and increased triglycerides, with normal or slightly increased LDL-C as well as increased small dense LDL. Obesity as well as dyslipidemia are associated with several diseases and co-morbidities. The management of obesity and dyslipidemia based on two main strategy; changing lifestyle and pharmacological treatment, however pharmacological treatment is dependent on the individual conditions he suffers.

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