JOURNAL OF MOLECULAR PATHOPHYSIOLOGY, 2020
VOL 9, NO. 1, PAGE 1–13
10.5455/jmp.20190717044204

REVIEW ARTICLE

Open Access

Factors associated with obesity and weight reduction among people with obesity: A systematic review

Adetola Morenikeji Ogunbode[1], Mayowa Ojo Owolabi[2], Olayinka Oladunjoye Ogunbode[3], Adesola Ogunniyi[2]

[1]Department of Family Medicine, University College Hospital, Ibadan, Oyo State, Nigeria

[2]Department of Medicine, College of Medicine, University of Ibadan, Ibadan, Oyo State, Nigeria

[3]Department of Obstetrics and Gynaecology, College of Medicine, University of Ibadan, Ibadan, Oyo State, Nigeria

ABSTRACT

Introduction: Obesity is a non-communicable disease of huge public health importance with several multi-systemic complications. Weight reduction techniques are useful in the management of obesity. The aim of this review was to determine the risk factors, health risks of obesity as well as factors influencing weight reduction among individuals with obesity.

Methods: Google, Google Scholar, and Pub Med databases were used to identify studies on obesity that assessed risk factors and complications of obesity plus factors influencing weight reduction among people with obesity. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines were used and 914 literature records were retrieved. These were limited to papers published in English up to 2019. We excluded 702 articles that did not match our theme and also excluded an additional 156 full articles due to incompleteness. The evidence available was critically appraised in line with our objectives.

Results: Fifty-six articles were reviewed, and it was found that obesity increased with age and was more in women. Inadequate diet, physical inactivity, and metabolic disorders were contributory factors, whereas the main factors associated with greater weight reduction were lower pre-treatment weight, lower waist circumference, doctors as role models, and absence of psychiatric co-morbidities.

Conclusions: Proven weight reduction methods are vital for the cost-effective management of patients as part of lifestyle modification.

ARTICLE HISTORY

Received July 17, 2019
Accepted January 16, 2020
Published March 21, 2020

KEYWORDS

Weight reduction; risk factors; health risks; obesity; overweight

Introduction

Obesity is attracting growing public health interest and as a risk factor for other non-communicable diseases (NCDs) and is a growing global health concern because of increasing westernization [1–3]. Several low-income countries are going through an epidemiological change in which you find more obesity in adults [4] as well as in adolescents [5]. Reduction in physical activity, diet, increased television viewing hours, and its positive perception in African communities are suggested to be responsible for the rising prevalence of obesity [3,4,6]. Obesity is one of the major modifiable risk factors for hypertension [6–8] and elevated Body Mass Index (BMI), Waist-Hip Ratio (WHR) plus/or waist circumference (WC) were found to increase the risk of hypertension more than high BMI or WHR alone, which leads to an increased risk of cerebrovascular and other cardiovascular diseases [9,10].

There are several multi-systemic complications associated with obesity and these include type 2 diabetes mellitus, degenerative arthritis, Obstructive Sleep Apnea (OSA), malignancies as well as increased depression and lower self-esteem [2,11–13]. Weight reduction is desirable due to these numerous health-related complications of obesity. The quantity and velocity of weight reduction are determined by several factors, which

Contact Olayinka Oladunjoye Ogunbode ✉ jamchose@yahoo.co.uk Department of Obstetrics and Gynaecology, College of Medicine, University of Ibadan, Ibadan, Oyo State, Nigeria.

include biological drivers- (heredity, leptins, and lipid level) and co-morbidities such as hypertension and diabetes mellitus [14]. Psycho-emotional factors, culture, and perceptions plus lifestyle such as dietary practices and physical activity are also implicated in weight reduction [1,15]. Other factors that influence weight reduction include family support, anthropometric measurements, and subjective confounders such as socio-economic and environmental factors [1]. Weight reduction in people with obesity is crucial because health risks rise exponentially with increasing BMI.

There are few studies that have specifically reviewed the literature on weight reduction techniques in obesity. Studies on obesity discussed weight reduction techniques and found that obese people were able to achieve weight reduction [10,16]. In addition to an appraisal of weight reduction techniques [17], this review is aimed at examining the common risk factors and complications of obesity as well as identifying factors influencing weight reduction in both sexes with special focus on peculiarities in the African setting.

Methods

Using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines (Fig. 1), literature searches were conducted with keywords such as obesity and overweight as the primary search items, risk factors and health risks of obesity as the secondary search items, and weight reduction and weight reduction techniques as the tertiary search items [18].

Types of studies included

This review included articles over three decades from 1985 to 2019 and was part of a larger study titled predictors of weight reduction among obese patients. Literature records in English language only were retrieved from Google, Google Scholar, and Pub Med databases. The publications were sought from high-income countries such as USA, UK, Italy, Netherlands, and low/middle countries like Nigeria, Indonesia, and Jamaica.

Identification, screening and eligibility

Eight hundred and ninety-four articles were retrieved from databases, whereas 20 others were identified using additional sources such as textbooks. Initially, 702 articles were excluded because they did not meet the inclusion criteria for the study and only 212 full-text articles were assessed for eligibility, while those that did not meet the stipulated criteria which included obesity were excluded. A manual search was also conducted on the included studies by checking through the reference sections. Risk factors for obesity and health risks of obesity were examined and 156 articles were then excluded. Only 56 articles were included. Factors associated with weight reduction and weight reduction techniques in obesity were also identified. We incorporated publications from cross-sectional studies, case–control studies, prospective studies, randomized controlled trials, and review articles.

Domain studied

Using rigorous designs, obesity was defined as BMI greater than or equal to 30 kg/m^2, whereas weight

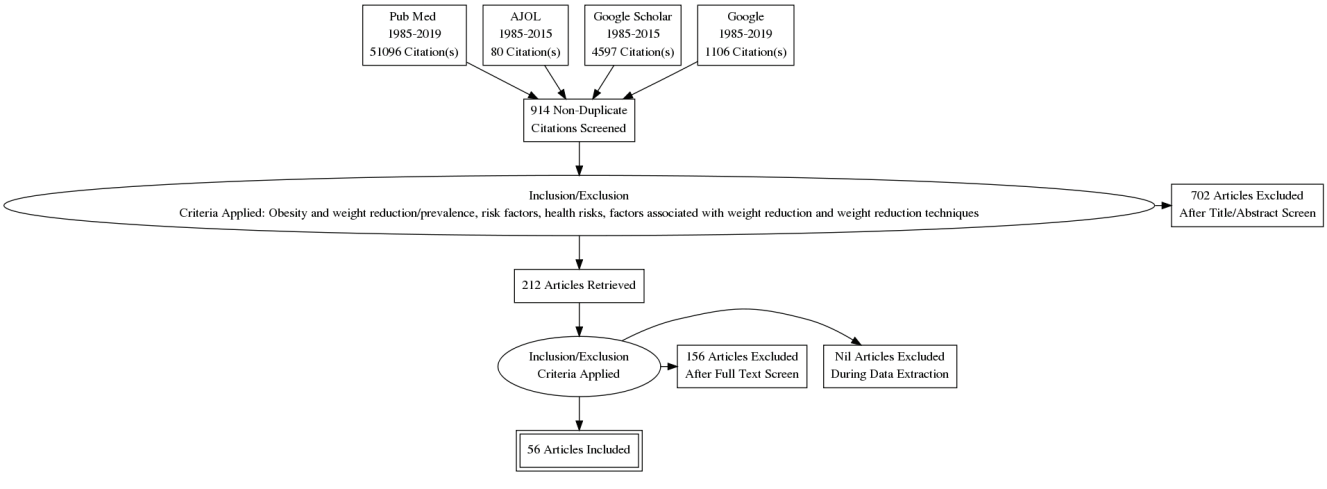

Figure 1. The PRISMA flow chart.

reduction was measured by weight change across a period of time. The weight change varied using criteria such as decline in BMI, WHR, WC, or weight loss greater than or equal to 10% of initial body weight [19].

Results

The studies emanated from different parts of the world and included both high- and low/middle-income developing countries. Prospective as well as retrospective studies were reviewed. Out of the 56 studies reviewed using the PRISMA guidelines [18], 12 employed the descriptive study design, whereas 10 were from secondary data analyses. Five were prospective cohort studies, whereas one was from an analytical dataset. Five were randomized controlled trials, one was a meta-analysis, seventeen were review articles, three were monographs, consensus papers, or briefing papers, and three were mixed study designs. Figure 2 is a world map showing the prevalence of obesity.

Tables 1(a), 1(b), and 2 show a listing of the study designs of the manuscripts included in high- and low/middle-income countries. There was an increase of 2% for each additional hour of television viewed [20], and prevalence of obesity in all respondents was 15%–20%, 6%–13% in men and 8%–15% in women [21]. In England/Wales, women had a prevalence of 20%, whereas men had a prevalence of 17%. In the USA, the prevalence for women was 25% and for men was 20% and was documented as 30.5% in another study in the USA [14]. In Urban Samoa, it was 75% for women and 60% for men [22]. In another report, 29.2% of men were overweight or obese (25 kg/m^2), whereas half of the women were overweight or obese [4]. Three Nigerian studies put the prevalence as 27.5% in males and 36.5% in females [23], 41.8% among women [3], and in nurses, a high prevalence of 62.2% was documented [24].

Discussion

The adipose tissue in individuals with obesity is categorized into brown adipose tissue and white adipose tissue (which is an endocrine organ that secretes adipokines) [25]. The increase in pro-inflammatory adipokines such as interleukin (IL)-1 beta, IL-6, Tumor Necrosing Factor (TNF)-alpha, and leptins and a decrease in anti-inflammatory adipokines such as adiponectin create low-grade inflammation, which leads to insulin resistance, type 2 Diabetes mellitus, hypertension, and cancer. Leptin is the 167 amino acid hormonal protein-product of the obesity gene implicated in the pathophysiology of obesity. Adipose abnormalities found in obesity have also been linked to central nervous system disorders such as brain metabolism issues, neuroinflammation, brain atrophy, and mood disorders cognitive reduction [25].

Zinc metabolism also affects the physiology and biochemistry of many hormones. Zinc is found in the pancreas in high amounts and therefore also regulates insulin. Low zinc levels and high leptin levels are found in obesity and this could imply an association between zinc and leptin [26]. Other determinants of

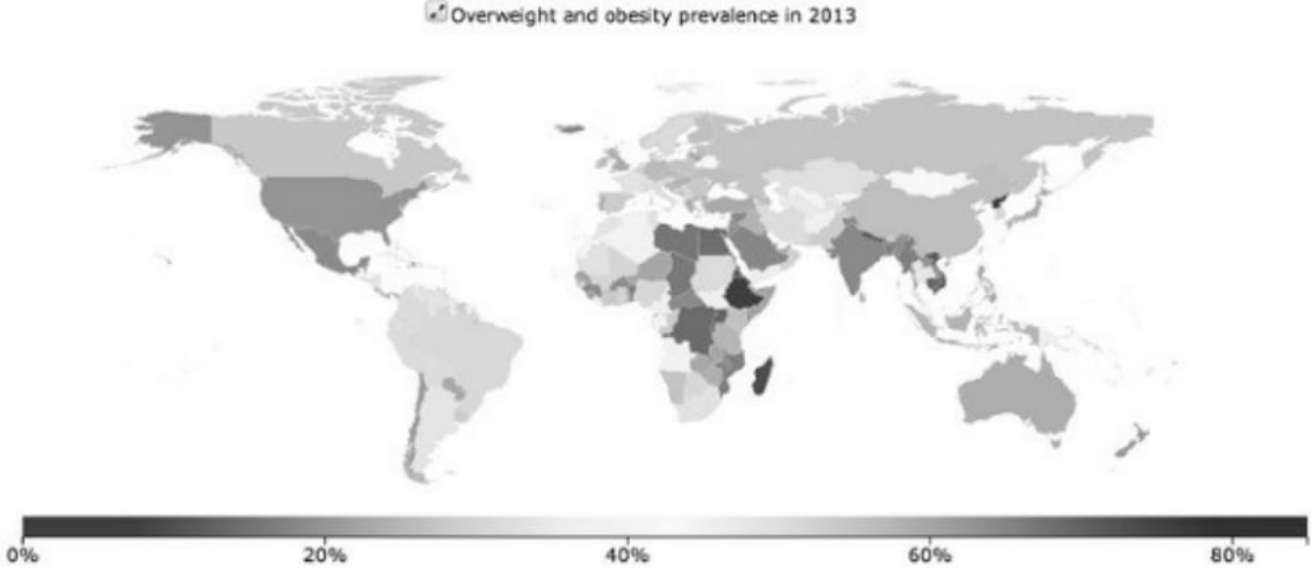

Figure 2. World map showing the prevalence of obesity (WHO 2013).

Table 1a. Study design of review on obesity in high-income countries.

First author	Year of study	Study site/country	Study design
Dietz and Gortmaker [20]	1985	USA	Two cross-sectional studies and one prospective sample (mixed design)
Hennekens et al. [51]	1987	USA	Secondary data
Barabasz and Spiegel [52]	1989	USA	Randomized Controlled Trial (RCT)
Adams and Murphy [21]	2000	United Kingdom	Review article
Kopelman [22]	2000	UK	Review article
Robert et al. [55]	2000	Canada	Randomized Controlled Trial (RCT)
Hansen et al. [45]	2001	8 European centres	RCT, double blinded
Stickles et al. [36]	2001	USA	Secondary data using a questionnaire-based registry
Wadden and Phelan [44]	2002	USA	Review article
American Academy of Family Physicians [14]	2003	USA	Monograph
Van Weel [49]	2003	Netherlands	Review article
Key et al. [11]	2004	UK, USA	Systematic reviews, meta-analyses and large prospective studies
Klein et al. [48]	2004	USA	Consensus statement
Pi-Xunyer [15]	2005	USA	Review paper
Elmer et al. [53]	2006	USA	3 arm RCT
Gong et al. [12]	2006	USA	Part of a randomized placebo controlled trial testing
Anderson and Hensrud [37]	2007	USA	Secondary data
De Panfilis et al. [19]	2007	Italy	Prospective cohort
Powell-Tuck [47]	2007	USA	Secondary data
Lementowski and Zelicof [31]	2008	USA	Review paper
Lavie et al. [28]	2009	USA	Review paper

Table 1b. Study design of review on obesity in high-income countries continued.

First author	Year of study	Study site/country	Study design
Moher et al: PRISMA group [18]	2009	Multicenter	Review article
Cavill and Ells [56]	2010	UK	Briefing paper
Aldaqal and Sehlo [13]	2011	Saudi Arabia	Prospective cohort
Burke et al. [39]	2011	USA	Review article
Grulich-Henn et al. [5]	2011	Germany	Prospective cohort
Pagoto [43]	2011	USA	Secondary data
Bleich et al. [40]	2012	USA	Descriptive cross-sectional study
Bleich et al. [41]	2012	USA	Descriptive cross-sectional study
Webber et al. [27]	2012	Latin America	Review article and cross-sectional regression analysis
Bleich et al. [42]	2014	USA	Descriptive cross-sectional study
Guenzel [38]	2015	USA	Secondary analysis of a dataset
Chouirnard et al. [34]	2016	USA	Descriptive cross-sectional study
Koinis-Mitchell et al. [32]	2017	USA	Secondary data
Forny-Germano et al. [25]	2019	Canada	Review article

obesity include globalization and socioeconomic factors such as an association between low educational level, increasing BMI, and ethnicity [1]. Globalization involves the integration of the populace with the world market economy giving rise to a nutritional shift from foods with low fat and high fiber, to meat and dairy containing large amounts of saturated fats [1]. Urbanization also leads to alteration in diet with higher fat and increased sedentary life with greater access to tobacco [1]. Obesity was found in a report

Table 2. Study design of review on obesity in low/middle-income countries.

First author	Year of study	Study site/country	Study design
Anate et al. [10]	1998	Nigeria	Review article
Luke et al. [46]	2002	Nigeria, USA	Prospective cohort
Puoane et al. [4]	2002	South Africa	Secondary data: demographic and health survey
Lucas and Gilles [50]	2003	Tropics	Secondary data
Tanchoco et al. [9]	2003	Philippines	Secondary data: nutrition survey
Yekeen et al. [23]	2003	Nigeria	Cross-sectional descriptive study
Kruger et al. [1]	2005	South Africa	Review
Durazo-Arvizu et al. [16]	2008	Nigeria, Jamaica and the USA	Analytical dataset
Okafor et al. [7]	2008	Nigeria	Cross-sectional
Mshelia et al. [29]	2009	Nigeria	Prospective case control
Ogunbode et al. [2]	2009	Nigeria	Review article
Tamin et al. [30]	2009	Indonesia	Case report
Adeyemo et al. [35]	2010	Nigeria	Descriptive recruiting consecutive patients
Ogunbode et al. [3]	2010	Nigeria	Descriptive cross-sectional
Ogunjimi et al. [24]	2010	Nigeria	Descriptive
Osuji et al. [6]	2010	Nigeria	Descriptive
Amole et al. [8]	2011	Nigeria	Cross-sectional descriptive study
Ogunbode et al. [17]	2011	Nigeria	Review article
Ogunbode et al. [54]	2015	Nigeria	Short communication
Mulugeta et al. [33]	2018	Ethiopia	Prospective cohort study
Baltaci et al. [26]	2019	Turkey	Review article

in both urban and rural women, even though rural women consumed less fat, had reduced household incomes and carried out greater physical activity than urban women [1]. More black men and women had obesity compared to men and women of mixed ancestry, Asians and Caucasian women in another report [1]. Age is also implicated in the development of obesity and obesity has been found to have an increasing prevalence in adolescents [5]. Other factors that lead to obesity include physical activity [20], cultural perceptions [1], perceptions [4], beliefs about body weight, and psycho-emotional factors. In addition, with the explosive increase in the prevalence of African people with full-blown Acquired Immune Deficiency Syndrome, obesity is seen to reflect persons who are healthy [4]. In Nigeria, reports show that obesity is perceived as an index of beauty and a sign of good living [3,24]. These risk factors from a review of the literature in high- and low/middle-income countries are depicted in Tables 3(a), 3(b), and 4.

Globally, there is an obesity epidemic, which is increasing the magnitude of NCDs [27]. Obesity has multi-systemic complications and in the cardiovascular system has been associated with hypertension. In a study conducted in south western Nigeria, out of the 250 hypertensive patients, mild hypertension was found to be more in the females (55.4%) with a higher proportion of females (56%) being overweight and obese (63.6%), whereas moderate and severe hypertension was more among males [23]. In another Nigerian study, it was determined that hypertension was strongly associated with obesity [8]. Obesity has an important effect on Cardio Vascular Disease (CVD) leading to heart failure through increased cardiac output and low total peripheral resistance with invariably lower systemic vascular resistance [28]. These causes what is known as the obesity paradox in which several people who have obesity with background CVD have a better prognosis than lean individuals. However, a lot of data is still more in favor of intentional weight reduction, which has been more beneficial. Other CVDs due to obesity include coronary heart disease, sudden cardiac death, and atrial fibrillation [28].

Health risks in the metabolic/endocrine system include dyslipidemia, which has been linked to obesity in Africans [7]. Out of the 166 patients who had serum cholesterol analysis in a Nigerian study, 9.6% had elevated cholesterol levels (>240 mg/dl) [23]. BMI, dietary practices, and level of physical activity predict the risk of developing

Table 3a. Risk factors from review on obesity in high-income countries.

First author	Year of study	Factors	Comments
Dietz and Gortmaker [20]	1985	A) Environmental B) Family characteristics C) Host	A) Geographic region, population density, and season B) Parental obesity, parental age, marital status, socioeconomic class, race, and family size C) Reduced thermogenesis in response to carbohydrates
Adams and Murphy [21]	2000	A) Poverty B) Wealth C) Ethnicity	A/B) Increased with poverty in developed countries and with wealth in developing countries C) Ethnicity: African and Mexican Americans have a greater risk than white Americans
Kopelman [22]	2000	A) Genetics B) Environmental factors C) Energy expenditure and intake D) Culture E) Fetal nutrition	A) Obesity runs in families. Leptin is a gene product which reduces body weight and body fat in animals by suppressing food intake. The hypothesis of a leptin deficiency leading to obesity in humans has not been sustained. Obesity is also found in Prader–Willi syndrome and Bardet–Biedl syndrome B) People with obesity are sometimes not sure when they were exposed to the obesogenic environment C) Energy expenditure: This deals with the physical activity which is equivalent to 20%–50% of total energy expenditure. Loss in weight for those who exercise 3 or more times a week. Energy intake: High fat diet increases obesity risk D) Culture: Increased westernization leads to increase in obesity E) Undernutrition of the fetus may lead to obesity; thrifty phenotype

Table 3b. Risk factors from review on obesity in high-income countries continued.

First author	Year of study	Factors	Comments
American Academy of Family Physicians [14]	2003	Over-the-counter drugs Parents with obesity	A) Over-the-counter drugs that increase binge eating B) Having one or more parents with obesity could lead to children or adolescents with obesity
Grulich-Henn et al. [5]	2011	Age	Obesity is more in adolescents
Guenzel [38]	2015	Mental health conditions:	These four mental health conditions, bipolar disorders, Attention Deficit Hyperactivity Disorder-ADHD, panic disorders, and agoraphobia are more significantly linked to increased BMI
Chouirnard et al. [34]	2016	Mental health conditions: A) Schizoaffective B) Schizophrenia	A) Schizoaffective conditions predispose to increased risk B) Schizophrenia predispose to decreased risk
Koinis-Mitchell et al. [32]	2017	A) Sleep B) Anxiety and depression	A) Sleeping less than 7–9 hours increases the risk B) Individuals with anxiety and depression are more at risk
Forny-Germano et al. [25]	2019	Genetics	Rise in pro-inflammatory adipokines, e.g., interleukin-1 and leptins and a fall in anti-inflammatory adipokines predisposes to increased risk in obesity
Baltaci et al. [26]	2019	A) Genetics B) Micronutrients	A) Increased Leptin B) Low Zinc

diabetes mellitus [29]. Patients with diabetes mellitus who were also obese and had increased high-density lipoprotein-cholesterol (HDL-C) had a triple risk of CVD in the future regardless of their total cholesterol or HDL-C values [29]. The peripheral distribution of fat is found to be commoner in females, whereas the central distribution of fat is commoner in males and is metabolically more active than fat in the periphery, thus is linked to dylipidemias, diabetes mellitus, and ischemic

Table 4. Risk factors from review on obesity in low/middle-income countries.

First author	Year	Factors	Comments
Luke et al. [46]	2002	Physical activity	Low levels of physical activity
Puoane et al. [4]	2002	A) Culture B) Age C) Education	A) Increasing obesity with increasing urbanization and affluence B) Age: obesity began at a younger age in women and 10% of women were obese by age 1–24 years C) Women with no education had a lower BMI than those with some schooling because they did more hard work and those with tertiary education had a lower BMI than those with some schooling because they knew more about the link between body weight and health
Kruger et al. [1]	2005	A) Urbanization/globalisation B) Socioeconomic factors C) Dietary practices D) Culture E) Physical activity	A) Increase in urbanization and globalization B) Socioeconomic factors such as low level of education C) Dietary practices, e.g., buying food high in fat from street vendors, contribute to obesity D) The culture of overeating plus finding overweight women more attractive E) Reduced physical activity all add up to cause obesity
Adeyemo et al. [35]	2010	A) Females B) Age C) Poverty	A) Obesity was more in females B) In patients above 60 years C) Poverty in a middle-income country (with a per capita Gross National Product (GNP) of about $3,000 per year) leads to a greater risk of obesity
Amole et al. [8]	2011	A) Women B) WC	A) Women were more sedentary than men and their families preferred high density food B) Increasing WC reflected obesity
Ogunbode et al. [17]	2011	A) Physical Activity B) Diet C) Antidepressants D) Steroids	A) Reduced physical activity B) Diet C) Antidepressants D) Steroids
Mulugeta et al. [33]	2018	Age	Obesity in mid-life is associated with depression

heart disease [21]. In a study among 58 children between the age of 8 and 17 years, it was found that there were higher insulin resistance and dyslipidemia, which reduced with 6 months of weight-reducing interventions [5]. The interventions among these children with obesity included training in physical activity, cognitive behavioral training, and nutritional counseling [5].

Osteoarthritis (OA) is a musculoskeletal health risk of obesity and a frequent complication of obesity [30]. A review paper highlighted literature that showed a statistically significant link between OA and obesity [31]. In one case–control study, when BMI was less than 20 kg/m^2, the odds ratio (OR) for developing OA was 0.1 (95% CI 0.0–0.5) as against 13.6 (95% CI 5.1–36.2) when BMI was more than 36 kg/m^2 [30]. It was of note that being overweight or obese at the age of 36–40 years was also associated with developing OA of the knee as one grew older [31].

Respiratory health risks of obesity also include sleep apnea. Patients with OSA in Obstructive Sleep Apnea Syndrome also present with snoring, daytime sleepiness, and morning headaches [21]. The initial consequence of OSA was noted to be respiratory acidosis with the long-term consequence being documented as type II respiratory failure and eventually the obesity hypoventilation syndrome [21], which was formerly known as the Pickwikian syndrome and comprises obesity, hypoxia, hypercapnia, and right ventricular failure [22].

From a review paper on published studies concentrating on recent systematic reviews, meta-analyses, and large prospective studies, overweight/obesity is convincingly related to risks for cancers of the esophagus (adenocarcinoma), colorectum, breast (postmenopausal), endometrium, and kidney [11]. Obesity is also associated with an increased risk of high-grade and thus clinically significant prostate cancer [12]. This was reported in

the USA in a study among 10,258 participants (1,936 prostate cancers) in the Prostate Cancer Prevention Trial, who all had the presence or absence of cancer determined by prostate biopsy [12]. In comparison with men who had BMI < 25 kg/m^2, obese men (BMI ≥ 30 kg/m^2) had an 18% [OR, 0.82; 95% confidence interval (95% CI), 0.69–0.98] decreased risk of low-grade prostate cancer (Gleason <7) and a 29% (OR, 1.29; 95% CI, 1.01–1.67) increased risk of high-grade prostate cancer (Gleason ≥7) [12].

A report showed that patients with obesity have lower self-esteem compared with matched healthy subjects and revealed a positive (direct) relationship between BMI and depression [13]. Koinis-Mitchell et al. [32] also obtained information for their research from the third wave of the Asthma, Depression, and Anxiety in Island Puerto Rican Youth (ADA) Study, among youths 4–17 years of age. They found out that the risk of developing obesity was higher in those youths who slept for less than 7–9 hours and those with anxiety/depression were more likely to have obesity [32]. Mulugeta et al. [33] in a mixed study design noted that individuals in their mid-life with obesity had a greater propensity towards depression. Chouirnard et al. [34] in 2016 also found out from a cross-sectional study among 262 in-patients and out-patients that people with schizophrenia had less risk of obesity, as compared with those with schizoaffective disorders who had more risk of developing overweight and obesity.

Individuals with obesity are also at a social disadvantage and may be discriminated against in employment opportunities [1]. Obesity can be associated with infertility and menstrual irregularities and surgical procedures could be challenging [17,35]. In Nigerian studies, it was stated that surgeons need to be aware of obesity-/overweight-related medical and surgical complications [35] and there may also be hesitancy among surgeons before operations in obese patients in view of complications that may arise [36].

Factors influencing weight reduction are documented in Table 5 and include individual factors such as stress, depression, and time constraints [37]. Furthermore, the absence of certain psychiatry co-morbidities is related to weight reduction and this was corroborated by the study by Guenzel [38] who performed a secondary analysis of the Collaborative Psychiatric Epidemiology Surveys (CPES) dataset using a descriptive case–control design. The CPES dataset comprised information on 20,013 adult community-dwellers chosen through multi-stage randomized sampling in the US who reported symptoms of disorders [38]. In this report by Guenzel [38], it showed that out of the disorders studied, most co-morbid psychiatric conditions are not related to a high risk of high BMI, however, four of this disorders (bipolar disorders, agoraphobia, attention-deficit hyperactivity disorder, and panic disorders) were significantly linked. Individual motivation, baseline weight, previous successes with weight reduction, and enrollment in weight reduction programs are also implicated [39]. Another factor that affects weight reduction

Table 5. Factors associated with weight reduction.

Hansen et al. [45]	2001	Pre-treatment body weight, height, fat-free mass, fat mass, and resting metabolic rate on univariate analysis, but only pre-treatment body weight on multivariate analysis
American Academy of Family Physicians [14]	2003	Doctors serving as role models for change. Having supportive staff and clinic environment
Klein et al. [48]	2004	WC measurement helps the doctor decide who should be checked for dyslipidemia and hyperglycemia
Kruger et al. [1]	2005	Fear of losing weight because of HIV stigma and personal safety affected their physical activity and subsequently their weight reduction
De Panfilis et al. [19]	2007	Psychiatric co-morbidities enhanced adherence and motivation to reduce weight
Aldaqal and Sehlo [13]	2011	1 year after laparoscopic sleeve gastrectomy, depression, self-esteem, and physical health improved
Amole et al. [8]	2011	Learning how to measure and interpret their waistline circumference
Burke et al. [39]	2011	Gender, ethnicity, enrollment in a structured weight loss program
Bleich et al. [40]	2012	Doctors as role models. Doctors with normal BMI reported more weight reduction consultations than their counterparts
Guenzel [38]	2015	Absence of psychiatry co-morbidities

is doctors and other health workers as role models and this was corroborated by Bleich et al. [40] in 2012 in a national cross-sectional study among primary care physicians in the USA, which comprised 500 general practitioners, family practitioners, and general internists. These authors reported that physicians with normal BMI reported more weight loss consultations among their patients with class II obesity than their colleagues who were overweight or obese, 30% versus 18%, $p = 0.01$ [40].

In another report on obesity causes and solutions, these researchers also found out that physicians who were <20 years in the practice felt that nutritionist and dieticians were better able to take care of patients with obesity [41]. Physicians in primary care also requested for more training in dietary and exercise requirements as well as practice-based changes such as making BMI the fifth vital sign in the patient chart [41]. Bleich et al. [42] in 2014 also carried out a survey among 500 non-physician health workers drawn from nutrition, nursing, behavioral health, exercise, and pharmacy. There was more success reported in helping patients to reduce in weight among health workers with normal BMI compared to those with obesity 52% versus 29%, $p = 0.01$ [42].

Family-related factors such as support and the family structure are also implicated in weight reduction. Conditions that cause weight gain or interfere with weight reduction efforts include diabetes mellitus, metabolic syndrome [14], and the use of antidepressants such as tricyclic antidepressants [43]. As many as 20%–30% of individuals who seek weight reduction have been found to suffer from binge eating [44]. In a study done in developed countries to determine weight reduction in patients with obesity, the Sibutramine Trial of Obesity Reduction and Maintenance, which was a randomized, double-blind, placebo-controlled, European multicenter study, the authors also concluded that only pre-treatment body weight seemed to be an important independent predictor of weight reduction [45].

The factors affecting weight reduction may play out differently among countries of different economic strata. In middle-income countries, weight change was greater than in low- or high-income countries, and this could be attributed to the cultural and behavioral shifts, which occur in these transitional societies [16]. A study using analytical datasets collated from studies between 1994 and 1999 examined weight change among 1242 Nigerian, 1409 Jamaican, and 809 American women and documented weight reduction among obese people [16]. In another study, the authors concluded that energy expended in physical activity was strongly associated with adiposity among populations of West African origin and may predict weight gain in individuals as low Activity Energy Expenditure was an important determinant of high percentages of body fat in black adults [46]. Determining the factors that influence weight reduction will lead to risk stratification and eventual management of the obese individual. The Malnutrition Universal Screening Tool combines BMI score, acute disease, and weight reduction score [36], then management plans are derived for each category of risks [47].

It is important to set a weight reduction goal that is both achievable and maintainable. Even a moderate weight reduction of 5% of body weight can produce significant health benefits and may be a reasonable initial goal for most patients [48], even though 10% weight reduction could also be an achievable goal for some individuals [19]. Management of obesity involves prevention, which includes lifestyle modification such as behavioral modification, increase in physical activity, and dietary modification with adequate follow-up [49]. The review on weight reduction methods in high- and low-income countries is shown in Tables 6(a), 6(b), and 7.

Prevention of obesity includes three levels such as primary, secondary, and tertiary [50]. Primary prevention involves health education about obesity, ensuring that there are enough parks for exercise and low cholesterol cooking oil is available for public consumption. Secondary prevention involves screening, early detection, and treatment of obesity. In the USA, the US Preventive Services Task Force recommended screening adults for obesity [37]. To qualify for screening, the disease must have public health significance; management was given before the symptoms started, which should be more helpful in lowering morbidity and mortality than that given after they develop; and the prevalence of pre-clinical disease should be high among the population screened [51]. Obesity fulfills these criteria. Tertiary prevention includes rehabilitation with the use of assistive devices for individuals with severe knee OA secondary to morbid obesity.

Proper management of patients with obesity will involve identifying the factors including lifestyle variables, which account for poor compliance and outcome in behavioral weight control programs [19]. Barabasz and Spiegel [52] added a modified form of hypnosis intervention, which includes specific food aversion to simple self-management methods and found an increase in weight reduction after

Table 6a. Weight reduction techniques from reviews on obesity in high-income countries.

Dietz and Gortmaker [20]	1985	Reduction in television viewing and increase in physical activity
Barabasz and Spiegel [52]	1989	Hypnosis intervention modified to include specific food aversion
Adams and Murphy [21]	2000	Dieticians needed
Kopelman [22]	2000	Healthy eating and increased physical activity. Find major and minor genes in the etiology
Robert et al. [55]	2000	The exercise-induced weight reduction group had more body weight and total fat reduction than the diet-induced weight reduction group
Hansen et al. [45]	2001	Weight loss program with low energy diet
Wadden and Phelan [44]	2002	Diet, physical activity, and behavioral therapy
Key et al. [11]	2004	Foods should have at least 400 g/day of total fruits and vegetables plus regular physical exercise
Klein et al. [48]	2004	Declining WC can be used to assess an individual's response to diet and regular aerobic exercise
Pi-Xunyer [15]	2005	Diet, exercise, and behavioral therapy
Elmer et al. [53]	2006	Behavioral intervention: three groups: 1. Established (guideline recommended), 2. Established and Dietary Advice to Stop Hypertension, 3. Advice only
Gong et al. [12]	2006	Healthy diet and increased physical activity
Anderson and Hensrud [37]	2007	Diet, exercise, behavioral therapy, and pharmacology
De Panfilis et al. [19]	2007	Weight loss program: individualized hypocaloric diet and daily light-to-moderate physical exercise. Behavioral counseling: regular self-monitoring. Full psychiatric evaluation and personality assessment
Powell-Tuck [47]	2007	Diet
Lementowski and Zelicof [31]	2008	Bariatric surgery, e.g., gastric stapling
Cavill and Ells [56]	2010	Physical activity component of 150 minutes per week. Dietary advice, commercial, and community-based weight management programs

Table 6b. Weight reduction techniques from reviews on obesity in high-income countries continued.

Aldaqal and Sehlo [13]	2011	Bariatric procedure performed with decline in the BMI
Burke et al. [39]	2011	Behavioral weight loss programs: self-monitoring using diaries to record food, exercise pattern, and weight. Diaries were either paper, internet-based, or PDAs.
Grulich-Henn et al. [5]	2011	Increased exercise, cognitive behavioral therapy, and dietary counseling led to weight reduction and a fall in dyslipidemia
Bleich et al. [41]	2012	Doctors with less than 20 years of experience felt that nutritionist and dieticians were more empowered to take care of people with obesity. The doctors wanted more training on diet and exercise and wanted practice-based changes, e.g., BMI as the fifth vital sign on the patient chart
Webber et al. [27]	2012	Health policies and greater surveillance needed
Bleich et al. [42]	2014	Non-physicians with normal BMI had more success in helping patients to reduce weight compared to non-physicians with obesity

3 months. Screening tools that will predict weight reduction and maintenance in patients with obesity will also need to be developed [45]. The main results from the PREMIER Collaborative Research Group trial supported the fact that comprehensive behavioral intervention programs improve lifestyle behavior and lower blood pressure [53].

In developing a physical activity program, the clinician should devise a plan that can be maintained without injury based on the patient's current level of activity and readiness to increase activity. Physical activity can be assessed using a 7 days interviewer-administered physical activity recall to assess energy expenditure [48]. The International Physical Activity Questionnaire (IPAQ) is short form enquires about the last 7 days and has a self-administered format for use with young and middle-aged adults (15–69 years). Versions of the IPAQ for use by either telephone or self-administered methods are available. The purpose of the IPAQ is to provide common instruments that can be used to obtain internationally comparable data on health-related

Table 7. Weight reduction techniques from reviews on obesity in low/middle-income countries.

Anate et al. [10]	1998	Diet, exercise and drugs
Puoane et al. [4]	2002	Obesity appears to begin at an earlier age group in South African females
Yekeen et al. [23]	2003	Diet
Kruger et al. [1]	2005	Lifestyle interventions. Preventive programs: education, diet, and exercise. Universal, selective, and targeted programs. Do-it-yourself, non-clinical, and clinical programs are also encouraged
Ogunbode et al. [2]	2009	Healthy diet and increase exercise
Tamin et al. [30]	2009	Exercise and diet
Adeyemo et al. [35]	2010	Require procedures for weight reduction such as intermaxillary fixation
Ogunbode et al. [3]	2010	BMI calculation and support groups
Ogunjimi et al. [24]	2010	Health promotion and mini gymnasiums in hospitals
Amole et al. [8]	2011	Increase physical exercise and adjust their diet to reduce the WC
Ogunbode et al. [17]	2011	Diet, exercise, behavioral therapy, group activities, medication for treating obesity, anti-depressants and bariatric surgery
Ogunbode et al. [54]	2015	Lifestyle modification using the mnemonic: WASHED Weight control, alcohol reduction, smoking cessation, health promotion, exercise and diet

physical activity. Exercise should then be recommended and increased gradually up to 30 minutes/day which adds up to 150 minutes/week [54].

A Randomized Control Trial (RCT) was performed among 52 men with obesity in a research center and the participants were divided into four groups: diet-induced weight reduction group, exercise-induced weight reduction group, exercise without weight reduction group, and a control group. After 3 months, it was found that body weight and total fat reduced in both the weight reduction groups, even though it was more in the exercise-induced group [55]. Grulich-Henn et al. [5] in their study among adolescents also found out that strategies such as increasing exercise, behavioral therapy, and dietary counseling caused the dyslipidemia to fall.

The dietary aspects of management should be personalized and follow the individual's lifestyle with the objective of lowering energy intake [56]. It should also fit food preferences and be adapted to suit the culture of the individual as well as the period, for example, seasonal fruit choices could be made. Dietary counseling must also involve targeted advice such as goals to achieve as well as family involvement.

Pharmacotherapy can be a useful adjunct to lifestyle modification in the long-term management of obesity in selected patients [48]. Orlistat (Xenical) is a gastric and pancreas lipase inhibitor, which reduces intestinal fat absorption [17]. It has several side effects and the risks versus benefits should be weighed before use. It must be emphasized that lifestyle modification techniques are still the first-line option in obesity management.

Surgery can also be done. Wiring of the jaws can be offered in extreme obesity. Gastroplasty may also be performed but it has high mortality. Gastric bypass, adjustable silicone gastric banding, and vertical gastric banding can also be done. Liposuction can also be carried out but with varying outcomes and uncosmetic scars [17].

Conclusion

Obesity is an NCD of increasing concern both in high- and low/middle-income countries. Following the review, obesity and its health risks were found to have an association with leptin, zinc, increase in age with a female predilection, and increasing WC. Inadequate diet, physical inactivity, and metabolic disorders were associated factors, whereas there was greater weight reduction with lower pre-treatment weight, doctors being role models, and no psychiatric co-morbidities. Appropriate weight reduction methods are very important as part of lifestyle modification.

Financial support and sponsorship

Nil

Conflicts of interest

There are no conflicts of interest.

References

[1] Kruger HS, Puoane T, Senekal M, van der Merwe MT. Obesity in South Africa: challenges for government and health professionals. Public Health Nutri 2005; 8(5):491–500.

[2] Ogunbode AM, Fatiregun AA, Ogunbode OO. Health risks of obesity. Ann Ibadan Med 2009; 7(2):22–5.
[3] Ogunbode AM, Ladipo MMA, Ajayi IO, Ogunbode OO, Adebusoye LA, Fatiregun AA. Prevalence of obesity among women attending a Nigerian primary care clinic. Trop J Health Sci 2010; 17(1):59–65.
[4] Puoane T, Steyn K, Bradshaw D, Laubscher R, Fourie J, Lambert V, et al. Obesity in South Africa: the South African demographic and health survey. Obesity Res 2002; 10(10):1038–48.
[5] Grulich-Henn J, Lichtenstein S, Horster F, Hoffmann GF, Nawroth PP, Hamann A. Moderate weight reduction in an outpatient obesity intervention program significantly reduces insulin resistance and risk factors for cardiovascular disease in severely obese adolescents. Int J Endocrinol 2011; 6; doi:10.1155/2011/541021
[6] Osuji CU, Nzerem BA, Meludu S, Dioka CE, Nwobodo E, Amilo GI. The prevalence of overweight/obesity and dyslipidemia amongst a group of women attending August meeting. Niger Med J 2010; 51(4):155–9.
[7] Okafor CI, Fasanmade OA, Oke DA. Pattern of dyslipaemia among Nigerians with type 2 Diabetes mellitus. Niger J Clin Pract 2008; 11(1):25–31.
[8] Amole IO, OlaOlorun AD, Odeigah LO, Adesina SA. The prevalence of abdominal obesity and hypertension amongst adults in Ogbomoso, Nigeria. Afr J Prm Health Care Fam Med 2011; 3(1):5.
[9] Tanchoco CC, Cruz AJ, Duante CA, Litonjua AD. Prevalence of metabolic syndrome among Filipino adults aged 20 years and over. Asia Pac J Clin Nutr 2003; 12(3):271–6.
[10] Anate M, Olatinwo AWO, Omesina AP. Obesity an overview. West AfrJMed 1998; 17(4):248–54.
[11] Key TJ, SchatzkinA, Willett WC, Allen NE, Spencer EA, Travis RC. Diet, nutrition and the prevention of cancer. Public Health Nutri 2004; 7(1A):187–200.
[12] Gong Z, Neuhouser ML, Goodman PJ, Albanes D, Chi C, Hsing AW, et al. Obesity, diabetes, and risk of prostate cancer: results from the prostate cancer prevention trial. Cancer Epidemiol Biomarkers Prev 2006; 15(10):1977–83.
[13] Aldaqal SM, Sehlo MG. Depression and self esteem in patients with morbid obesity: the effect of sleeve gastrectomy. J Am Sci 2011; 7(12):1116–23.
[14] American Academy of Family Physicians. Practical Advice for Family Physicians to help Overweight Patients. Obesity Monograph 2003; 1:1–24.
[15] Pi-Xunyer FX. Weight loss in type 2 diabetic patients. Diabetes Care 2005; 28(6):1526–7.
[16] Durazo-Arvizu RA, Luke A, Cooper RS, Cao G, Dugas L, Adeyemo A, et al. Rapid increases in obesity in Jamaica, compared to Nigeria and the United States. BMC Public Health 2008; 8:133.
[17] Ogunbode AM, Ladipo M, Ajayi IO, Fatiregun AA. Obesity: an emerging disease. Niger J Clin Pract 2011; 14(4):390–4.
[18] Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic review and meta-analyses: the PRISMA statement. BMJ 2009; 339:b2535.
[19] De Panfilis C, Cero S, Dall'Aglio E, Salvatore P, Torre M, Maggini C. Psychopathological predictors of compliance and outcome in weight-loss obesity treatment. Acta Biomed 2007; 78(1); 22–8.
[20] Dietz WH, Gortmaker SL. Do we fatten our children at the television set? Obesity and television viewing in children and adolescents. Pediatrics 1985; 75(5); 807–12.
[21] Adams JP, Murphy PG. Obesity in anaesthesia and intensive care. Br J Anaesth 2000; 85(1):91–108.
[22] Kopelman PG. Obesity as a medical problem. Nature 2000; 404:635–43.
[23] Yekeen LA, Sanusi RA, Ketiku AO. Prevalence of obesity and high level of cholesterol in hypertension: analysis of data from the University College Hospital. Ibadan Afr J Biomed Res 2003; 6:129–32.
[24] Ogunjimi LO, Ikorok MM, Yusuf OO. Prevalence of obesity among Nigeria nurses: the Akwa Ibom State experience. Int NGO J 2010; 5(2):45–9. Available via http://www.academicjournals.org/ingoj (Accessed 16 July 2012).
[25] Forny-Germano L, De Felice FG, do Nascimento Vieira MN. The role of Leptin and adiponectin in obesity-associated cognitive decline and Alzheimer's disease front. Neurosci 2019; https://doi.org/10.3389/fnins.2018.01027
[26] Baltaci AK, Mogulkoc R, Baltaci SB. Review: the role of zinc in the endocrine system. Pak J Pharm Sci 2019; 32(1):231–9.
[27] Webber L, Kilpi F, Marsh T, Rtveladze K, Brown M, McPherson K. High rates of obesity and non-communicable diseases predicted across Latin America. PLoS One 2012; 7(8):e39589.
[28] Lavie CJ, Milani RV, Ventura HO. Obesity and cardiovascular disease: risk factors, paradox and impact of weight loss. J Am College Cardiol 2009; 53(21):1925–32.
[29] Mshelia DS, Garbati MA, Ndahi AA, Mamza YP, Sheikh HA. The usefulness of total cholesterol and high density lipoprotein-cholesterol ratio in interpreting lipid profile results of diabetes mellitus patients. Niger J Clin Pract. 2009; 12(4):345–9.
[30] Tamin TZ, Witjaksono F, Winokan MAC, Soewito, F. The management for grade I obesity as the underlying disease of osteoarthritis. Maj Kedokt Indon 2009; 59(3):129–33.
[31] Lementowski PW, Zelicof SB. Obesity and osteoarthritis. Am J Orthop 2008; 37(3):148–51.
[32] Koinis-Mitchell D, Rosario-Matos N, Ramírez RR, García P, Canino GJ, Ortega AN. Sleep, depressive/anxiety disorders, and obesity in Puerto Rican Youth. J Clin Psychol Med Settings 2017; 24(1):59–73.

[33] Mulugeta A, Zhou A, Power C, Hyppönen E. Obesity and depressive symptoms in midlife: a population-based cohort study. BMC Psychiatry 2018; 18:297.
[34] Chouirnard VA, Pingali SM, Chouirnard G, Henderson DC, Maliya SG, Cypress AM. Factors associated with overweight and obesity in schizophrenia, schizoaffective and bipolar disorders. Psychiatry Res 2016; 237:304–10.
[35] Adeyemo WL, Bamgbose BO, Ogunlewe MO, Ladeinde AL, Taiwo OA. Overweight and obesity among patients attending a Nigerian oral surgery clinic: implications for oral surgical practice in Nigeria. Afr Health Sci 2010; 10(1):40–5.
[36] Stickles B, Phillips L, Brox WT, Owens B, Lanzer WL. Defining the relationship between obesity and total joint arthroplasty. Obes Res 2001; 9(3):219–23.
[37] Anderson GJ, Hensrud DD. Obesity. In: Robert E. Rakel (ed). Textbook of Family Practice, 7th edition, Philadelphia, Saunders, pp 1107–58, 2007.
[38] Guenzel N. Psychiatric comorbidities and BMI: an exploratory analysis. Theses & Dissertations, 2015. https://digitalcommons.unmc.edu/etd/19
[39] Burke LE, Wang J, Sevick MA. Self-monitoring in weight loss: a systematic review of the literature. J Am Diet Assoc 2011; 111(1):92–102.
[40] Bleich SN, Bennett WL, Gudzune KA, Cooper LA. Impact of physician BMI on obesity care and beliefs. Obesity 2012; 20:999–1005.
[41] Bleich SN, Bennett WL, Gudzune KA, Cooper LA. National survey of US primary care physicians' perspectives about causes of obesity and solutions to improve care. BMJ Open 2012; 2:e001871.
[42] Bleich SN, Bandara S, Bennett WL, Cooper LA, Gudzune KA. Impact of non-physician health professionals' BMI on obesity care and beliefs. Obesity (Silver Spring) 2014; 22(12):2476–80.
[43] Pagoto S. Psychological co-morbidities of physical illness. A behavioural medicine perspective. In: Pagoto S, Schneider K, Appelhans BM, Curtin C, Hagduk A (eds.). Psychological co-morbidities of obesity, Springer, New York, NY, pp 1–72, 2011.
[44] Wadden TA, Phelan S. Assessment of quality of life in obese individuals. Obes Res 2002; 10(1):50S–7S.
[45] Hansen DL, Astrup A, Toubro S, Finer N, Kopelman P, Hilsted J, et al. STORM study group. Predictors of weight loss and maintenance during 2 years of treatment by sibutramine in obesity. Results from the European multi-centre STORM trial. Int J Obesity 2001; 25(4):496–501.
[46] Luke A, Durazo-Arvizu RA, Rotimi CN, Iams H, Schoeller DA, Adeyemo AA, et al. Activity energy expenditure and adiposity among black adults in Nigeria and the United States. Am J Clin Nutr 2002; 75(6):1045–50.
[47] Powell-Tuck J. Nutritional assessment. In: Swash M, Glynn M (eds.). Hutchison's clinical methods. An intergrated approach to clinical practice. 22nd edition, Saunders Elsevier, Toronto, Canada, pp 44–50, 2007.
[48] Klein S, Sheard NF, Pi-Sunyer X, Daly A, Wylie-Rosett J, Kulkarni K, et al.. Weight management through lifestyle modification for the prevention and management of type 2 diabetes: rationale and strategies. Diabetes Care 2004; 27(8):2067–73.
[49] Van Weel C. Dietary advice in family medicine. Am J Clin Nutr 2003; 77(4):1008S–10S.
[50] Lucas A, Gilles H. In: A short textbook of preventive medicine for the tropics. 3rd edition, English Language Book Society/Hodder & Stoughton, England, UK, 2003.
[51] Hennekens CH, Buring JE. Edited by Laurent SL. Epidemiology in Medicine. 1st edition, Little Brown, Boston\Toronto, OH, Chapter 13, pp 327–47, 1987.
[52] Barabasz M, Spiegel D. Hypnotizability and weight loss in obese subjects. Int J Eating Dis 1989; 8(3):335–41.
[53] Elmer PJ, Obarzanek E, Vollmer WM, Simons-Morton D, Stevens VJ, Young DR, et al. PREMIER collaborative research group. Effects of comprehensive lifestyle modification on diet, weight, physical fitness, and blood pressure control: 18 months results of a randomized trial. Ann Intern Med 2006; 144(7):485–95.
[54] Ogunbode AM, Owolabi MO, Ogunniyi A, Ogunbode OO. Weight control, alcohol reduction, smoking cessation, health promotion, exercise and diet (WASHED)': a mnemonic for lifestyle modification in obesity. Niger J Clin Pract 2015; 18(6):831–2.
[55] Robert R, Dagnone D, Jones PJH, Smith H, Paddags A, Hudson R, et al. Reduction in obesity and related comorbid conditions after diet-induced weight loss or exercise-induced weight loss in men: a randomized, controlled trial. Ann Intern Med 2000; 133(2):92–103.
[56] Cavill N, Ells L. Treating adult obesity through lifestyle change interventions. A briefing paper for commissioners. National Obesity Observatory, Oxford, UK, 2010.