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Obesity in South Asia: Phenotype, Morbidities, and Mitigation

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Abstract

Purpose of Review Obesity has increased in South Asian countries that are still grappling with undernutrition. In this review, we highlight the characteristics of obesity, its relation to morbidities, and its management in South Asians. A literature search was conducted using relevant search engines and based on key words focusing on obesity in South Asians.

Recent Findings The increasing trend in obesity prevalence is caused by imbalanced diets and physical inactivity. South Asians, in general, have higher body fat and lower skeletal muscle mass at the same or lower BMIs compared to white people ("high body fat-normal BMI-low muscle mass" phenotype). In addition, excess abdominal adiposity, typically seen in South Asians, and increased hepatic fat (non-alcoholic fatty liver disease) are associated with an increased risk for type 2 diabetes and cardiovascular disease. Challenges in treatment include lack of awareness regarding correct diets and non-compliance to diet and exercise regimens. Social and cultural issues limit physical activity in South Asian women. Finally, there is a lack of expert health professionals to deal with increased cases of obesity. Aggressive management of obesity is required in South Asians, with more intensive and earlier diet and exercise interventions (i.e., at lower BMI levels than internationally accepted). At a population level, there is no clear policy for tackling obesity in any South Asian country. Prevention strategies focusing on obesity in childhood and the creation of food and activity environments that encourage healthy lifestyles should be firmly applied.

Summary Obesity in South Asians should be evaluated with ethnic-specific guidelines and prevention and management strategies should be applied early and aggressively.

Keywords Obesity · Management · Comorbidities · Counseling · South Asians · Asian Indians · Diet · Physical activity · Pharmacotherapy · Bariatric surgery

Introduction

Cardiovascular disease, diabetes mellitus, and chronic kidney disease account for 27%, 4.0%, and 3.0% of deaths, respectively, in South Asia [1•]. There is an appreciable increase in obesity in all South Asians countries [2]. The existing trend indicates that obesity is increasing among both genders (see further discussion below) and in children and adolescents [3, 4]. This increase in obesity has led to an increase in associated comorbidities such as type 2 diabetes mellitus (T2DM), hypertension, dyslipidemia, coronary heart disease (CHD), non-alcoholic fatty liver disease (NAFLD), obstructive sleep apnea, and certain cancers. The occurrence of multiple morbidities leads to a financial burden on the individual and drains health care resources in these developing economies [5].

We have conducted a literature search on medical search engines, PubMed (National Library of Medicine, Bethesda, MD, USA) and Google Scholar using the key words, "obesity; South Asians; diagnosis; comorbidities; management; diet; physical activity; lifestyle intervention; and pharmacotherapy." Specifically, the following discussion takes into consideration the published guidelines for Asian Indians, international

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guidelines, and review articles from India and developed countries. For prevalence statistics, data from the most recent nationally representative samples were used.

A few general points regarding obesity, commonly seen in all South Asians, are outlined below:

1. In developed countries, the prevalence of obesity is lower among urban residents compared to their rural counterparts. However, opposite associations can be seen among South Asian countries. Urban living is a risk factor for obesity [6–8]. Recently, the prevalence of obesity has been increasing in low and middle socioeconomic strata in South Asia [8].
2. The prevalence of obesity is observed to be higher in women than men [7], more so in postmenopausal women [9].
3. Abdominal obesity is particularly common in South Asians [10] and has been recognized as an important risk factor for T2DM and CVD [3, 8].
4. Traditionally, overweight/obesity has been considered a sign of health and wealth in this region. Therefore, weight misperception is a practical limitation for successful weight loss strategies. For example, more than two-thirds of overweight adults and one-third of obese adults in Sri Lanka perceive that they are in the correct weight category or are underweight [11]. Significant underperception of body size was seen among subgroups who had comorbid diseases [12].
5. An obese and "chubby" baby is considered healthy by mothers. There is a tendency for mothers to overfeed children to increase their weight by giving them foods that are calorie-dense and saturated fat–dense [5, 13, 14]

Phenotype, Epidemiology, and Guidelines for Diagnosis of Obesity

A number of studies indicate that South Asians are at risk for the development of diabetes mellitus and other comorbidities at lower levels of body mass index (BMI) and waist circumference than white people [15, 16]. Furthermore, they have higher body fat at a given value of BMI than white people [17]. These data have prompted lower BMI cutoffs as ≥ 23.0–24.9 kg/m^2 and ≥ 25 kg/m^2 for overweight and obesity, respectively, in South Asians. Typical phenotypes of obesity include abdominal obesity (increase in subcutaneous, deep subcutaneous, and intra-abdominal visceral adipose tissue) and excess liver fat [18, 19, 20••, 21]. It is possible that abdominal subcutaneous (particularly deep subcutaneous) and intra-abdominal visceral adipose tissue combined together contribute to insulin resistance in South Asians [20••]. Although the relationship between obesity and NAFLD, insulin resistance, and T2DM in South Asians is increasingly being researched [22–25], that of pancreatic fat needs more data [26•, 27]. Finally, low skeletal muscle mass (sarcopenia) is now recognized to be more common in South Asians and was shown to be independently associated with T2DM [28]. The "high body fat-normal weight/BMI-low muscle mass" phenotype is typical of South Asians [8]. While BMI continues to be a common measure to classify obesity, waist circumference is less measured by clinicians. Because a higher risk for T2DM and CVD is evident at a lower cutoff of waist circumference in South Asians than white people, most international bodies state, and clinicians now use lower limits of waist circumference for South Asians (less than 80 cm for women and 90 cm for men) [19, 20••, 29, 30].

Generalized and abdominal obesity is increasing in South Asia (Table 1). Nearly two-thirds of Maldivians are overweight (BMI ≥ 23 kg/m^2), whereas rural India has the lowest prevalence of overweight (M, 14%; F, 17%). The lowest prevalence of obesity is reported from Bangladesh (4.6%), and the highest prevalence is in Maldives (43.5%). According to the ICMR-INDIAB study in India, the prevalence of abdominal obesity varied from 16.9% in Jharkhand (Central India) to 36.3% in Chandigarh (North India) [10]. The prevalence of abdominal obesity is generally high in all studies [37] (Table 1), even among children [38] and underprivileged populations [39]. All South Asian studies reported a high prevalence of obesity among urban populations. In Sri Lanka, living in a rural area is considered to be a protective factor. This is mainly because those who live in rural areas are more active and have less purchasing power to buy calorie-rich foods [6]. Among South Asians, the prevalence of obesity and abdominal obesity appears to be higher among women than men [18, 40, 41] (see later discussion).

There are several limitations of prevalence data of obesity in South Asians. First, there are no secular data by any research group or government of individual countries. Second, prevalence values have been reported in disparate age groups making comparisons difficult. Third, not all surveys are likely to be truly representative of the whole population. Finally, differences in the prevalence of obesity in different South Asian countries depend on criteria of diagnosis, year of survey, and extent of urban population sampled.

Urbanization, Globalization, and Sociocultural Behaviors Drive Obesity in South Asia

With increasing wealth throughout South Asia, people in all strata of society, including those belonging to lower socioeconomic strata, have more dietary choices and "Western foods" are available at relatively low prices [42, 43]. The nutrition transition in South Asia is reflected by the consumption of

Table 1 Prevalence of overweight, obesity, and abdominal (central) obesity in South Asian Countries

Country [reference]	Setting	Year	Sample size	Age group	Overweight (%)	Obesity (%)	Abdominal obesity (%)	Diagnosis criteria
Afghanistan [31]	Urban	2013	1200	25–65	A, 32.5 M, 33.8 F, 31.0	A, 24.9 M, 15.9 F, 35.8	A, 56.6 M, 49.3 F, 65.5	OW25–30, Ob ≥ 30, WC > 80 (F); WC > 94 (M)
Bangladesh [32]	National	2011	5495	≥ 35	A, 18.9 M, 17.4 F, 18.4	A, 4.6 M, 3.0 F, 6.0	NR	OW 23.0–27.5, Ob ≥ 27.5
India [10] Chandigarh	Urban and rural	2008–2010	3216	≥ 20	A, 15.9	A, 31.3	A, 36.1	OW ≥ 23, Ob ≥ 25 WC ≥ 80 (F); WC ≥ 90 (M)
Jharkhand			3207		A, 7.8	A, 11.8	A, 16.9	
Maharashtra			3809		A, 11.3	A, 16.6	A, 18.7	
Tamil Nadu			3568		A, 15.2	A, 24.6	A, 26.6	
India [33]	Urban	2015–2016	171,155	15–49	M, 26.0 F, 36.0	NR	NR	OW > 22.99
	Rural	2015–2016	425,289	15–54	M, 14.0 F, 17.0	NR	NR	OW > 22.99
Maldives [34]	Urban	2004	2028	25–64	A, 63.3 M, 60.8 F, 65.5	A, 43.5 M, 38.1 F, 48.1	A, 40.0 M, 24.2 F, 54.1	OW ≥ 23, Ob ≥ 25, WC > 80 (F); WC > 90 (M)
Nepal [35]	National	2016	13,542	≥ 18	M, 28.8 F, 32.8	NR	NR	OW/Ob ≥23.0
Pakistan [36]	Urban and rural	2013–2014	7366	≥ 18	A, 26.3 M, 26.5 F, 26.2	A, 14.9 M, 12.1 F, 17.1	NR	OW 25–29, Ob ≥ 30,
Sri Lanka [6]	National	2005–2006	4532	≥ 18	A, 25.2 M, 22.6 F, 28.0	A, 9.2 M, 7.2 F, 11.3	A, 26.2 M, 16.5 F, 36.3	OW ≥ 23,Ob ≥ 27.5, WC ≥ 80 (F); WC ≥ 90 (M)

NR, not reported; *OW*, overweight (kg m^{-2}); *Ob*, obesity (kg m^{-2}); *WC*, waist circumference (cm); *A*, all; *M*, males; *F*, females

foods high in saturated fats, sugar, and refined carbohydrates and low intake of polyunsaturated fatty acids and fiber [42, 43]. Of particular importance are the common and nutritionally dense "fast foods" sold by street vendors who use partially hydrogenated oil mixtures containing high amounts of saturated fats and trans-fatty acids (TFA). These oils are heated and reheated (this increases trans-fatty acid formation) in a vessel to make local snacks [44]. Interestingly, in urban areas (New Delhi) of North India, proximity and density of Indian "fast food" and full-service Indian restaurants (rather than restaurants serving Western foods) were associated with obesity [45]. In particular, intake of fried snacks or sweets appeared to be positively associated with abdominal adiposity [46, 47] (Table 2). Overall, a mix of calorie-dense South Asian and Western "fast foods" are increasingly consumed by South Asians. Those who are unaware of healthy nutrition (often people belonging to middle and low socioeconomic strata) are increasingly becoming obese [48]. Furthermore, migration from rural habitats to cities is associated with dietary imbalances and physical inactivity. We have shown an increasing gradient of non-communicable disease among rural residents, rural-urban migrants, and urban residents. Importantly, there was a significant correlation ($p < 0.001$) between duration of migration to cities with waist size and high fat content in their diets [49].

Another prime driver of obesity and T2DM in South Asians is sedentary behavior and lack of physical activity [8]. Almost all studies show that South Asians are less physically active than white people [5, 18]. In a countrywide study in India (National Nutrition Monitoring Bureau Survey, 2017), 28% of men and only 15% of women participated in regular physical exercise [50]. Interestingly, physical activity is not optimal even in rural populations, as reported in Punjab (North India) and Vellore (South India) [51, 52]. In a UK study, Asian Indians, Pakistanis, and Bangladeshis had lower levels of physical activity and it was inversely correlated with BMI, abdominal obesity, systolic blood pressure, plasma glucose, and insulin levels [53].

Diet and physical activity in South Asia are often influenced by traditional but incorrect beliefs. In general, slight overweight/obesity is considered a sign of "good health" [11]. A common misconception is that an "obese child is a healthy child," and thus should be given good ("excess") food. Mothers feel that feeding excess *ghee* (clarified butter) and butter to children will impart them with physical strength [14].

Obesity Is More Pronounced in Women than in Men

An increasing prevalence of overweight and obesity in women has been shown in repeated surveys in India [40,

Table 2 Food habits related to obesity/abdominal obesity in South Asians

1. Excess intake of refined carbohydrates, particularly high sugar and sweet intake
2. Frequent intake of fried snacks/snacks made with high–saturated fat oils
3. Use of oils high in saturated fats for cooking
4. Low intake of fiber due to low fruit and vegetable intake
5. Increasing intake of:
   a. Sugar-sweetened beverages
   b. "Westernized" calorie-dense foods

54]. The National Family Health Survey (NHFS; NHFS-2 (1998–1999), conducted on 90,000 women belonging to different socioeconomic strata with various educational and occupational backgrounds and differing caste, community, and religion between the ages of 15 and 49 years in 26 states in India, and NHFS-3 (2005–2006, conducted on 124,385 women in 29 states) [55, 56] showed that obesity in urban women ($\geq$ 23 kg/m^2) had increased from 9.4 to 24% between the two surveys. In rural areas, the prevalence has increased from 2.6% in NFHS-2 to 7% in NFHS-3 [55–57]. We have also shown similar data in postmenopausal women residing in urban slums in New Delhi; overweight and abdominal obesity were present in 23.7% and 28% of women, respectively [39]. In a multi-site study in rural, urban-poor, and urban-middle class women, the prevalence of overweight/obesity (BMI $\geq$ 25 kg/m^2) was 22.5, 45.6, and 57.4%, respectively [7]. Similarly, nationally representative data on 4767 women between the ages of 15 and 49 years (2012–13) in Pakistan, showed that 25% were overweight (BMI 25.0–29.9 kg/m^2) and 14% were obese (BMI $\geq$ 30 kg/m^2), with prevalence highest in urban areas and in those belonging to high socioeconomic stratum [58]. The prevalence of obesity in women in Bangladesh and Nepal is also substantial, and higher among those from high socioeconomic stratum [59]. Finally, data from Sri Lanka showed that women were twice as likely to be obese compared to men [6]. Consistent with increasing obesity, abdominal obesity, and the metabolic syndrome, the prevalence of T2DM in South Asian women, presently similar to men, is likely to increase further [10, 18, 40, 41, 51, 60].

There are multiple reasons for obesity in South Asian women. Lifestyle practices in South Asian women remain poor, and views and beliefs regarding diet and obesity are often incorrect ("sterilization is a cause of obesity") [61]. Other factors that predispose Indian women to obesity include sedentary behavior, imbalanced diets, sequential and additive postpartum weight gain and a decrease in physical activity during this period, and cultural and security concerns relating to outdoor physical exercise [40, 61]. Interestingly, obesity in mothers and their erroneous nutrition-related beliefs also correlate to obesity in their offspring [14].

Cardiovascular Risk and Mortality with Obesity in South Asians

Mortality due to CVD is increasing globally, with the incidence of CVD being predicted to increase further in the coming decades. South Asian populations have higher mortality rates due to CVD than Western populations. This is because of differences in urbanization, life expectancy, demographic profiles, and differences in environmental and genetic risk factors [5]. The early onset of multiple cardiovascular risk factors has been reported from India [62]. One of the significant risk factors for early myocardial infarction in South Asians was elevated waist-to-hip ratio [63].

Data regarding the relationship of BMI or waist circumference to all-cause mortality in South Asians are scarce. In a pooled analysis of 20 prospective cohorts (mean follow-up of 9.7 years) in Asia, including data from 835,082 East Asians (China, Taiwan, Singapore, Japan, and Korea) and 289,815 South Asians (India and Bangladesh), the association of BMI with death from CVD was the primary endpoint. In South Asians, the association between BMI and mortality from CVD was less pronounced than that in East Asians. Importantly, South Asians had an increased risk of CVD death observed only in individuals who had a BMI greater than 35 kg/m^2 (hazard ratio 1.90; 95% confidence interval 1.15 to 3.12) [64] (Fig. 1). The only evidence linking both overweight and obesity with increased premature mortality in South Asians is from a study in Mauritius that took into account both waist circumference and the protective effect of larger hip circumference. [65]. In the recent 2-year prospective CARRS study (conducted in Chennai and New Delhi, India and Karachi, Pakistan), the predisposition for hypertension was 28% higher in participants whose BMI was greater than 25 kg/m^2 compared to individuals whose BMI ranged from 18.0 to 22.9 kg/m^2, after adjusting for the effect of waist circumference and other potential confounding variables [66]. In another study of 148,173 individuals from Mumbai, Western India, an increased risk of mortality at low and high BMI was reported. In this 6-year follow-up study, the risk of mortality for overweight (BMI 25.0–30.0 kg/m^2) men (relative risk = 0.87) and women (primarily aged 60 years or more, relative risk = 0.82) was lower than those who had a normal BMI (18.5–25.0 kg/m^2). Only obese men older than 60 years of age (BMI $\geq$ 30.0 kg/m^2) had an increased mortality risk (RR, 1.22) [67]. It is possible that BMI and waist circumference cannot capture mortality risk in South Asians, unless other factors (hip circumference, protective factor [65], sarcopenia, potential independent risk factor) [68]) are considered. Overall, more data are required for more definitive statement to be made.

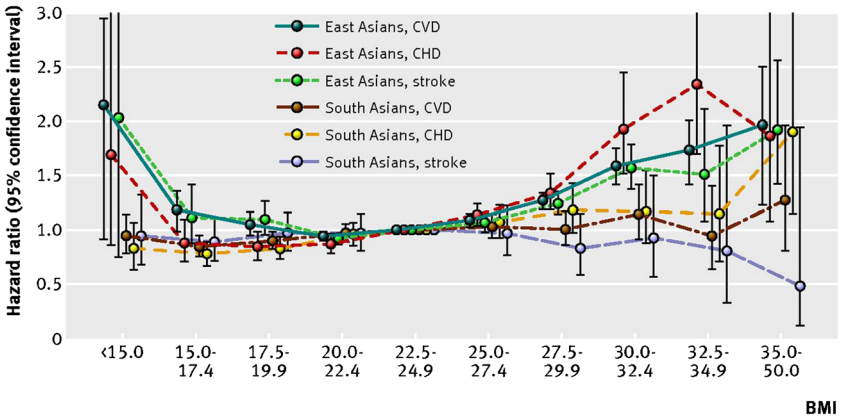

Fig. 1 Association between BMI and CVD mortality in East Asians and South Asians. Analyses for the calculation of hazard ratios were adjusted for baseline age, sex, cigarette smoking, alcohol consumption, educational attainment, marital status, urban residence, and baseline status of cancer. All analyses excluded the first 3 years of follow-up. Reproduced from Chen et al. [64] ©2013, with permission from the BMJ Publishing Group Ltd

Management of Obesity in South Asians

In general, management strategies should be discussed with patients to prevent T2DM and CVD [69••]. All interventions, including diet, exercise, drug therapy, and bariatric surgery, should be attempted in South Asians at lower cutoffs of BMI than would typically be recommended in other populations (Table 3**)** [70]. A general plan for the management of obesity for South Asian clinicians is shown in Table 4. Diet and exercise advice should be individualized according to sociocultural, geographical, and economic contexts.

South Asians consume diets that are often high in carbohydrates (rice, simple sugars, such as popular sweets), saturated fats (fried snacks and high–saturated fat oils), and trans-fatty acids (use of unhealthy oils) and are low in fiber (low intake of fruits), monounsaturated fatty acids (MUFA), and ω-3 polyunsaturated fatty acids (PUFA) [8, 43, 72, 73]. The intake of fruits and vegetables is very low among Sri Lankans; only 3.5% of the population ate the recommended amount of five fruits and vegetables daily [74]. Moreover, protein intake is low, with approximately 10% energy intake among Sri Lankan adults [75]. Some foods (e.g., fruits) are considered by patients to be "bad" for diabetes mellitus, and others (curry leaves, bitter gourd) are considered to be "good" [76]. Furthermore, adherence to prescribed diets is generally poor in South Asians and poses problems for weight loss, particularly in patients who have diabetes mellitus [77]. South Asians should be advised to reduce calorie intake, reduce sugar intake, increase consumption of complex carbohydrates, proteins, and nuts, and reduce the consumption of saturated fats and partially hydrogenated vegetable oils (*vanaspati*) [42, 43, 77, 78]. Interestingly, most South Asians are not aware that obesity is a strong risk factor for diabetes mellitus, and weight loss is often not considered to be part of the management of diabetes mellitus by South Asian patients [76].

There is a paucity of dietary intervention studies in South Asians. Intervention studies with nuts in patients who have metabolic syndrome [79] and with high monounsaturated vegetable oils in patients who have NAFLD [23] have shown reductions in weight and liver fat, respectively. In vegetarians, increasing protein intake to 26.9% energy has led to a significant weight loss in Asian Indians [80]. Furthermore, meal replacement with a protein drink led to a decrease in body weight, body fat, and waist circumference, and it also had beneficial effects on metabolic parameters [81]. Although a varied diet is considered to be indicative of healthy behaviors, a study done in Sri Lanka reported a positive association between obesity and high dietary diversity; hence, obese patients should improve dietary diversity in selective food items [82]. Reduced rice intake along with increased intake of vegetables and protein may improve the obesity-associated metabolic

Table 3 BMI cutoffs for management of obesity in Asian Indians

Treatment	25–26.9 23	27–29.9 25	30–34.9 27	35–39.9 32.5	≥40 37.5
Diet, exercise, behavioral therapy	+	+	+	+	+
Drug therapy[a]		With comorbidities	+	+	+
Bariatric surgery				With comorbidities	+

The top two rows indicate BMI cutoffs in kg/m^2; the first one as per international guidelines, and the second row as suggested for Asian Indians/South Asians. BMI figures indicate cutoff after which a particular treatment should be started. In all rows, + indicates that intervention modality is applicable at indicated BMI cutoff

[a] Can also be applied if waist circumference is 10 cm more than normal

Adapted from [70]

Table 4 Recommendations for medical management of Asian Indians with obesity

		Recommendations
1	Clinical work-up (excluding history)	Physical exam: height, weight, waist circumference, waist-hip ratio, body mass index, estimation of percentage body fat[a], acanthosis nigricans, xanthelasma, arcus, double chin[b], "buffalo hump"[b], tendon xanthoma, gynecomastia, abdominal striae, thyroid palpation
		Laboratory tests: 75-gram oral glucose tolerance test, glycated hemoglobin (HbA1c), fasting lipid panel, thyroid function test, uric acid, blood urea and serum creatinine, hepatic transaminases, serum cortisol[c]
2	Diet	• Advise an individualized hypocaloric diet. Reduce carbohydrate and saturated fats. Advise use of correct oils and cooking methods.
		• High-protein diets or meal replacement with high-protein drink could be attempted if not contraindicated (see text).
3	Physical activity	Advise at least 60 minutes of physical activity (a combination of aerobic and resistance exercises) daily or > 300 minutes of activity per week.
4	Drug therapy	• Orlistat (BMI ≥ 27 kg/m^2 or a BMI of greater than 25 kg/m^2 with comorbidities)
		• Lorcaserine[d]
		• Liraglutide for carefully selected non-diabetic individuals
		• Judicious use of metformin, SGLT2 inhibitors, and other GLP-1 agonists in obese patients with diabetes
5	Bariatric surgery	For patients with BMI of 32.5 kg/m^2 in the presence of comorbidities and 37.5 kg/m^2 in the absence of co-morbidities

[a] Optional investigations, [b] correlated with metabolic syndrome in Asian Indians [71], [c] if clinically suspected, [d] will be available soon in India. *SGLT-2*, sodium glucose transporter-2; *GLP-1*, glucagon-like

Adapted from Behl and Misra [69••] ©2017, with permission from Elsevier

risk profile [83]. Comprehensive dietary guidelines for healthy eating and weight loss for Asian Indians are available for reference [73]. To have more robust data, long-term weight loss studies and research on gene-diet interactions are needed. Unfortunately, detailed dietary discussions and planning are infrequent due to the high number of patients seen by each physician in South Asia, and the shortage of trained nutritionists and allied health care personnel [8]. Further innovations are needed, such as delivery of dietary interventions at home [84] or in the community area by trained health personnel with the use of customized vehicles for checkups, a popular intervention in underprivileged patients who have diabetes mellitus in North India [5].

South Asians have lower levels of physical activity compared to white people [8, 18, 54, 85•], as stated previously. Lack of time, absence of facilities for exercise, climate extremes, environmental pollution, and social and security reasons (for women) are frequently cited as reasons for the inability to perform adequate exercise. For patients, a physical activity best suited to their socioeconomic status, lifestyle, and environment is advisable. A combination of aerobic and muscle strengthening exercises (resistance) is beneficial and should be modulated to gender and environment. A goal of 60 min of physical activity daily or ≥ 300 min of weekly moderate intensity physical activity is recommended. An increase in duration and intensity will lead to further weight loss. Guidelines for physical activity for Asian Indians are available for reference [86]. The benefits of *Yogic Asanas*, common in South Asia, on weight loss, if any, remain poorly researched [87]. The use of non-prescription weight loss products has increased and is often propagated by online social media [88].

Pharmacotherapy can be added to lifestyle changes to increase weight loss. The recommended cutoffs for use of pharmacotherapy in Asian Indians are BMI ≥ 27 kg/m^2 without comorbidities and ≥ 25 kg/m^2 with comorbidities [70] (Table 3). In addition, it may be considered if waist circumference is 10 cm higher than the upper limit of gender-specific normal values for Asian Indians [70] (Table 3. Medications approved by the US Food and Drug Administration (US FDA) for weight loss include orlistat, liraglutide, lorcaserin, phentermine-topiramate combination, and bupropion-naltrexone combination. Of these medications, orlistat and liraglutide are available in South Asia. In India, liraglutide (*Victoza*®) is available in pens that deliver a maximum of 1.8 mg for the treatment of T2DM. In addition, SGLT2 inhibitors could aid in weight loss in obese patients who have diabetes mellitus, as shown in a recent study in India [89].

Barriers to any weight loss regimen include non-compliance to allocated therapy, use of alternative medicines, personal and social engagements interfering with diets and exercise, and cost issues. These barriers pose significant interference with the management of obesity and diabetes mellitus in South Asians [90].

Prevention of Obesity

Some data suggest that multicomponent interventions can reduce weight in schoolchildren [91–93] and adults [79, 81, 94] in India, but few studies have involved a large number of subjects or were long-term trials. There is no clear policy for tackling obesity in schoolchildren or in adults in any South Asian country. Given the shortage of resources for individual treatment of obesity in South Asia, environmental interventions that encourage healthy lifestyles for all may be particularly cost-effective. Modeling has shown that taxation on sugar-sweetened beverages (SSBs) could reduce the prevalence of overweight and obesity by 3.0% and the incidence of T2DM by 1.6% in India between 2014 and 2023 [95], but no policy change on this issue is in place yet. In July 2016, a "fat" tax (tax on burgers, pizza, and other junk food available in branded outlets) of 14.5% was introduced in the state of Kerala (South India) that may make people more conscious of their food choices [96]. Finally, screening and education for the prevention of diabetes mellitus through National Diabetes Control Programs in various South Asian countries is likely to have a salutary effect on obesity, but the impact of these initiatives has not been completed [8].

Conclusions

South Asians are facing growing "epidemics" of obesity and diabetes mellitus. Several factors, including rapid urbanization, demographic changes, rural-to-urban migration, poor diets, and sedentary lifestyle, have emerged as major contributory factors. Obesity in South Asians shows certain distinct features including the preponderance of abdominal obesity, more intra-abdominal and truncal subcutaneous adiposity, and fat depositions in the liver. Different and lower cutoffs for BMI and waist circumference, and specific guidelines for diet and physical activity, have been advocated for Asian Indians. Diet and lifestyle management should start at lower limits of BMI (according to Indian guidelines) and waist circumference. Reducing excess calories from carbohydrates and fat should be the main focus, and inclusion of high-quality protein will be helpful. Diet and exercise need to be more intensive in Asian Indians for the prevention and management of obesity and its comorbidities. The limited number of drugs (orlistat and liraglutide) available in India for obesity management may be used judiciously. In those patients who have T2DM, additional help in weight loss can be obtained by using metformin, SGLT2 inhibitors, and GLP-1 analogues. Prevention strategies focusing on obesity and nutrition in childhood and the creation of food and activity environments that encourage healthy lifestyles should be strongly encouraged.

Compliance with Ethical Standards

Conflict of Interest Anoop Misra has received research funding from Herbalife International and has received compensation from Dr. Reddy's Laboratories, Boehringer Ingelheim, AstraZeneca, Janssen, Sanofi-Aventis, and Lilly for service as a consultant. Ranil Jayawardena declares that he has no conflict of interest. Shajith Anoop declares that he has no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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- • Of importance
- •• Of major importance

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