



Nutrition and diabetes in South Asia

Hema S Gopalan¹ · Anoop Misra^{1,2,3} · Ranil Jayawardena⁴ 

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Introduction

Economic liberalization of India in the late 1990s ushered in an increase in life-expectancy, food security, urbanization, mechanization and shift towards a sedentary lifestyle and decreased energy expenditure. Together with an increased intake of energy-dense foods, consumption of alcohol and tobacco, these have resulted in nutritional imbalance, obesity and stress culminating into an ‘epidemic’ of type 2 diabetes mellitus (T2DM) and other non-communicable diseases (NCDs) [1]. To quantify deaths due to cardiovascular disease (CVD) and diabetes attributable to dietary and metabolic risks in South Asian countries, Yakoob and colleagues analysed data from the 2010 Global Burden of Disease national surveys and concluded that suboptimal diets were the leading cause. Such diets are characterised by low intake of fruits, whole grains, vegetables, and omega-3 polyunsaturated fatty acids [2]. In children and adolescents, nutritional risk factors associated with overweight / obesity include reduced fruit and vegetable consumption, consumption of energy-dense ‘junk’ foods and sugar-sweetened beverages (SSBs) [3].

In this review, we discuss determinants, emerging nutrition issues in social context, and some possible solutions for prevention of diabetes. The literature search has been carried using the terms ‘diet, nutrition or nutrient in Asian Indians or South Asians combined with ‘diabetes’ in the following

medical search databases; [1] PubMed (National Library of Medicine, Bethesda, MD) from 2006 to June, 2018, [2] Current Contents (Institute for Scientific Information, Thomson Scientific, Philadelphia, and [3] and Google Scholar. A manual search of the references was also carried out.

What is already known?

Intake of sugar and SSBs

Intake of sugars from various sources is high in Asian Indians, owing to the traditional association of offering of sugar-laden sweets in social and religious gatherings [4] (Fig. 1). SSBs, composed of energy-containing sweeteners are linked to T2DM, CVDs and obesity, even after adjustment for weight and total calorie consumption [5]. Though sales of SSBs have been static or declining in many high-income countries in recent years, the sales are rising in low- and middle-income countries (LMICs); India reports a 7% annual increase in sales [6]. Specifically, increased consumption of SSBs was observed in children and adolescents in a multi-country study and positively associated with excess body mass index [7].

Trans fats and food frying process (TFAs)

Adverse effects associated with excess consumption of trans-fatty acids (TFA) include dyslipidaemia, low-grade systemic inflammation and endothelial dysfunction, which may lead to CVDs [8] and affect insulin sensitivity possibly contributing to development of diabetes [9]. Oils conventionally utilized by South Asians contain high amount of TFAs (*Vanaspati*) or saturated fats [*desi ghee (clarified butter)*, coconut oil]. Besides, the consumption of high fat snacks and fried street foods are prevalent in patients with T2DM in India [10]. Also, faulty cooking practices consisting of high-heat-treatment and frying in leftover oils, generates more TFAs regardless of the cooking oil used [11]. Regulations on utilization of low TFA oils and public

✉ Anoop Misra
anoopmisra@gmail.com

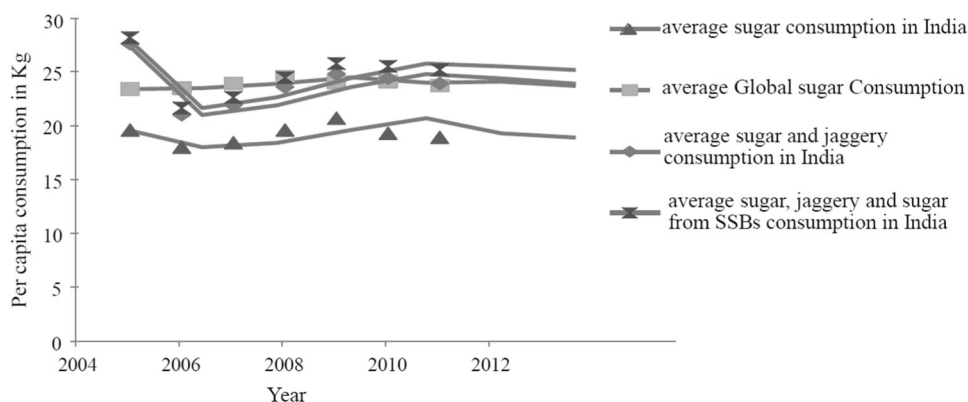
¹ National-Diabetes, Obesity and Cholesterol Foundation (N-DOC), SDA, New Delhi 110016, India

² Diabetes Foundation (India), New Delhi 110016, India

³ Fortis C-DOC Center of Excellence for Diabetes, Metabolic Diseases, and Endocrinology, B 16Chirag Enclave, New Delhi, India

⁴ Department of Physiology, Faculty of Medicine, University of Colombo, Colombo, Sri Lanka

Fig. 1 Average intake of sugar globally vs. India (Reproduced with permission from Gulati and Misra [4])



awareness drives regarding unpropitious effects of frying/refrying must be done as a priority [12].

What we are getting to know now?

Processed foods

Processed foods contain high amount of refined fats e.g. saturated fats and TFAs, sugar and salt that may contribute to obesity, T2DM, and CVDs. Between 1999 and 2017 intake of processed foods in India and Pakistan has increased 2–3 folds. In contrast, the developed Asian countries (Japan, Singapore) have reported either a decrease or a plateau in consumption of processed foods [13]. Further, though there is no national level data regarding sodium intake among South Asians; most of the South Asian snacks, curries and pickles contain high levels of salt [14] which may increase hypertension and CVD in south Asians with T2DM [15].

Vegetarian diets

South Asian countries like India and Nepal have a substantial population who are vegetarian, or those who, in addition, sparingly consume non-vegetarian foods. Although research on health effects of vegetarian diets is sparse, studies have shown improvement in insulin resistance in patients with T2DM consuming vegetarian diets [16]. However vegetarian diets of India often contain large amounts of carbohydrates and fried foods, which may have adverse metabolic consequences. Nevertheless, one study showed that vegetarian diets consumed by Asian Indians from India resulted in a better lipid profile and lower blood glucose levels than the non-vegetarians [17].

Need for nutrition guidelines

Traditionally, under-nutrition and nutritional deficiencies are the focus of nutrition researchers and policy makers in

South Asia. The existing nutritional guidelines rarely focus on NCDs, especially diabetes. Previously, we have highlighted the nutritional issues associated with diabetes among South Asians [18]. The currently available nutrition guidelines do not focus strongly on strategies for prevention and control of diabetes. Exercise guidelines for control and prevention obesity and diabetes are also not available for South Asians countries, except for India [19].

Erroneous beliefs and inadequate nutrition education in the population

Information transfer is becoming more and more rapid with the advent of mobile phones and computers in urban and in rural areas. Even though this has, to an extent, increased knowledge of nutrition, there is a possibility of people receiving incorrect messages or ‘half-truths’ [20]. Erroneous beliefs regarding the “health-value” of foods have been shown to influence consumption patterns in patients with diabetes in India [10]. Interestingly, in Sri Lanka, among all food and beverage-related advertisements on television, 78% were targeted at children and among these, 74% claimed health benefits without any disclaimers [21].

Non-compliance of medical nutrition therapy in type 2 diabetes

Diabetes-related self-care practices in South Asians are faulty with major non-compliance related to exercise and diets [22]. A study conducted in 11 cities of India showed that about 67% patients with T2DM faced major challenges in following correct diets [23]. Another study observed that about 19% of patients with diabetes were unaware of the role of diets in relation to glycaemic control [24]. Compliance to diets in South Asian patients with diabetes is affected by several factors; socio-economic strata, level of literacy, traditional dietary myths and practices, audio-visual media, and peer influences. Further, dietetic counselling services by trained personnel are available only with a small proportion of physicians. On most occasions,

Table 1 Sources of Complex Carbohydrates

Type of food	English name	Hindi name
Cereals	Whole wheat	<i>Gehun</i>
	Brown rice	<i>Chawal</i>
Millets	Pearl Millet	<i>Bajra</i>
	Finger millet	<i>Ragi</i>
	Great millet /Sorghum	<i>Jowar</i>
Pulses	Red Gram	<i>Tur Dal</i>
	Green Gram	<i>Sabut Moong</i>
Legumes	Soya	<i>Soya</i>
	Peas	<i>Muttar</i>
	Horsegram	<i>Kulthi</i>

Source: Adapted from ref. [30]

patients receive hasty and incomplete dietary advice from their treating physicians [25]. Migrant South Asian patients state that cultural expectations and fear of alienation are reasons for the unrestricted food intake at social and community get-togethers where energy-dense fried foods and sweets are served [26]. It has also been demonstrated that improvement of dietary habits alone could help to reduce incident diabetes among pre-diabetic Asian Indian men [27].

Quality of carbohydrates

Carbohydrates in Indian diets in general and in patients with T2DM, are much higher than that recommended (64.1% of total dietary energy in one study) [28]. The focus however, should be to combine the following; decrease the 'quantity' and change 'quality' of the carbohydrate source, e.g., lesser-milled/high-quality/complex carbohydrates [29]. Table 1 shows primary sources of complex carbohydrates available in India [30]. In particular, millets are low-cost, low glycaemic index (GI), locally available complex carbohydrates, which are attractive alternative carbohydrate sources for patients with diabetes (Table 2).

Consumption of lesser processed grains; brown rice with legumes [41], pearl millet (*Bajra*) or barley instead of white bread [42], and wheat-based or millet-based formulations as dietary supplements instead of rice-based preparations [43] showed decreased glycaemic response among overweight, normoglycemic individuals and patients with T2DM. Millet-processed items for the modern consumers, e.g. leavened breads [44, 45], ready-to-cook flakes [46] and other products are also available along with efforts to include millets into staple diets (e.g., *dosas* or Indian pancakes or crepes) [38]. Overall, data regarding metabolic effects of complex carbohydrates in South Asians need further research.

What we need to know in the future?

Protein intake

Protein consumption among South Asians (particularly in India and Nepal) is low in quantity and quality, and is affected by factors like type of diet followed (vegetarianism) and the price-to-nutrient ratio. Pulses account for only 10 and 11% (rural and urban) of protein intake, while milk and dairy products contribute to 10 and 12% in rural and urban Indian diets, respectively. About 50–60% of protein intake in both rural and urban areas is from cereals [12, 47], the main source of protein intake in India.

Poor protein intake is associated with loss of muscle mass and function (Sarcopenia). Sarcopenia, as assessed by hand grip strength, is higher in South Asians as compared to Caucasians and Blacks and is independently associated with T2DM [48]. To improve glucose-insulin metabolism in skeletal muscles, more protein intake along with a combination of aerobic and resistance physical activity is required in South Asians [49]. Further, to target obesity and poor muscle function at the same time, increasing protein in diet is a viable option in South Asians. Importantly, two recent studies in India have shown the beneficial effects of high-protein diets on multiple metabolic parameters including glycaemic control [12, 50].

Food choices

There could be several reasons and perceptions for staple food choices in South Asian populations. Factors responsible for dietary changes in rural regions of India are due to three primary causes (i) state-mandated fair price shops operated through the Public Distribution System (PDS) that sell refined wheat, sugar, palm oil, pulses, and kerosene fostering an environment to forego traditional staples in favour of products distributed by the PDS-nutrient-price ratio (ii) 'new' foods at low prices at local food stalls and shops (iii) shift in agricultural patterns due to the financial incentives of commercial crop production [29, 51].

A clinic-based study on high-income group patients with T2DM in an urban setting in north India revealed a paucity of knowledge level related to the healthy food choices and the basic concept of 'simple carbohydrates' and dietary fibre [10]. Another study in children and their mothers in north India showed incorrect notions about food (e.g., 'home-cooked meals are old-fashioned'); and mothers considered that feeding *desi ghee* to their children 'made the children strong' [52]. Another factor is the adoption of imbalanced urban-based diet and lifestyle by migrant populations from rural areas settled in urban slums [53]. These factors, along with epidemiological and nutrition transitions, need more studies.

Table 2 Glycaemic Index of various Millets based food items as available in India

Type of millet	Food items prepared with ^a :- Millets	Local or hindi name of Millets	Glycaemic index (Mean value)	Indian states where commonly consumed
Major	Pearl millet	<i>Bajra</i>	55.0 [31]	Gujarat and Rajasthan [32]
Major	Sorghum	<i>Jowar</i>	44.32 [33]	Eastern and western Maharashtra, and northern Karnataka [34]
Minor	Finger millet	<i>Ragi or Nachni</i>	45.13 [35]	Karnataka, Tamil Nadu, Andhra Pradesh and parts of Uttarakhand [36]
Minor	Little Millet	<i>Kutki</i>	52.54 [37]	Eastern Madhya Pradesh [38]
Minor	Foxtail millet	<i>Kaangni</i>	59.25 [39]	Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, Bihar, Madhya Pradesh and Maharashtra
Minor	Barnyard millet	<i>Samak</i>	50.00 [40]	Uttar Pradesh, North-Eastern region and plains of North Bihar and Western Uttar Pradesh and Maharashtra

^a Food items may have more than one ingredient (other than millet)

Tools for dissemination of diet-related messages

Prevention/intervention programs and multi-level campaigns (audio-visual media, billboards and posters, street plays etc.) have been used to affect various health behaviours in India [54]. Further, e-health or m-health applications could be effectively utilized for prevention of T2DM [55, 56]. School-based educative interventions showed improvement in nutrition- and obesity-related knowledge, and anthropometric and biochemical profiles in children and adolescents [57–59]. Pandey et al. [60], with use of mass communication methods in a population-based intervention study, showed a significant increase in knowledge among women regarding importance of dietary proteins, fats, fibres and fruits.

It must be noted that for any individual behaviour change, cultural tailoring of health and nutrition messages should align with sociocultural belief systems with the use of multiple methods for information diffusion [61]. An apt example is a community-based participatory diabetes prevention and management intervention in state of Gujarat, India, using community health workers that administered ten culturally and linguistically appropriate health education messages through face-to-face individual and group sessions (e.g. demonstrations of model meals and cooking techniques) that resulted in the significant improvement of knowledge regarding diabetes and CVDs, particularly in low socio-economic stratum [62]. Research on effective messages for prevention and control of diabetes tailored to geographical and cultural contexts in South Asia is clearly needed.

Food labelling

The Food Safety and Standards Authority of India (FSSAI) has introduced guidelines for advertising and labelling claims for packaged products providing information (nutritional value, weight and cost) regarding the ingredients. This regulation introduces transparency regarding high in fat, salt or sugar (HFSS) contents in processed foods. An expert group constituted by FSSAI for the food labelling of HFSS packaged/processed foods recommended ban on advertising of HFSS foods on children television channels and discouraged celebrity endorsements and recommended additional taxes on these (see below). Simple food labelling, which could be understood by all strata of society, its proper regulation, and its impact on T2DM and NCD is needed for all South Asian countries [63, 64].

Taxation

Basu et al. [65] suggested that a 20% excise tax on SSBs in India will prevent 11.2 million new cases of overweight and obesity (decrease of 3%), and 400,000 cases of T2DM

(decrease of 1.6%) between 2014 and 2023. A similar tax (20%) on purchase of palm oil is estimated to result in a 1.3% reduction in cardiovascular deaths [66]. The state of Kerala in India has introduced a 'fat tax' (14.5%) that is added to HFSS foods sold at restaurants [67]. Impact of such taxation should be assessed, and if found to be effective, should be applied to all South Asian countries.

Neutraceuticals and natural compounds

A number of neutraceuticals and herbal compounds have been used for management of T2DM in South Asia, but few have been properly researched. There is emerging interest in cinnamon for improvement of metabolic parameters. In a recently conducted double-blind randomized trial on Asian Indians, use of cinnamon in individuals with metabolic syndrome lead to decrease in weight, glycaemic parameters, subclinical inflammation and hepatic transaminases [68]. Other locally available foods such as bitter melon, fenugreek seeds etc., need to be evaluated through well-designed clinical trials.

Conclusions

Epidemiological transition in South Asian countries has resulted in rural-urban migration, higher availability of processed foods (SSBs, fried foods), more purchasing power and a shift from traditional whole grain diets and high physical activity pattern to over-consumption of energy dense and poor physical activity. Coupled with inadequate health and nutrition-related information, these have become a recipe for an epidemic of NCDs particularly T2DM. Increasing awareness regarding importance of whole grain consumption, limiting sugar and saturated fat (fried foods) intake, use of healthier edible oils, and increase in protein intake through correctly positioned large scale nutrition education programs could help sensitize the community to adopt better health and nutrition practices. The government must strictly regulate HFSS foods in both unorganized and organized sectors and impose taxation on sales of SSBs and unhealthy oils. Research on nutraceuticals and functional foods requires further attention.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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