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Transcultural Diabetes Nutrition Therapy Algorithm: The Asian Indian Application

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Abstract India and other countries in Asia are experiencing rapidly escalating epidemics of type 2 diabetes (T2D) and cardiovascular disease. The dramatic rise in the prevalence of these illnesses has been attributed to rapid changes in demographic, socioeconomic, and nutritional factors. The rapid transition in dietary patterns in India—coupled with a sedentary lifestyle and specific socioeconomic pressures—has led to an increase in obesity and other diet-related noncommunicable diseases. Studies have shown that nutritional interventions significantly enhance metabolic control and weight loss. Current clinical practice guidelines (CPGs) are not portable to diverse cultures, constraining the applicability of this type of practical educational instrument. Therefore, a transcultural Diabetes Nutrition Algorithm (tDNA) was developed and then customized per regional variations in India. The resultant India-specific tDNA reflects differences in epidemiologic, physiologic, and nutritional aspects of disease, anthropometric cutoff points, and lifestyle interventions unique to this region of the world. Specific features of this transculturalization process for India include characteristics of a transitional economy with a persistently high poverty rate in a majority of people; higher percentage of body fat and lower muscle mass for a given body mass index; higher rate of sedentary lifestyle; elements of the thrifty phenotype; impact of festivals and holidays on adherence with clinic appointments; and the role of a systems or holistic approach to the problem that must involve politics, policy, and government. This Asian Indian tDNA promises to help guide physicians in the management of prediabetes and T2D in India in a more structured, systematic, and effective way compared with previous methods and currently available CPGs.

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Introduction

The transcultural Diabetes Nutrition Algorithm (tDNA) is being developed under the direction of an international panel of expert health care professionals. The tDNA is intended to 1) increase awareness of the benefits of nutritional interventions for patients with prediabetes and type 2 diabetes (T2D); 2) encourage healthy eating practices that accommodate regional differences in lifestyles, foods, and cultures; 3) enhance the implementation of existing clinical practice guidelines (CPGs) for prediabetes and T2D management; and 4) simplify nutritional therapy for patients with prediabetes and T2D by facilitating global application and portability. The tDNA represents a consensus of highly experienced practitioners, researchers, and academicians and is supported by evidence and opinion that were rated based on scientific substantiation, according to the standards expressed in the American Association of Clinical Endocrinologists "Protocol for Standardized Production of Clinical Practice Guidelines—2010 Update" [1]. Customization per regional variations in dietary habits, culture, lifestyle, body mass index (BMI), and other parameters was initiated as a part of the first regional conference in India.

India and other countries in Asia (Note: throughout the text: "Southeast Asian" refers to natives of India, Pakistan, and Bangladesh; "Asian Indian" refers to people who resided in India and migrated to East and South Africa, the United Kingdom, Singapore, Indonesia, and the United States; "East Asian" refers to people living in China, Korea, Taiwan, etc.; and the term "South Asian" is more generic than "Southeast Asian" or "Asian Indian") are experiencing rapidly escalating epidemics of T2D and cardiovascular disease (CVD). This dramatic rise in T2D has been attributed to rapid changes in demographic, socioeconomic, and nutritional factors. These epidemiologic, nutritional, financial, and social transitions are characteristic for "transitional economies." According to the Diabetes Atlas 5 [2], India currently has the second largest number of people with T2D in the world; this has been confirmed by a recent national study [3]. The Indian Council of Medical Research–India Diabetes (ICMR–INDIAB) study [3, 4] is a community-based survey conceived with the aim of identifying prevalence rates of T2D in India as a whole (covering all 28 states, the National Capital Territory of Delhi, and 2 of the union territories in the mainland of India), in a phased manner, with a total proposed sample size of 124,000 individuals. According to the first phase results of this study—done in four states of India representing north, south, east, and west, and covering a population of 218 million people—there are currently 62.4 million people with T2D and 77.2 million people with prediabetes [3]. Multiple logistic regression analysis showed that age, male gender, family history of T2D, urban residence, abdominal obesity, generalized obesity, hypertension, and income status were significantly associated with T2D. Significant risk factors for prediabetes were age, family history of T2D, abdominal obesity, hypertension, and income status.

This review highlights key forces that have incited transitions in India, increased the burden of T2D in India, and led to the transculturalization required for an Asian Indian tDNA development. Furthermore, this review demonstrates the importance of the Asian Indian tDNA in primary, secondary, and tertiary T2D prevention strategies.

Epidemiologic Transitions to Noncommunicable Diseases

Demographic and associated economic and sociologic changes induce complex shifts in health, disease states, and mortality rates. In transition economies, especially in developing countries such as India, infectious and communicable diseases are being replaced by chronic degenerative or metabolic noncommunicable diseases (NCDs) as the primary causes of morbidity and mortality [5]. This epidemiologic transition in India contributes to premature deaths in adults, particularly in urban areas [6]. There is also emerging evidence for infective agents in the development of chronic diseases, as shown by raised concentrations of inflammatory markers [7]. Studies from India support the view that urbanization increases the levels of certain cytokines and contributes in some measure to the urban–rural differences in NCD risk [8].

On the one hand, when Asian Indian migrants adopt the lifestyles—including the dietary patterns and broad sociocultural practices—of the indigenous population, they take on the disease patterns of the native population as well. Conversely, following migration, a genetic predisposition to the risk of early-onset adult NCDs can be unmasked. One specific example of the interplay between environmental and genetic factors is the increased risk of T2D and NCDs among Asian Indian migrants to the United Kingdom [9]. Another important feature of the developmental transition in India is the rapid urbanization and large population shifts from rural to urban areas [6].

The impact of nutritional transitions and related metabolic disorders has been regarded as diet-related noncommunicable diseases by a consensus group formed for revising previous dietary guidelines for India. The rapid nutritional transition observed in India results in excess consumption of calories, saturated fats, trans fatty acids, simple sugars, and salt, with low intake of fiber, monounsaturated fatty acids, and n-3 polyunsaturated fatty acids. This dietary pattern, coupled with sedentary behaviors, promotes obesity, T2D, and CVD in both urban and rural areas [10]. This phenomenon has recently been confirmed by the first phase results of the ICMR–INDIAB study [3].

Fetal Origins Hypothesis in India and Its Role in Diabetes

The susceptibility to T2D may be conferred by evolutionary enrichment of thrifty genes, which long ago enhanced survival during periods of famine, but have now created detriment with conditions of plentiful food and sedentary lifestyles [11]. An alternative explanation that has been recently proposed is the thrifty phenotype hypothesis (subsequently generalized as fetal origins), which links the obesity and T2D epidemic to an unfavorable intrauterine environment [12, 13]. This thinking is based on certain observations of an inverse relationship between birth weight and risk of T2D and metabolic syndrome (MS) in elderly populations.

Asians, as a group, have small body size. Women from the rural parts of India are small and are thought to be chronically undernourished because of their low BMI. Iron and other nutrient deficiencies are very common in this group. Indian babies are the smallest in the world; one-third are born with low birth weight (LBW; <2.5 kg) [14]. Thus, it is possible that maternal and fetal undernutrition contribute to the T2D epidemic in Asian countries [15]. In Indians, T2D is diagnosed at least a decade earlier and individuals are considerably thinner than their UK counterparts [15]. Indians have thinner limbs, which is suggestive of smaller muscle mass. However, despite their thinness, they are centrally obese, with higher waist-hip ratio (WHR) and higher subscapular-triceps skinfold ratio than their UK counterparts [15]. Many studies show that Indians have more body fat for any given BMI compared with Caucasians and black Africans [16, 17]. Indians also have higher levels of central obesity (measured as waist circumference [WC], WHR, visceral fat, and posterior subcutaneous abdominal fat). This is reflected in higher plasma nonesterified fatty acid and triglyceride concentrations, hyperinsulinemia with fasting as well as post-glucose challenge states, and higher insulin resistance [18]. Thus, Indians have an unusual thin-fat body composition associated with the insulin resistance syndrome.

The Pune Maternal Nutrition Study [19, 20] has given insight into fetal development in Indian populations. This prospective, population-based, observational research assessed rural Indian women and their offspring. Mothers were short and thin (mean pre-pregnant height and BMI: 152 cm and 18.1 kg/m^2, respectively); mean full-term birth weight was only 2.7 kg. Detailed anthropometry of the newborns showed that their body composition differed from white Caucasian babies born in the United Kingdom. The Indian babies were lighter by almost 2 standard deviations (SDs), and lean tissues such as muscle (mid-upper arm circumference) and abdominal viscera (abdominal circumference) showed a similar deficit. However, truncal fat (subscapular skinfolds) was relatively spared (−0.5 SD). Thus, although extremely small and thin, the babies had relatively increased adiposity. A similar pattern is seen in urban Indian adults. It has been suggested that increasing maternal parity predicts increasing adiposity in the newborn infant. This may result from maternal nutritional, cardiovascular, or immunologic factors [19, 20].

Nutrition Transition and Increased Risk of T2D

Epidemiologic, nutritional, and economic transitions have also revealed certain trends and patterns in the nutritional transition in India. A hectic lifestyle and the easy availability of convenience foods have led to irregular meals and frequent snacking on energy-dense fast foods, including ready-to-use gravies and soups, packaged salty snacks, ready-made cookies, and commercial fast foods, rather than traditional home-cooked food. Furthermore, consumption of animal foods, sugar (especially sweetened, carbonated beverages), and traditional Indian energy-dense foods has also increased. The diets of all income groups have moved away from whole-grain cereals to other food groups, with greater shifts noted among the urban populations and the higher-income groups [10].

India progressed toward caloric adequacy in the 1970s and early 1980s, as documented by the National Nutrition Monitoring Bureau [21] and other surveys. The surveys showed a gradual improvement in caloric intake per capita, typified by an increase in consumption of cereal grains, while the intake of most other food items—such as milk, oil, sugar, etc.—remained largely unchanged. However, many of these surveys revealed disparities in the intakes of most foods between rural and urban populations and between different socioeconomic groups. Comparison of food consumption patterns shows a gradual reduction in cereal grain consumption between 1975 and 1995 that has not affected the average energy intake. This is largely the result of a progressive increase in the intake of protein and, likely, fats. The latter is due to a significant increase in the consumption of milk and other dairy products, as well as an increase in the intake of animal products (designated flesh foods), fats, and oils. The production of pulses and legumes is also a concern; consequently, their cost and consumption have fallen dramatically. This is somewhat worrisome because pulses and legumes were once a very important source of vegetable proteins in the traditional Indian diet. Trends in the changes in consumption of urban populations are not readily available, although the surveys conducted between the late 1970s and the 1990s show wide differences between the socioeconomic strata in an urban environment. One would have expected these disparities to have widened further over the years, although this is not evident from the data [21].

While carbohydrates remain the major source of energy in Indian diets, the percentage of total energy intake derived from carbohydrates has declined (1975–1979, 80.3%; 2001, 75.5%); however, the quality of carbohydrates has changed from the traditional high-fiber carbohydrates to the low-fiber carbohydrates such as polished white rice, which has a higher glycemic index. There is also an increase in the percentage of energy coming from dietary fats (1975–1979, 8.9%; 2001, 13.9%). However, the proportion of dietary energy coming from fat still remains less than 15%, which is lower than the recommended dietary allowance of 15% to 30% [22]. Consumption of oils, fats, and animal products has increased in almost all the states [21]. Energy intake is lower in urban areas, in spite of higher intake of fats and oils, because of lower cereal consumption compared with rural areas [23]. Reasons for these dichotomous observations of decreased energy intake with rising prevalence of obesity could be under-reporting of dietary consumption data [23], higher energy intake compared with energy expenditure [24], and increasingly sedentary lifestyles [21–24].

Regional Disparities in India

India is a diverse country covering 28 states, the National Capital Region of Delhi, and several union territories in the mainland of India. Regional disparities in prediabetes and T2D are common, attributable to the vast variation in culture and dietary habits across regions. In an attempt to understand these variations and disparities, there has been an explosion in T2D epidemiology studies in India over the past 20 years [25]. In the large cities of north and south India (Chennai [26–28], Trivandrum [29, 30], Mumbai [31], Delhi [32, 33], Jaipur [34], and Gauhati [35]), in large metropolises [36], and in industrial populations [37], T2D prevalence among adults (>20 years of age) has ranged from 8% to 15%. Within urban populations, a large heterogeneity of T2D prevalence is noted, depending on the socioeconomic stratum studied and sampling response rates.

There are few epidemiological studies in semi-urban India [38, 39], and many in rural populations [40, 41]. In earlier years, there was a very low prevalence of T2D in rural populations. However, recent studies from Maharashtra [42] and Andhra Pradesh [43] report very high prevalence rates similar to those in urban Indian populations. Interestingly, a significant correlation of BMI with T2D has been observed in these studies. It has been hypothesized that although there is a significant increase in T2D as populations move from rural to semi-urban to urban and cosmopolitan habitats, a reverse migration of culture may already be taking place in Indian rural populations. Earlier rural–urban disparities in T2D could be due to a low prevalence of overweight and obesity in rural, compared to urban, subjects [44].

The recent ICMR–INDIAB study [3] has featured the regional disparities more prominently, with the first phase results stating that in 2011, Maharashtra will have 6 million individuals with T2D and 9.2 million with prediabetes; Tamilnadu will have 4.8 million people with T2D and 3.9 million with prediabetes; Jharkhand will have 0.96 million people with T2D and 1.5 million with prediabetes; and Chandigarh will have 0.12 million people with T2D and 0.13 million with prediabetes. With greater urbanization, growth of the middle class, and aging of the population, tremendous increases in the numbers of people with T2D in India are projected in the future [3].

In south India, rice is the staple food, and highly polished white rice has been linked to T2D [45, 46] and MS [47]. The ICMR-INDIAB study may help to throw more light on the role of dietary factors in the differences in T2D and prediabetes prevalence rates.

Studies confirm that risk factors tend to develop early in the life cycle in Indian subjects; consequently, T2D occurs at least 10 to 15 years earlier than it does in people of non-Indian origin [48]. The generalized and central obesity levels at which T2D occurs are also lower in Indian subjects compared with Caucasian populations [49]. For Southeast Asians and Asian Indians, a waist size of greater than 90 cm in men and greater than 80 cm in women is now accepted as a major risk factor for T2D and other CVD risk factors of MS [50]. The influence of societal affluence levels on T2D prevalence in India suggests that a global solution with the greatest impact on reducing the T2D epidemic lies with policy makers and governments [51]. There is a need to change the economic/environmental structure and culture in urban areas of India so that physical activity and healthy dietary choices are available [52].

Trends and Transition in Obesity

Obesity has increased rapidly in many populations in recent years [53–55] due to an interaction between genetic and environmental factors. These include metabolic characteristics [51, 52, 56], physical inactivity [57–59], habitual energy intake in relation to expenditure, and macronutrient composition of the diet [60–64]. The increases in obesity prevalence have been accompanied by concomitant increases in T2D prevalence [56]; so much so that an etiological connection between the two seems obvious. Data from the Nurses' Health study suggest that the lowest risk of T2D occurs in individuals who have a BMI less than 21 kg/m^2, with increasing prevalence seen as obesity levels increase [56]. Those with higher BMIs have much higher incidence rates of T2D at earlier ages than those with lower BMIs, among whom the incidence rises in the older age groups. Several studies indicate that WC or WHR may be a better indicator of the risk of developing diabetes than BMI [65–67]. Such data suggest that the distribution of body fat is an important determinant of risk, as these measures reflect abdominal or visceral obesity.

A recent review has shown higher risks for Asians compared with Caucasians for the development of obesity and obesity-related NCDs (OR-NCDs), including insulin resistance, MS, T2D, and CVD [68]. Differences in determinants and associated factors for OR-NCDs between Asian Indians and Caucasians include body phenotype (high body fat; high truncal, subcutaneous and intra-abdominal fat; and low muscle mass), biochemical parameters (hyperinsulinemia, hyperglycemia, dyslipidemia, hyperleptinemia, low levels of adiponectin, and high levels of C-reactive protein), procoagulant state, and endothelial dysfunction [69, 70]. Epidemiologic research has demonstrated an association between low muscle mass and increased insulin resistance [71], which may relate to phenotype, aging with muscle wasting, low dietary protein intake, or insufficient resistance training. Higher prevalence, earlier onset, and increased occurrence of T2D and CVD are often seen at lower levels of BMI and WC in Asian Indians than in Caucasians. Given the importance of central adiposity as a determinant of T2D risk, it is necessary to consider whether the usually quoted normal range for BMI (18.5–24.9 kg/m^2) is appropriate for all populations. Lower cutoffs for obesity and abdominal obesity have been advocated for Asian Indians (BMI: overweight >23 to 24.9 kg/m^2 and obesity ≥25 kg/m^2; WC: men ≥90 cm and women ≥80 cm, respectively). A minimal rise in the BMI or WC would act adversely in a subject with a genetic susceptibility to T2D. Studies in India have shown that central obesity was more strongly associated with glucose intolerance than generalized obesity was [68].

In urban India, data show a prevalence of obesity of 10% and 15.1% (2003) [72]; 20.8% and 32.3% (2004) [73]; and 43.2% and 47.4% (2007) in men and women, respectively [74]. Interestingly, a high prevalence has been reported in economically disadvantaged adults residing in urban slums (14%) [32], specifically in postmenopausal women (28%) [75]. An increased prevalence of obesity has also been reported in rural areas from 8% reported in 1997 [76] to 32.4% in men and 41.4% in women in 2007 [77]. Of particular concern, childhood obesity is also increasing from 16% in 2002 to about 24% in 2006 in North India [78], and from 4.9% in 2003 to 6.6% in 2005 in South India [79].

Trends and Transition in Physical Inactivity

Numerous studies have indicated the importance of physical inactivity in the development T2D [80, 81]. In the Nurses' Health Study [81], women who reported exercising vigorously had an age-adjusted incidence rate of self-reported, clinically diagnosed T2D that was two thirds as high as that of women who exercised less frequently. The deleterious effect of low levels of physical activity is seen particularly among those subjects who have other risk factors, such as high BMI, hypertension, or parental T2D. Similarly, among male physicians, the incidence of self-reported T2D was negatively related to the frequency of vigorous exercise, and the strength of this relationship was greater in those with higher BMI [80]. For equivalent degrees of obesity, more physically active subjects have a lower incidence of the disease [82].

Several studies have shown that Asian Indians are more sedentary than Caucasians [83]. For example, findings from the Newcastle Heart Project (comprising Asian Indians [n=105] and Europeans [n=416]) showed that Asian Indians are less physically active than Europeans. Similarly, another UK study showed that lower physical activity in Asian Indians, Pakistanis, or Bangladeshis, compared with their European counterparts, was inversely correlated with BMI, WC, systolic blood pressure, plasma glucose, and plasma insulin levels [84]. The prevalence of T2D and impaired glucose tolerance has been shown to be significantly lower in higher quartiles of physical activity in South Indians (ie, 17.0%, 9.7%, and 5.6% for sedentary, moderately heavy, and heavy physical activity, respectively) [85]. It is believed that a sedentary lifestyle is an important factor contributing to the development of T2D and CVD in Asian Indians [86, 87]. The Consensus Development Group for formulating the Consensus Physician Activity Guidelines for Asian Indians considered the available physical activity guidelines from international and Indian studies and formulated the following India-specific guidelines.

A total of 60 min of physical activity per day is recommended for healthy Asian Indians, in view of the high predisposition to develop T2D and CVD. This should include at least 30 min of moderate-intensity aerobic activity, 15 min of work-related activity, and 15 min of muscle-strengthening exercises. For children, moderate-intensity physical activity for 60 min daily should be in the form of sports and physical activity. This consensus statement also includes physical activity guidelines for pregnant women, the elderly, and those suffering from obesity, T2D, CVD, and other components of MS. Proper application of guidelines is likely to have a significant impact on the prevalence and management of these cardiometabolic factors in Asian Indians [88].

Studies have looked at a community-based participatory research approach to translate the original Diabetes Prevention Program in the United States into one that is age-specific and culture-specific for other regions of the world. These studies have evaluated cultural strategies for healthy behaviors, including culture-specific physical activities, knowledge and access to healthy foods, physical activity for youth and their parents, interactive hands-on learning activities for healthy lifestyles, and group formats for adopting healthy behaviors [89].

Barriers to Clinical Management

Sociocultural and religious factors influence health beliefs, diet, and lifestyle management in Asian Indians [90–92]. Cultural factors (eg, festivals and holidays) contribute to a greater frequency of missed clinic appointments by Asian Indians compared with Caucasians. Furthermore, poor adherence with T2D therapy (insulin or oral agents) is common among Asian Indians during holidays, and glycemic control is unsatisfactory due to religious fasting [93–95]. Asian Indian patients with T2D also tend to have a more negative attitude and tend to believe they were made to wait longer in clinics than UK Caucasians do [96]. Response to drugs has been suspected to be different in Asian Indians compared with Caucasians, but this phenomenon has not been adequately investigated. Prevalence of associated conditions such as dyslipidemia, hypertension, and CVD is also affected by differences in body fat composition, dietary changes, abdominal obesity, and BMI [69]. A recent study showed that self-efficacy is an important factor in determining outcomes [97]. In contrast, an advantageous sociocultural factor seen in Asian Indians is the extended family structure, often helping patients to cope better with insulin therapy and morbidities.

Asian Indian Holistic Approach Toward Management of Prediabetes and T2D

The enormous social and personal cost of T2D makes a compelling case for prevention. In view of the evidence and the devastating health impact of cardiometabolic disease, it seems prudent that primary prevention should be a major priority. The greatest hope lies in implementing lifestyle intervention programs on a large scale, targeting multiple nodes in a complex cultural network or system, buttressed by a favorable political and regulatory strategy, and initially focused on high-risk persons. Meta-analysis studies [98] looking at T2D education and a variety of weight loss methods have shown that nutrition interventions have the largest statistically significant effect on metabolic control and weight loss. In addition, these meta-analyses have shown that T2D education, in general, is effective in improving knowledge, skills, psychosocial adjustment, and metabolic control. Overall, the evidence involving medical nutrition therapy in T2D management supports nutritional intervention.

Conclusions

Many developing countries, including India, now report the onset of T2D at increasingly younger ages. This trend toward younger age of onset implies a huge additional burden to the affected individuals and to society, and necessitates a lifetime approach to prevention and treatment. To achieve maximal benefit from lifestyle interventions, changes in governmental policies and legislation will be needed, in addition to individual and community-based programs. Thus, evidence-based advice to governments and public health authorities must emphasize the role of weight reduction in the overweight and obese, nutritional interventions, and modified focused lifestyle interventions. This approach can also be expected to have a positive effect on the prevention of other major NCDs, such as CVD and hypertension. The tDNA focuses on interventions in prediabetes and T2D, taking into consideration the regional differences across various cultures, and focuses on comorbidities and interventions at all levels. Efforts for an Asian Indian customization that will reflect various physiologic, nutritional, epidemiologic, pathologic, and anthropometric factors, as well as nutritional and cultural factors, are in progress and will be incorporated into the algorithm template. The goal of this initiative is to provide guidance to physicians in the management of prediabetes and T2D in a much more structured, systematic, and effective way.

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