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EPIDEMIOLOGICAL DATA ON DIABETES IN INDIA

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Introduction

Urbanization has significantly impacted societal demographics worldwide, leading to notable effects on public health and economics. The surge in non-communicable diseases (NCDs) such as diabetes, cardiovascular disease, and respiratory conditions poses substantial global and regional challenges[1]. Diabetes has become a leading cause of death globally, emphasizing the need for urgent attention. According to the International Diabetes Federation (IDF), the prevalence of diabetes is escalating globally, particularly in developing economies like India, driven by the rising rates of overweight/obesity and unhealthy lifestyles[2]. India is currently experiencing a diabetes epidemic, with 101 million people already affected, as reported by the Indian Council of Medical Research-INdia DIABetes (ICMR-INDIAB) study Group[3]. In India, the epidemiology of diabetes has an extensive history, with available data indicating a significant rise in prevalence among both urban and rural populations[4].

Burden of diabetes in India

According to the IDF estimates, India accounts for 1 in 7 of all adults living with diabetes worldwide. The mean annual expenditure per person with diabetes was estimated to be 114.4 US dollars in 2021[2]. The earliest national study conducted by ICMR in 1972 reported a diabetes prevalence of 2.3% in urban regions and 1.5% in rural areas. Population-based studies conducted across various regions in India reveal a significant surge in the prevalence of diabetes over the last two decades, affecting both urban and rural areas (Table 1)[4-11]. It is estimated that current prevalence rate of diabetes in urban areas of India is more than 20%. The Chennai Urban Rural Epidemiology Study (CURES) conducted by our team reported a crude prevalence of diabetes of 15.5% while the age standardized prevalence was 14.3%[11]. Diabetes prevalence in Chennai increased by 39.8 % (from 8.3% to 11.6%) from 1989 to 1995, 16.3% (11.6% to 13.5%) from 1995 to 2000, and 6.0% from 2000 to 2004 (13.5% to 14.3%), amounting to a 72.3% increase over a 14-year period[11].

Earlier estimates of diabetes prevalence in India were derived from data from a limited number of studies. There was no comprehensive study on diabetes that systematically sampled all states in the country or even fully sampled a single state. Furthermore, previous studies had significant limitations, including their regional nature, small sample sizes, low response rates, varied diagnostic criteria, issues with study design, lack of standardization and measurement errors[4]. The ICMR-INDIAB study was a large nationally representative epidemiological survey conducted between 2008 and 2020, in all 31 states/union territories of India in 113,043 adults (33 537-urban areas and 79 506-rural areas) aged ≥ 20 years[3,12,13]. The primary objectives of the study were to estimate the prevalence rates of diabetes and pre-diabetes at the state level in India and to assess the prevalence of metabolic non-communicable diseases (NCDs) such as hypertension, dyslipidemia and obesity. Additionally, the study sought to evaluate the level of glycaemic control in individuals with self-reported diabetes. This national study employed a stratified multi-stage sampling design similar to the one utilized in the National Family Health Survey-3 (NFHS-3). The sampling strategy involved a three-level stratification based on location, population size, and socio-economic status (SES) within each state to ensure a comprehensive representation of the population. Primary sampling units were villages in rural areas and census enumeration blocks in urban areas, with households as the final stage units. The findings of the ICMR-INDIAB study provide valuable insights into the prevalence of diabetes and pre-diabetes, as well as other metabolic NCDs in urban and rural areas across India.

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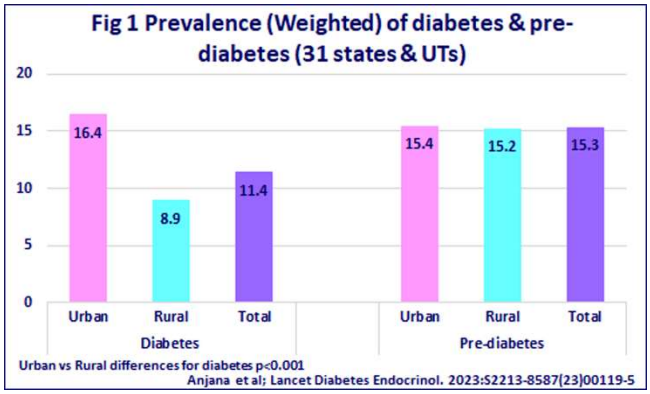


The overall prevalence of diabetes in India was reported to be 11.4%, which varied from 4.8% in Uttar Pradesh to 26.4% in Goa[3]. The prevalence of diabetes was significantly higher in urban areas (16.4%) compared to that in rural areas (8.9%). The overall prevalence of pre-diabetes was 15.3%, there was no significant difference in prevalence of pre-diabetes between urban and rural settings. It is estimated that in 2021, 101 and 136 million people in India had diabetes and pre-diabetes respectively (Fig 3).

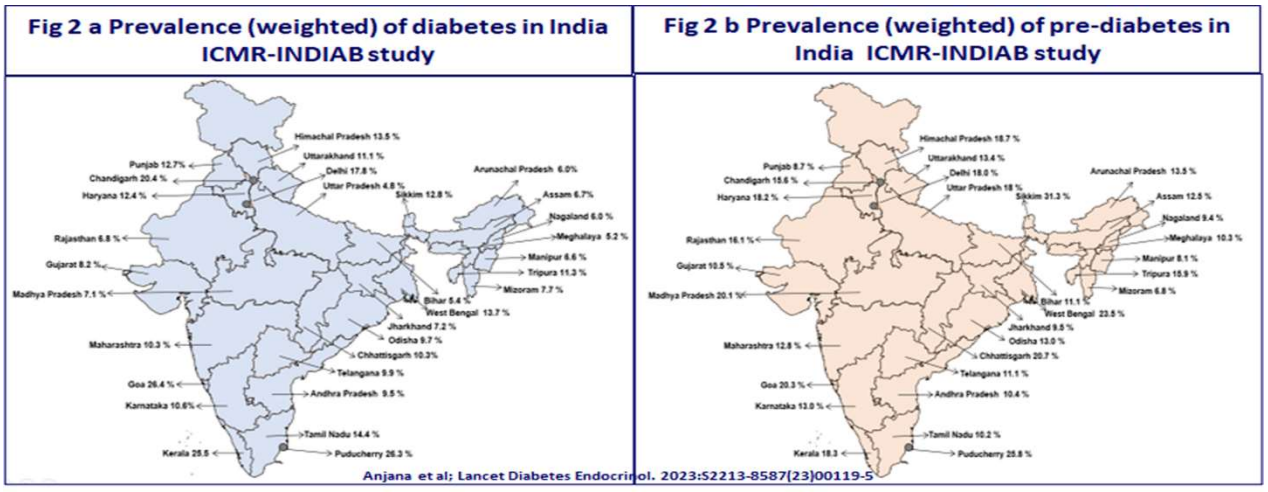
Table 1: Studies on prevalence of diabetes in India (1972-2019)

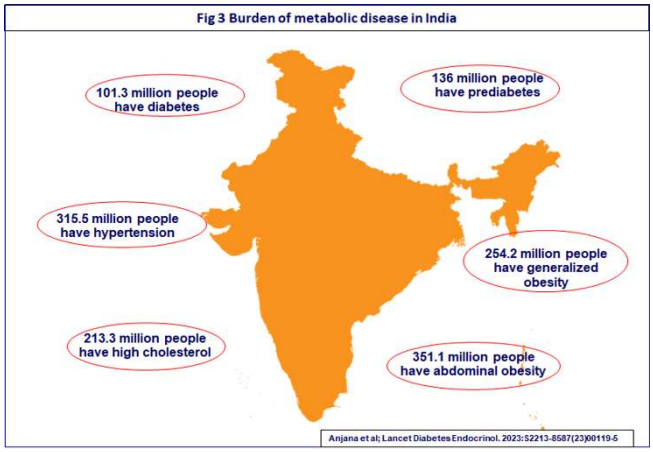
Year	Author	Place	Prevalence (%)	
			Urban	Rural
1972	Ahuja et al	Multicentre (ICMR)	2.3	1.5
1984	Murthy et al	Tenali	4.7	-
1988	Ramachandran et al	Kudremukh	5.0	-
1997	Ramachandran et al	Chennai	11.6	-
2000	Raman Kutty et al	Kerala	12.4	2.5
2001	Ramachandran et al	Hyderabad, Chennai Bengaluru Kolkata New Delhi Mumbai	16.6 13.5 12.4 11.7 11.6 9.3	
2001	Mohan et al	Chennai	12.1	-
2004	Ramachandran et al	Tamil Nadu	-	6.4
2004	Mohan et al	Chennai	14.3	-
2006	Menon et al	Ernakulam	19.5	-
2008	Ramachandran et al	Chennai	18.6	-
2009	Vijayakumar et al	Kerala	-	14.6
2010	Rao et al	Coastal Karnataka	-	16.0
2012	Murthy et al	Tenali	18.0	-
2015	Deepa et al (CARRS)	Chennai Delhi	22.8 25.2	-
2016	Nirmala et al	Vishakhapatnam	15.1	-
2019	Vijayakumar et al	Kerala	21.9	-

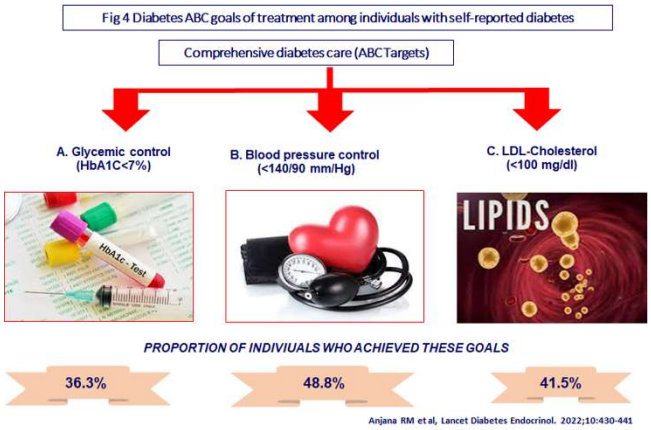
Figs 1, 2a and 2b presents the weighted prevalence of diabetes and prediabetes, respectively in 31 States/UT of India[3].

Management of diabetes

The objectives of diabetes management encompass alleviating symptoms, preventing or delaying the onset of micro and macrovascular complications linked to diabetes, reducing mortality, and ensuring a high quality of life with life expectancy comparable to that of healthy individuals[14].







Effective diabetes management extends beyond regulating blood glucose levels and includes control of other risk factors such as blood pressure and dyslipidemia[15]. The ICMR-INDIAB study, provided the first comprehensive overview of management goals: glycaemic control (A) with A1c <7%, blood pressure control (B) with BP <140/90 mmHg, and cholesterol (C) with LDL cholesterol <100 mg/dl among 5,789 individuals with self-reported diabetes, across the entire country[16]. In India, only one-third (36.3%) of individuals with known diabetes maintain good glycaemic control, while fewer than half achieve satisfactory blood pressure (48.8%) and LDL cholesterol levels (41.5%) [Fig 4]. A mere 7.7% successfully met all three goals (A1c, blood pressure, and cholesterol targets).

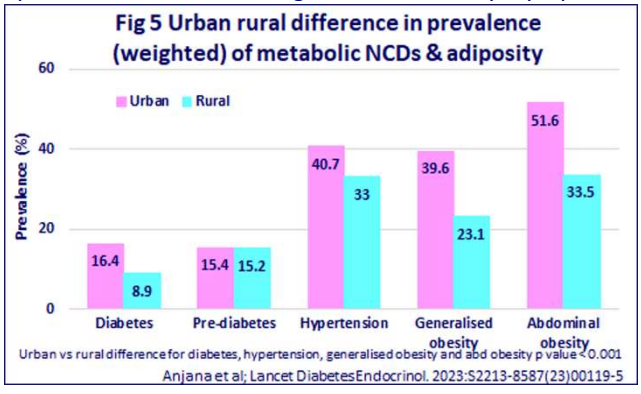
The findings from the ICMR–INDIAB study indicate worrisome trends in self-care practices among individuals with diabetes. Specifically, only 16.7% of those with diabetes reported monitoring their blood sugar levels at home using a blood glucose monitor. Even among those using insulin, a mere 36.9% engaged in any form of self-monitoring of blood glucose. Moreover, the study revealed that <20% of individuals with diabetes incorporated a minimum of three servings of fruits and vegetables into their daily diet and fewer than 25% of those with diabetes participate in moderate to intense physical activity[16]. Addressing these gaps in self-care and lifestyle practices could significantly contribute to better diabetes management and overall well-being.

Metabolic NCDs in India - The ICMR INDIAB study

The most widely recognized of the metabolic risk factors apart from elevated blood glucose are obesity, dyslipidemia and elevated blood pressure, all of which increase the risk of atherosclerotic cardiovascular disease. India has a very high burden of hypertension, obesity and dyslipidemia as compared to rest of the world[17,18]. The ICMR-INDIAB study has reported that India has a much higher burden of metabolic NCDs compared to other studies[3]. Figs 5-6 present the prevalence of cardiometabolic risk factors in the ICMR INDIAB study population. The overall prevalence of hypertension (defined as blood pressure ≥140/90 mmHg and/or on hypertensive medications) was 35.5% (Fig 5), generalized obesity (defined as body mass index ≥ 25 kg/m^2) and abdominal obesity (defined as waist circumference ≥90 cm in men and ≥80 cm in women) were present in 28.6% and 39.5% of the population, respectively (Fig 5) and hypercholesterolemia (defined as total cholesterol ≥ 200 mg/dl and/or on lipid lowering medications) was present in 24%, hypertriglyceridemia (defined as serum triglycerides ≥ 150 mg/dl and/or on lipid lowering medications) in 32.1% and low HDL cholesterol (defined as HDL cholesterol <40 mg/dl for men and <50 mg/dl for women) in 66.9% (Fig 6). All these cardio-metabolic risk factors were significantly higher among urban compared to rural residents. The ICMR-INDIAB study estimated that in 2021, 315 million persons had hypertension, 252 million and 351 million had generalized and abdominal obesity respectively and 213 million had high cholesterol (Fig 3).

Are migrants more susceptible to diabetes?

Numerous studies provide evidence that the prevalence of type 2 diabetes and other metabolic NCDs are on the rise among migrant Indians. There has been a greater increase in urban as compared to rural population in developing countries like India, which can partly be attributed to the



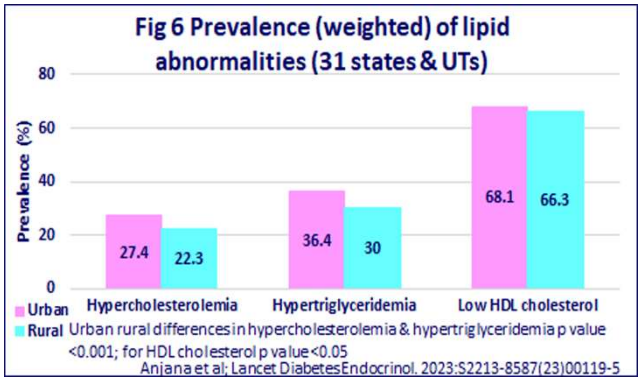


Fig 7 Prevalence of various disorders in migrant and non-migrant urban and rural dwellers

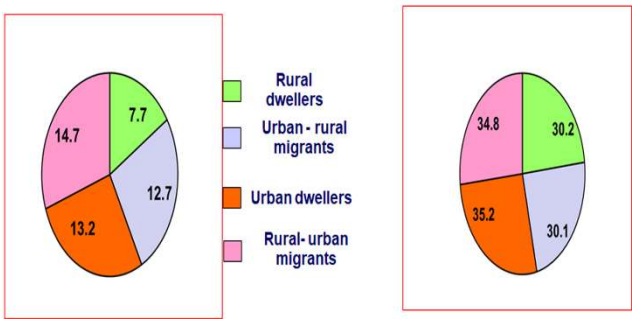
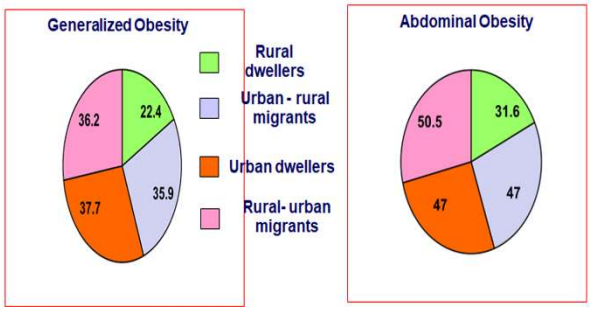


Fig 8 Prevalence of various disorders in migrant and non-migrant urban and rural dwellers



increased migration from rural to urban areas. In India, the percentage of the population residing in urban areas has increased from < 20% in 1960 to > 36% in 2022[19]. Presently, the rates of diabetes and other metabolic NCDs in metropolitan cities in India are reaching levels comparable to those reported in prosperous migrant Indian communities abroad. This upsurge is attributed largely to environmental and lifestyle changes due to industrialization and the transition from rural to urban settings. The migration process appears to be playing a significant role in the emergence of the type 2 diabetes epidemic in Indians. In the ICMR-INDIAB study[20], it was found that 66.4% of the participants were non-migrant rural residents, 19.4% non-migrant urban residents; 8.4% were rural-urban migrants, 2.0% were urban-rural migrants, and 3.8% had undergone two or more migrations between rural and urban areas. The study identified 10.8% as distinct migrants, encompassing those who had migrated either from rural to urban or vice versa.

The prevalence rates of diabetes, hypertension, generalized obesity, and abdominal obesity were assessed based on migrant status (Figs 7-8). The weighted prevalence of diabetes exhibited a significant increasing trend with the highest prevalence observed in rural-urban migrants at 14.7%, followed by urban dwellers at 13.2%, urban-rural migrants at 12.7%, and rural dwellers at 7.7%. Similarly, a significant trend was noted for abdominal obesity, with the highest prevalence of 50.5% observed among rural-urban migrants compared to the other three groups. A comparable significant trend was observed for generalized obesity, with urban dwellers having the highest prevalence at 37.7%. The highest prevalence of hypertension was found in urban dwellers at 35.2%, followed by rural-urban migrants at 34.8%. This study also reported that those who migrated from rural to urban areas were at 1.9 times higher risk of developing diabetes in comparison to individuals who did not migrate and continued to reside in rural areas[20]. These findings carry significant implications for cities and healthcare systems, particularly in developing nations such as India, and underscore the need for prevention programmes. These programmes should prioritize the promotion of healthy lifestyles for individuals residing in urban settings, regardless of their place of origin.

Role of lifestyle factors in the epidemic of diabetes

The majority of NCDs, including type 2 diabetes arise from the combined impact of behavioural risk factors, including unhealthy dietary patterns, physical inactivity, tobacco consumption, and excessive alcohol use. Of these, the two most important and modifiable factors are physical inactivity and unhealthy diet, thereby presenting an opportunity to prevent, or at the very least, delay the onset of type 2 diabetes[21]. Inadequate physical activity and the shift from traditional diets to those abundant in energy-dense industrialized foods are significant risk factors contributing to the development of type 2 diabetes[22].

Role of diet

There is clear evidence of nutrition transition in India that is fuelling the epidemic of chronic diseases and obesity, particularly in urban areas. The nutrition transition in India refers to significant changes in dietary patterns and nutrition-related behaviours that have occurred over time. This transition is characterized by shifts from traditional diets to more westernized or industrialized patterns. Specifically, there is a notable rise in the intake of white rice in southern and eastern India and refined wheat in northern and western part of India[23]. The key factors that contribute to the nutrition transition in India include food availability, urbanization, and affordability of food products. This transition has resulted in notable changes in the composition of the Indian diet: i) traditional diets high in legumes, vegetables, and whole grains are gradually being replaced by diets that are high in calories, fats, and sugars, ii) coarse grains are being substituted with more refined and polished cereals, iii) meat consumption is increasing, iv) there is higher intake of sugar and sweetened beverages, v) consumption of processed and convenience foods are increasing , and vi) intake of fruits and vegetables are not increasing[21].

Carbohydrates and diabetes

Presently, Asian Indian diets in transition are primarily centred around carbohydrates, featuring an excessive intake of calories but lacking sufficient protein, fibre and micronutrients. Cereals continue to be the staple food, contributing to two-thirds of the total carbohydrates consumed[24]. The quantity and quality of carbohydrates play a crucial role in both the prevention and management of diabetes. Notably, there has been a significant increase in the consumption of refined cereals, particularly white rice, among Asian Indians in recent years[25]. The CURES study reported that in urban south India, higher carbohydrates in the diet, higher glycaemic index and glycaemic load of the diet were positively associated with the risk of type 2

diabetes while higher dietary fibre intake was inversely associated with risk of diabetes[26]. This study also reported that the highest carbohydrate intake of 587 g/day was associated with a five-fold increased risk of type 2 diabetes as compared to the lowest intake of 294 g/day[26]. Studies have shown that enhancing the quality of dietary carbohydrates by substituting the commonly consumed cereal staple white rice with brown rice could have beneficial effects in reducing the risk of diabetes and related complications[27,28].

A study which compared the effects of brown rice, white rice and brown rice plus legume diets on 24-h glycaemic and insulinemic responses among overweight Indians, demonstrated that substituting white rice as a staple in the diet with brown rice or brown rice with legumes led to a decrease in 24-h glucose and serum insulin levels[27]. Another study which compared the effects of brown rice and white rice on risk factors for type 2 diabetes, reported that there was a significant reduction in HbA1c in the brown rice-consuming group and that this reduction was particularly pronounced in individuals with metabolic syndrome. Additionally, participants with obesity showed improvements in both total and LDL cholesterol with the consumption of brown rice[28]. This study also reported beneficial trends on high-sensitivity C-reactive protein (hs-CRP) for brown rice group compared with the white rice group. Therefore, opting for brown rice over white rice may represent a healthier choice, especially for individuals at high cardiometabolic risk.

Millets and diabetes

Millets are one of the earliest cultivated crops. They include major millets (sorghum, finger millet and pearl millet) and minor millets (foxtail, kodo, barnyard, proso and little millet). Millets are rich in minerals and vitamins, and have low fat, dietary energy, high fibre and low glycaemic index; millets contain numerous phytochemicals, particularly phenolic compounds, offering a broad spectrum of health benefits[29]. Traditionally, many kinds of foods and beverages were prepared from these millets in different regions of India. over the years millet consumption in the Indian diet has been declining largely due to increased production and consumption of fine cereals, such as rice and wheat. Increasing income and urbanization have also contributed to this decline. Shobana et al[30] have reported the glycaemic index (GI) of selected traditional Indian foods including millets (Fig 9). Many of the millet preparations, including polished finger millet upma, finger millet flakes upma, finger millet balls, and plain cooked unpolished foxtail millet, along with little millet, sorghum, and pearl millet roti, exhibited low glycaemic index (GI). On the other hand, sorghum idly demonstrated a medium GI.

In addition to GI studies, our continuous glucose monitoring study investigating the glycaemic properties of finger millet diets, as opposed to comparable white rice-based diets, revealed no significant differences in the 24-hour interstitial glucose response among healthy volunteers, despite the significantly higher dietary fibre content diets. However, it is noteworthy that fasting insulin levels were 18% lower with millet diets in comparison to white rice diets, emphasizing the need for further exploration[31]. Thus, there should be encouragement for the inclusion of unpolished millets in daily diets, coupled with efforts to promote the production and market supply of unpolished millets.

Fig 9 Glycemic indices of traditional Indian foods

FOODS	GI CLASSIFICATION
BROKEN WHEET UPMA	Low
WHEAT DOSA	Medium
METHI PARATHA	Medium
SORGHUM IDLI	Medium
WHEAT FLAKES SNACKS	High
FINGER MILLET DUMPLINGS (RAGI MUDDE)	High
SORGHUM ROTI	High
PEARL MILLET ROTI	High
MAIZE ROTI	High
UNPOLISHED LITTLE MILLET	High
UNPOLISHED FOXTAIL MILLET	High

Shobana et al., Indian J Med Res. 2022;155:56-65

Nuts and diabetes

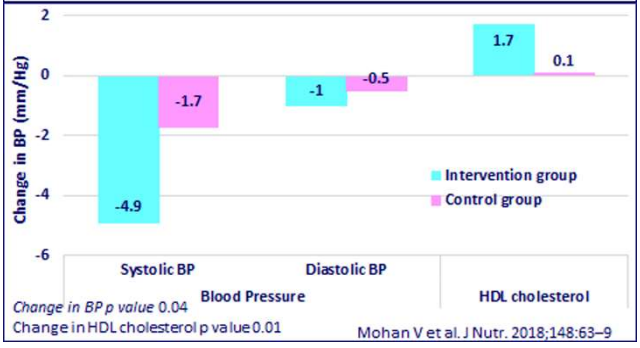
Contrary to the common misconception that nuts might contribute to obesity and negatively impact lipid profiles, studies involving almonds, cashew nuts and pistachios in individuals with pre-diabetes and type 2 diabetes have demonstrated no adverse effects on body weight. In fact, these nuts have been shown to lead to significant improvements in HbA1c, fasting blood glucose and lipid profile and blood pressure[32,33]. A study showed that consumption of 30g of cashew daily for 12 weeks, led to a decrease in systolic blood pressure and increase in HDL cholesterol concentrations in type 2 diabetes without adverse effects on body weight, glycaemia, or other lipid parameters (Fig 10)[32]. Another study showed that in overweight and obese adults consuming 43g of almonds daily as a snack over a period of 12 weeks resulted in

improvement in insulin resistance and β cell function, lowering serum total cholesterol and body weight[33].These findings suggest that regular consumption of cashew nuts and almonds in the long run could help in reducing the risk of diabetes and other cardiometabolic diseases in Indians.

Fats and diabetes

Vegetable oils are commonly used in cooking and food processing, and they provide a concentrated source of energy and essential fatty acids. The shift from traditional

Fig 10 Changes in blood pressure and HDL-cholesterol after 12-week cashew nut supplementation



Mohan V et al. J Nutr. 2018;148:63–9

cooking oils to more processed vegetable oils has been observed in many developing countries, including India[34]. Despite being the world's fifth-largest producer of oilseeds, India struggled to match the per capita consumption of edible oils which increased from 2.9 kg per annum in 1950-60 to 17.07 kg per annum in 2010-20[35]. Studies have shown that some dietary fats may contribute to reduced diabetes risk. The CURES study reported that the quality of fat is sub-optimal in south Indian adults, as exemplified by low intake of mono-unsaturated fats (MUFA) which confer protective health effects at 7%E level, whereas higher intake of saturated fats (SFA) and poly-unsaturated fats (PUFA) even at the levels of 8.6%E and 6%E, respectively, and within the recommended intake increases the risk of diabetes[36]. Furthermore, the CURES study highlighted that the use of Linoleic acid (LA) PUFA-rich oils, such as sunflower oil, might exacerbate the risk of metabolic syndrome[37]. The Asian Indian population typically follows a dietary pattern based on cereal staples, primarily composed of refined grains and characterized by low intakes of Alpha-Linolenic Acid (ALA). Opting for traditional oils like groundnut appears to be a preferable choice over sunflower oil as it ensures an optimal intake of MUFA, LA, and maintains a balanced PUFA to SFA ratio. However, relying solely on a single oil may not be sufficient to achieve the recommended intake of all essential fatty acids and to reduce the LA/ALA ratio. Therefore, the use of blended oils with a lower LA/ALA ratio, incorporating dietary sources of ALA or Eicosapentaenoic Acid (EPA) and Docosahexaenoic Acid (DHA), along with the consumption of whole grains, holds the potential to mitigate the risk of insulin resistance and metabolic syndrome in the Asian Indian population. Intervention studies using such blended oils are thus urgently needed. Data from the 10 year follow-up of the CURES population reported that MUFA (derived from edible oil and nuts in the study population) could prevent 30% of cases of diabetes[38].

Milk and diabetes

Dairy products, such as milk and yogurt, are good sources of protein, calcium, and vitamin D. There have been a few studies investigating the relationship between dairy consumption and type 2 diabetes. Research has suggested that consuming dairy products, particularly those with a higher fat content, may be associated with a lower risk of developing type 2 diabetes[39-41]. According to Health Professionals Follow-up Study researchers, there was a 9% decrease in the risk of type 2 diabetes for each additional serving of total dairy intake/day. Consequently, the authors concluded that there was an association between dairy consumption and a modestly reduced risk of developing type 2 diabetes among men[40], while the Women's Health Study concluded that adopting a dietary pattern that includes increased consumption of low-fat dairy products may reduce the likelihood of developing type 2 diabetes in middle-aged or older women[41]. Our research studies showed that consumption of ≥5 cups/day of total dairy products was linked to a decreased risk of high fasting plasma glucose and blood pressure, low high-density lipoprotein and metabolic syndrome. A high intake of unfermented dairy (≥4 cups/day) was associated with a reduced risk of high body mass index, while a fermented dairy intake of ≥2 cups/day was linked to a lower risk of metabolic syndrome[42]. These findings suggest that increasing consumption of dairy products may contribute to mitigating cardiovascular risk factors and metabolic syndrome in Indians. However, the relationship is complex, and more research is needed to fully understand the mechanisms involved.

Role of physical activity

Physical inactivity is an important public health concern given its harmful impact on the health of the population. It has been identified as a significant risk factor for numerous chronic diseases, including type 2 diabetes, and appears to elevate the risk of developing type 2 diabetes irrespective of dietary habits. If physical inactivity were eliminated globally, it is estimated that 6-10% of major NCDs could be prevented, thereby extending life expectancy[43]. Prolonged engagement in a sedentary lifestyle (activities such as sleeping, sitting, lying down, computer use, and watching television) has been demonstrated to be linked with an elevated risk of type 2 diabetes[44].

The revised World Health Organization (WHO) guidelines recommend a minimum of 150-300 minutes of physical activity/week for healthy adults and older people and encourages people to exceed these targets i.e., recommends more than 300 minutes of physical activity/week for those who can, for better health benefits. However, over 25% of adults and over 80% of adolescents fail to meet the WHO recommended levels of physical activity for optimal health[45].

Over the past decade, several studies carried out globally and in India, have shown high prevalence of physical inactivity[46,47]. The ICMR–INDIAB study reported that levels of physical inactivity were high (~55%) among Indians (Urban - 65.0% vs. rural - 50.0%)[47]. This study also highlighted that merely 10% of individuals participate in any form of recreational physical activity. This underscores the remarkably low levels of leisure-time or recreational physical activity in India. When the ICMR-INDIAB study assessed the physical activity levels among individuals with diabetes, only <25% of the individuals with diabetes were found to engage in moderate to intense physical activity[16].

A systematic review conducted in South Asia on barriers to exercise/physical activity among older adults, reported lack of awareness about the benefits, challenges in communication with healthcare professionals, cultural beliefs, and insufficient facilities as hindering factors for physical activity[48]. In the Diabetes Community Lifestyle Improvement Program (D-CLIP) study, conducted by Anjana and colleagues[49] in 1281 participants, the most frequently cited barriers to exercise by men were "limited places to exercise" and "fatigue," followed by concerns about time constraints and the distance to exercise locations. Women, on the other hand, cited "time constraints" followed by concerns about "limited places to exercise" and the impact on family time (Fig 11). It is evident that overcoming these

barriers to physical activity is crucial for enhancing overall levels of physical activity in the community.

How can we halt the epidemic of diabetes and metabolic NCDs?

The South Asian populations are experiencing a nutrition transition along with the adoption of increasingly sedentary lifestyles; these two factors acting synergistically, increase the risk of diabetes. Effective prevention strategies targeting the diabetes epidemic necessitate a comprehensive understanding of the significance of various modifiable risk factors. A few studies have estimated the contribution of various modifiable risk factors to the Population Attributable Risk (PAR) for diabetes[38,50]. CURES study reported that a combination of risk factors including obesity, an unfavourable diet risk score, physical inactivity, high triglycerides, and low HDL cholesterol could contribute to 80.7% of all incident type 2 diabetes cases (Fig 12)[38].

Adopting a healthy diet alone could prevent nearly 30% of all incident type 2 diabetes, while improving both diet and physical activity could prevent nearly 52%. Controlling abdominal obesity could potentially prevent over 70% of all incident type 2 diabetes. The ICMR-INDIAB study demonstrated that modifying five risk factors-hypertension, abdominal/generalized obesity, physical inactivity, and low fruit and vegetable intake-could result in the prevention of nearly 70% of diabetes among rural-urban migrants when compared to non-migrant urban dwellers[20].

To prevent the onset/progression of diabetes, as well as to achieve 'remission' of diabetes back to normoglycaemia, it is crucial to make significant changes to unhealthy dietary habits. The ICMR-INDIAB study, which attempted to frame macronutrient guidelines for the prevention/remission of type 2 diabetes, reported that a reduction in energy (E) from carbohydrate (54-57% (E) and an increase in protein (16-20%E) in individuals with pre-diabetes for prevention of diabetes and reduction in carbohydrate (49-54%E) and an increase in protein (19-20%E) in individuals with newly diagnosed diabetes for remission was recommended[51]. Macronutrient recommendations to achieve remission in those with newly diagnosed diabetes (NDD) and pre-diabetes are provided in Table 2. A minimum protein intake of 14-16%E was found to be necessary to prevent the progression in the pre-diabetes and NGT categories. These findings emphasize the importance of revising dietary guidelines to recommend suitable adjustments to the macronutrient composition of diets for decreasing the prevalence of diabetes among Indians.

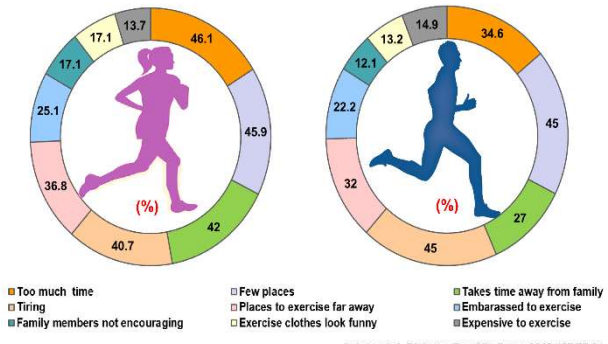
Table 2: Macronutrient recommended to achieve remission in those with newly diagnosed diabetes (NDD) and prediabetes (Ref 51)

Macronutrient	Remission targets (%E) in individuals with newly diagnosed diabetes (n= 1594)	Remission targets (%E) in individuals with prediabetes (n= 7336)
Carbohydrates(%E)	49-54 (8 –13↓)	50-56 (6-12↓)
Protein (%E)	19-20 (7- 8↑)	18 - 20 (6- 8↑)
Total Fat (%E)	21- 26	21- 27
Total Fat (%E)	21- 26	21- 27
Dietary Fibre (%E)	5- 6 (1.5 – 2.5↑)	3-5 (1.5↑)

In recent years, there has been considerable interest in dance interventions to improve health. In view of the barriers to conventional forms of exercise[49], a novel intervention called THANDAV (Taking High-Intensity Interval Training [HIIT] ANd Dance to Adolescents for Victory over noncommunicable diseases) was designed by Anjana et al[52] specifically for adolescent girls and women. As dance is an integral part of Indian culture with each state/region having its own classical dance form, THANDAV consists of an accepted form of exercise for girls/women in India. A typical 10-min THANDAV routine with high-intensity dance steps consists of 4 popular Bollywood/regional/contemporary/folk songs (each song for 2½ mins). The routine was pilot tested in 23 adolescent girls and showed that THANDAV met HIIT norms, improved cardiorespiratory fitness and overall cardio metabolic health in adolescent girls. Moreover, the girls loved it and found it to be an acceptable, fun, unique and sustainable way to maintain physical activity. Currently THANDAV has been disseminated to 10,000 women and girls in India, UK and Australia.

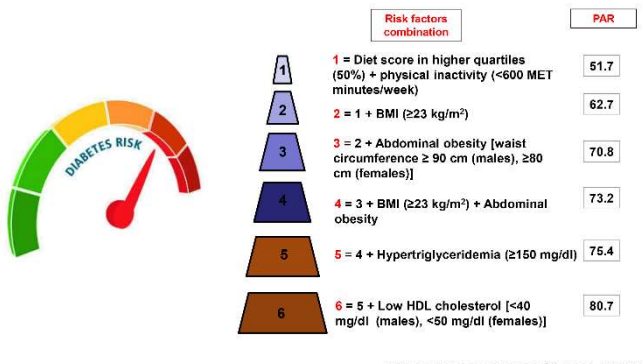
Conclusion

Figure 11: Perceived barriers to exercise among the non exercisers



Anjana et al, Diabetes Res Clin Pract. 2015;107:77-84

Figure 12: Partial Population attributable risks of type 2 diabetes



Anjana RM et al., Diabetes Res Clin Pract. 2015;10

The burden of diabetes and metabolic NCDs is increasing in both urban and rural areas of India and the increase in prevalence of diabetes and prediabetes is inevitable. Among those with diabetes, only a third have good glycemic control and fewer than half of the individuals have good control of blood pressure and LDL cholesterol. Rural-to-urban migration is associated with increased risk of developing diabetes and other cardio-metabolic abnormalities. Unhealthy diets with high refined grain consumption and very low consumption of fruits and vegetables are widely prevalent. Physical activity levels in our population (especially in women) are low, primarily due to barriers that hinder physical activity. The good news is that these factors are all highly modifiable. The need of the hour is to promote healthier lifestyles to prevent/reverse diabetes.

A comprehensive approach is crucial for achieving success in diabetes prevention/control programmes at the regional or national level. Key strategies encompass (i) minimizing exposure to risk factors through health promotion and primary prevention, (ii) early detection and management, and (iii) surveillance to track trends in risk factors, diabetes and metabolic NCDs. Policies that could contribute to slowing down the epidemic of diabetes and metabolic NCDs in India include: a) implementing national food policies that focus on improving the availability and accessibility of healthy and nutritious foods such as whole grains, fruits, vegetables, legumes, and nuts, b) enforcing health policies to reduce harmful behaviours like smoking, alcohol misuse, the use of trans fat, and the consumption of junk foods. Increasing physical activity can be achieved by creating amenities such as public spaces for activities like walking and cycling and introducing novel ideas such as THANDAV, c) executing policies aimed at reducing the cost of drugs and ensuring reasonable access to healthcare services, d) introducing prevention policies, including health information and communication initiatives to enhance population awareness about healthy lifestyles and e) developing national guidelines on management, prevention and remission of diabetes. Implementation of these policies collectively addresses multiple facets of diabetes and other NCD prevention, from promoting healthier lifestyles to ensuring accessible healthcare, ultimately working towards curbing the diabetes epidemic at the national level.

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FOUNDATION NEWS

The Fourth Dr C Gopalan Memorial Webinar was held on 03.10.2023 from 10.00 AM to 1.30 PM. The theme of the Webinar is “Diabetes in India during the dual nutrition burden era”.

Dr Soumya Swaminathan, Chairperson MSSRF, Chennai, delivered the C Ramachandran Memorial Lecture in virtual mode on 29.11.2023 from 3.00 PM to 5.00 PM

NUTRITION NEWS

The 55th Annual Conference of Nutrition Society of India was held on 25th and 26th of November 2023 at the National Institute of Nutrition, Hyderabad. The theme of the Conference is “Nutri-cereals for one health”. During the Conference Dr Ramesh Chand Member NITI Aayog delivered the Dr C Gopalan Oration and Dr Shaly Awasthi delivered the Dr SG Srikantia Oration.