Salis Sheryl (Orcid ID: 0000-0002-6115-5618)
 KAPOOR NITIN (Orcid ID: 0000-0002-9520-2072)
 Irani Aspi (Orcid ID: 0000-0002-4288-4313)

Medical Nutrition Therapy of Pediatric Type 1 Diabetes Mellitus in India: Unique Aspects and Challenges

Sheryl Salis¹, Mini Joseph², Anuja Agarwala³, Rajni Sharma⁴, Nitin Kapoor^{5,6}, Aspi J. Irani^{7,8}

¹ Registered Dietitian ,Certified Diabetes Educator and Certified Insulin Pump Trainer, Director- Nurture Health Solutions, Mumbai, India; ²Assistant Professor and Head of the Department of Home science, Government College for Women, Trivandrum, Kerala, India; ³Senior Dietitian, All India Institute of Medical Sciences, New Delhi India ; ⁴Associate Professor, Division of Pediatric Endocrinology, Department of Pediatrics, All India Institute of Medical Sciences, New Delhi, India; ⁵Associate Professor, Dept. of Endocrinology, Diabetes and Metabolism, Christian Medical College, Vellore, Tamil Nadu, India. ; ⁶NCD Unit, Melbourne School of Population and Global Health, Faculty of Medicine, Dentistry and Health Sciences, University of Melbourne, Australia. ⁷Consultant Paediatrician, Nanavati Super Speciality Hospital, Mumbai, India; ⁸Trustee and In-Charge: Juvenile Diabetes Foundation, Maharashtra Chapter, India

Key words – Medical nutrition therapy, Type 1 Diabetes Mellitus, Indian diets

Running title – Medical nutrition therapy in Indian children

Acknowledgements: We would like to acknowledge Dr Vijayalaksmi Bhatia, Professor of Pediatric Endocrinology, Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, India for her valuable suggestions to improve the manuscript.

Corresponding author:

Dr Aspi J. Irani
 Consultant Paediatrician,
 Nanavati Super Speciality hospital,

This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the [Version of Record](#). Please cite this article as doi: [10.1111/pedi.13080](https://doi.org/10.1111/pedi.13080)

Mumbai, Maharashtra, India
Email : aspi131@hotmail.com
Ph: +91-9518340376(M)

The authors declare no conflict of interest for this manuscript. No funding or ethics approval was required for this paper

Background

Medical Nutrition therapy (MNT) is a vital aspect of management of type 1 diabetes mellitus (T1DM) and should be tailored to ethnic and family traditions and the socioeconomic and educational status of the patient.

Objectives

In this article, we discuss the unique aspects of MNT in children and adolescents with T1DM in the Indian setting, with focus on the challenges faced by patients, dieticians and physicians and how these can be overcome.

Methods

The authors reviewed the available literature on MNT in T1DM from India and prepared the document based on their vast collective clinical experience in treating patients with T1DM from different regions in India.

Results

Indian diets are predominantly carbohydrate-based with high glycemic index (GI) and low protein content. Various methods are available to increase the protein and fiber content and reduce the GI of food in order to limit glycemic excursions. Insulin regimens need to be tailored to the child's school timings, meal schedule and the availability of a responsible adult to supervise/administer insulin. All patients, irrespective of economic and education background, should be taught the broad

principles of healthy eating, balanced diet and carbohydrate counting. There are various barriers to dietary compliance including joint family system, changing lifestyles and other factors which need to be addressed.

Conclusion

There is a need to customize dietary management according to patient characteristics and needs and develop standardized patient educational material on principles of healthy eating in various regional languages.

Medical Nutrition Therapy of Pediatric Type 1 Diabetes Mellitus (T1DM) in India: Unique Aspects and Challenges

India is home to the second largest number of children and adolescents with Type 1 diabetes mellitus (T1DM) in the world, with approximately 171,300 patients in the age group 0-19 years.(1) Due to its large population, India adds the highest number of children with T1DM per year in the age group 0 to 14 years (15900 as estimated by the IDF in its 2019 atlas).(1) Medical Nutrition Therapy (MNT) is an essential component of the management of T1DM.(2) In a country as large and diverse as India, with a variety of diets (3), traditional meal practices(4, 5), and regional, cultural, religious, socio-economic and agriculture differences(6), dietary management of T1DM can be a challenge for health care professionals.(5) There is need for a personalized therapeutic care regime with evidence-based medicine for each patient.(7)

In this article, we discuss the unique aspects and challenges of MNT in the Indian setting, with focus on healthy eating practices, insulin regimes to match meal plans, components of nutrition education and issues related to dietary compliance.

Healthy eating in the Indian setting

Indian cuisine varies from one region to another and from season to season reflecting cultural pluralism.(8) The Starch study documented that diets across all regions in India contain 65-70 percent of calories from carbohydrates, mostly from refined sources like polished white rice, or refined wheat and its products. Only 10-12% of calories are derived from protein, chiefly from milk and vegetarian sources.(9) This high carbohydrate, low fibre diet results in higher post prandial glycaemic values.(10) This data is mainly gathered from patients with Type 2 Diabetes Mellitus (T2DM) as limited information is available in these aspects among individuals with T1DM.

Improving the glycemic index (GI) and protein content of diet: Low GI foods may be beneficial by blunting the glycaemic excursions after meals.(11) The recipes of traditional Indian foods could be modified to increase the fibre and protein content and lower the GI. This can be done without affecting the palatability and without making major changes in the patient's eating preferences (Table 1).(10, 12-21)

Fibre content of Indian diets can be increased by consuming whole grains (whole wheat, barley, broken wheat), millets, whole pulses (green gram, red gram, chickpea, and kidney beans), vegetables, salads and fibrous fruits. Addition of dairy products (curd, cottage cheese or *paneer*), pulses, soybean and egg can augment the protein content especially in those who cannot afford / do not eat meat, fish or poultry.

Traditional main meals in India comprise of a flat bread with vegetables and / or a non-vegetarian item, dal/whole pulses/sprouts with rice, and a dairy product (curd/buttermilk).(22)

Main meals can be started with some protein and fibre.(16) Patients can be advised to have carrot, cucumber or radish sticks with curd, buttermilk or *raita* (an Indian side dish with curd, chopped vegetables and spices). Besides improving post prandial glucose control this also helps achieve early satiety.(14, 15, 23)

Low carbohydrate snacks (table 2): are recommended when it is not practical to administer a pre-snack insulin bolus. These do not have a significant impact on blood glucose levels provided they are consumed in prescribed amounts. These snacks should be selected cautiously as snacks that are low in carbohydrates could be high in fats especially trans fats and saturated fats which can be detrimental to health (21, 24, 25). Patients are encouraged to select those snacks which are also good sources of protein, healthy fats and fibre. A few examples of low carbohydrate snacks/foods (0 to 5 g carbohydrate per serving) that contain less than 10g total fat and 5 g saturated fat per serving are listed in Table 2.

Fats in diet: There should be emphasis on both quantity as well as quality of cooking oil used. The National Institute of Nutrition (NIN), India, recommends rotation of oils or use of commercially available blended oils to acquire the right balance of fatty acids in the diet. Depending on the region, one could choose between groundnut/sesame/rice bran oil and mustard/soybean oil.(26) *Ghee* (clarified butter) and coconut oil have been used traditionally as a part of the Indian diet. Intake of these and other sources of saturated fat should ideally not exceed the recommended amount of 7-10% daily calorie intake from saturated fats.

Nuts are a good source of monounsaturated fatty acids as well as protein, fibre and antioxidants. They are low in carbohydrates. Walnuts are a good source of omega-3 fatty acids. When carbohydrate and saturated fat in a snack are partially replaced with raw unsalted nuts such as pistachios, walnuts and almonds it could lead to improved glycemic control and blood lipids. This has been studied in individuals with T2DM and may also hold good in patients with T1DM. (27, 28)

Micronutrients: A significant proportion of India's population has dietary deficits in protein and micronutrients. The key micronutrient deficiencies reported in the Indian population include Vitamin A, B and C, iron, calcium, zinc, copper, magnesium, selenium and chromium. (29) This is further compounded in patients with T1DM due to the additional dietary restrictions levied on them. A nutritionist can suggest wholesome recipes to enhance micronutrient composition without adversely affecting the energy intake or glycaemic load (GL). These recipes can be made from low GI and low-medium GL whole grains, millets, pulses, sprouts,

soybean, nuts, seeds (pumpkin seeds, sesame seeds, popped amaranth seeds), and seasonal local fruits (in particular apple, pear, sweet lime, orange) and vegetables (such as red amaranth, fenugreek, spinach and radish).(30, 31)

Salt intake needs to be reduced in most Indian diets Pickle and *papad* (a thin, crisp, round flatbread made from lentils, either fried in oil or cooked with dry heat) are common examples of high salt items in India. Salt adjuncts unique to India are lemon, tamarind, *kokum* (garcinia indica), vinegar, onion, garlic powder and dry mango powder which can supplement well known spices and herbs like oregano, basil, mint and cilantro.(32)

Food labelling in India leaves much to be desired. Products with tag lines like sugar free, low sugar and fat free are easily available at stores in India. Terms used for added sugars include corn syrup, high-fructose corn syrup, fruit juice concentrate, dates, jaggery, honey, and maple syrup and these are often marketed as “low sugar/sugar free” products. Patients must be made aware that “sugar free” need not mean that the item is carbohydrate or calorie free.

Anthropometric indicators in India: Similar to patients with T2DM, anthropometric indicators play an important role in determining dietary recommendations of a given child.(33) There has been a rapid increase in obesity across the country and this is further compounded by the ethnicity specific risk attributed by the unique thin-fat Indian phenotype.(34, 35) The Indian Academy of Paediatrics (IAP) 2015 growth charts(36) were developed using 33148 children from 13 different centres and have been further validated in another population.(37, 38) These are currently most representative of the Indian population but it is important to understand their development, utility and limitations, before prescribing dietary recommendations based on them. For children below the age of 5 years the IAP recommends the WHO growth charts.

Celiac disease (CD)

The prevalence of CD in India among children with T1DM, ranges between 8 to 18%.(39) There is a higher reported prevalence of celiac disease from north India as compared to southern states.(40, 41) This could be attributed to differences in the genetic make-up further compounded by a very different dietary pattern. Wheat is one of the most important constituents of almost every meal in north India while rice is the staple cereal in the south and north-east. A typical north Indian diet contains about 25–30 g of gluten per day; whereas average gluten intake in west India varies from 10 to 20 g/day. (42, 43).

Strict adherence to gluten free diet is essential (Table 3). Even small amounts of gluten (50 mg/day) can be immunogenic, hence all food items and drugs that contain gluten and its derivatives must be eliminated completely from the diet.(44) Gluten is used in thickeners, stabilizing agents, fillers and binders and also in a number of medicines, cosmetics, toothpastes, and malted beverages.(45) Food contamination can occur during harvesting, storage and packaging.

Earlier there was lack of awareness that the easily available millets are gluten free. The production of gluten free foods in India is a small-scale industry, with limited choices and the products are expensive. A study carried out in India, on various breakfast products, flours, and batters made from grain that are naturally gluten free, showed a likelihood of gluten contamination in products that are sourced from local retailers and millers.(46) Nutritionists in India often advise families with celiac disease to have their own small flour grinder at home.

The Indian school systems-their impact on insulin regime and meal plan

The insulin prescription should be finalized only after knowing the convenient times when child can eat and whether it will be possible to administer insulin prior to eating. This would depend on the school schedule and also on the availability of a responsible adult to administer or supervise insulin shots and blood tests in school and at home. Indian schools, with the exception of few elite ones, do not have a nurse nor, in many instances, are the teachers prepared to supervise insulin injections or SMBG. Hence, if insulin has to be taken in school, one would have to rely on the child's cooperation and skill. Children are often reluctant to monitor blood glucose

or inject in school. Further, the duration of the breaks (10-15 minutes and 30-35 minutes, or a single break of 30-45 minutes); may be too short for the child to inject and eat. The likelihood of snack box sharing is very high. In some schools, a home snack box is not permitted and meals are provided by the school. All these factors together can make it difficult to have consistent good control during school hours.

Based on the school timings, school schedules in India could be categorized into three broad groups:

Group A- Early riser: these children leave for school around 7 am barely an hour after waking up and are back home by about 2 pm. They generally eat a very light snack at home, followed by breakfast during the recess in school between 9.30-10 am and then return home for lunch by 2 pm, often snacking on the way home.

Group B- Afternoon commencer: these children are in school between 12 noon and 6 pm. They wake up late, have breakfast on waking up, a snack before leaving home for school and lunch during the school break, followed by another snack on returning home at 6 pm.

Group C- Mid-day scholar: this category leaves for school at 8-8.30 am and returns by 4 pm. They have breakfast at home and a mid-morning snack and lunch in school.

Dinner time in India varies from 8 pm to 10 pm and hence many children do not take a bedtime snack.

The bolus insulin could be a rapid acting analogue but human regular insulin being nearly 4 times cheaper, is preferred if affordability is an issue. It is also preferred in groups A and B prior to the light snack consumed before leaving for school if injecting insulin is not possible for the first snack / meal in school a few hours later. However, when breakfast is heavy and the school snack is several hours after leaving home, one may suggest either low carb items for the snack or use pre-mixed insulins before starting from home to cover school hours when injecting insulin is not an option.

In the very poor, meal choices are limited and meals are likely to remain constant from day to day. In this group, if an afternoon dose of insulin is not practical the 2-injections-a-day regimen using regular and NPH insulins can be prescribed.

Imparting nutritional advice and education

Nutrition education plays a pivotal role in the management of diabetes in the young. The literacy level, comprehending capacity, affordability, family composition, school / college schedule, academic pressures, peer pressures, location of residence and accessibility to the medical care team, are influencing factors to be deliberated upon while laying out the diet plan.

Nutritional advice should be practical, tailored to the patients' needs and provided in the mother tongue of the patients. There are 22 major languages in India. Resource constrained medical teams can take the help of trained "parent-educators". Frequent contact with the patient on mobile phone or whatsapp is helpful. Mobile phones are used extensively in India and mobile calls and data are inexpensive.(47, 48)

In India, most people have a routine meal pattern which generally remains the same throughout the week. Carbohydrate exchanges are easy to teach and can be used by the patient when consuming the routine diet. Knowledge of carbohydrate counting and insulin adjustment for selected foods / snacks gives additional flexibility in making food choices. It is the experience of the authors that even parents with primary school education are able to make successful insulin dose adjustments and in motivated patients, age of the child has not been a deterrent in adopting a carbohydrate counting method. The Indian Food Composition Tables (IFCT-2017)(21), published by NIN, India, is a reliable reference for computing the carbohydrate content of foods. Standardized educational modules from basic to advanced must be developed as this is lacking in our country.

Issues in adherence with MNT

Adherence to dietary therapy is the most challenging part of diabetes management.(49) The biggest problem in a resource-poor setting is the lack of

trained dieticians and lack of physician time for adequate nutritional counseling. An individualized approach may be difficult to follow in a busy outpatient setting and families are often given a printed chart of a sample diet which deters compliance.(50, 51)

There are various other challenges in ensuring adherence to MNT that should be anticipated and addressed in problem-solving sessions.

- **Economic barriers:** A systematic review of the possible barriers affecting good diabetes management found that besides attitude, beliefs and knowledge, finance resources is an important factor.(52) A study from south India noted that over 50% of patients attending an integrated diabetes clinic were daily wage earners who had to travel long distances to seek medical care, incurring travel costs besides loss of income.(53, 54) A study from north India revealed that the mean direct cost of diabetes management per patient per year was 18.6% of annual family income. Patients from lower income bracket spend a larger proportion of the family income (32.6%) on diabetes care. (48). Many state governments, NGOs, pharmaceutical companies and diabetes support groups provide free glucometers, strips, and insulin. However, food costs are mostly borne by the patients. The Public Distribution System (PDS) was established by the Government of India to provide essential food items (rice, wheat, oil and sugar) to India's needy. Policy change is necessary to include fiber rich grains, millets, pulses, and eggs in the PDS in place of cheaper high carb foods. The kitchen garden concept (growing vegetables in the backyard / terrace) can be initiated wherever possible.
- **Lack of support by family, peers and at the work place:** Many patients live in a joint family setting with grandparents, uncles, aunts and cousins and share a common kitchen. A study on young diabetes patients in India showed that not all patients get positive support from their family, workplace or their peers and on the contrary are often excluded by them.(55) Only 50% of patients followed nutritional advice quoting work related responsibilities and academic pressures as major deterrents to nutritional compliance.(55) Members of the joint family may be resistant to changes in their existing

dietary patterns. Elders in the family should be made to understand that diet for T1DM is based on the principles of healthy eating and would also benefit them. Peer support groups have shown promising results in optimizing diabetes care in India and this can be considered as a cost effective model in both patients with T1DM and T2DM.(56, 57) The role of a counsellor, especially in adolescent age group, is of prime importance in correcting non-compliant behaviour.(58)

- **Educational level of the patients/caregiver:** A study from south India found that nutritional advice was not clearly understood by patients despite regular hospital visits.(55) Similar findings have been reported in north Indian patients with T2DM, where knowledge, attitude, and practices with respect to diabetes management were found to be unsatisfactory.(59) There is evidence that academic knowledge does not always translate into positive action. (54)
- **Lack of supervision:** Communication with school authorities about providing a nurse or other responsible staff to supervise procedures / meals and having a responsible adult at home do the same (in an unobtrusive manner) can improve compliance.
- **Widespread availability of junk food:** Unhealthy packaged foods are freely available in Indian markets.(60) In urban areas, adolescents consume junk food regularly for between-meal snacks.(61) Mothers should be taught how to prepare healthy homemade snacks with locally available ingredients.(31)
- **Food fads:** Patients may be misled by the media or by relatives/friends and adopt fad food diets including low carbohydrate or fruit only diets. Parents may hold myths that calorie restriction is required to achieve glycemic control. These diets can negatively affect growth, energy, and well-being and should be discouraged.(31)
- **Festivals and special occasions:** As many as 37 festivals are celebrated through the year in India! Festive food is high in sugar and fat. Severe restrictions on these foods may not work and hence patients should receive

clear instructions regarding the need for moderation and amount of additional insulin required to cover these items.

- **Fasting:** Fasts are a part of many religions and cultures in India. Markedly altered food and fluid intake during fasts can lead to complications including hypoglycemia, dehydration, electrolyte imbalance and DKA. Fasting is to be discouraged in pediatric patients with T1DM. Indian guidelines for management of diabetes during fasts have been published. (62)

In this article we have discussed the unique features and challenges with MNT in pediatric T1DM in the Indian setting. The cultural practice of having unprocessed home-made meals offers an advantage. At the same time, rapid modernization and changing lifestyles with increased consumption of junk food poses a challenge. Moderation of carbohydrate intake with increase in protein and fibre content of traditional meals can improve glycemic control. MNT has to be catered to the socio-economic background and educational level of the family. There is a need to develop educational tools on principles of healthy eating in various vernacular languages taking regional differences into account.

References

1. Cho NH, Shaw JE, Karuranga S, Huang Y, da Rocha Fernandes JD, Ohlrogge AW, et al. IDF Diabetes Atlas: Global estimates of diabetes prevalence for 2017 and projections for 2045. *Diabetes research and clinical practice*. 2018; 138:271-81.
2. Smart CE, Annan F, Higgins LA, Jelleryd E, Lopez M, Acerini CL. ISPAD Clinical Practice Consensus Guidelines 2018: Nutritional management in children and adolescents with diabetes. 2018; 19 Suppl 27:136-54.
3. Gupta R, Guptha S, Sharma KK, Gupta A, Deedwania P. Regional variations in cardiovascular risk factors in India: India heart watch. *World journal of cardiology*. 2012; 4:112-20.
4. Nations within a nation: variations in epidemiological transition across the states of India, 1990-2016 in the Global Burden of Disease Study. *Lancet (London, England)*. 2017; 390:2437-60.
5. Vecchio MG, Paramesh EC, Paramesh H, Loganesh C, Ballali S, Gafare CE, et al. Types of food and nutrient intake in India: a literature review. *Indian journal of pediatrics*. 2014; 81 Suppl 1:17-22.

6. Subramanyam MA, Kawachi I, Berkman LF, Subramanian SV. Socioeconomic inequalities in childhood undernutrition in India: analyzing trends between 1992 and 2005. *PloS one*. 2010; 5:e11392.
7. Sanjay Kalra, Nitin Kapoor, Sunil Kota, Das S. Person-centred Obesity Care – Techniques, Thresholds, Tools and Targets. *European Endocrinology*. 2020; 16.
8. Green R, Milner J, Joy EJ, Agrawal S, Dangour AD. Dietary patterns in India: a systematic review. *The British journal of nutrition*. 2016; 116:142-8.
9. Joshi SR, Bhansali A, Bajaj S, Banzal SS, Dharmalingam M, Gupta S, et al. Results from a dietary survey in an Indian T2DM population: a STARCH study. 2014; 4:e005138.
10. Eleazu CO. The concept of low glycemic index and glycemic load foods as panacea for type 2 diabetes mellitus; prospects, challenges and solutions. *African health sciences*. 2016; 16:468-79.
11. Brand-Miller J, Hayne S, Petocz P, Colagiuri S. Low-glycemic index diets in the management of diabetes: a meta-analysis of randomized controlled trials. *Diabetes Care*. 2003; 26:2261-7.
12. Atkinson FS, Foster-Powell K, Brand-Miller JC. International tables of glycemic index and glycemic load values: 2008. *Diabetes Care*. 2008; 31:2281-3.
13. Shobana S, Selvi RP, Kavitha V, Gayathri N, Geetha G, Gayathri R, et al. Development and evaluation of nutritional, sensory and glycemic properties of finger millet (*Eleusine coracana* L.) based food products. *Asia Pacific journal of clinical nutrition*. 2018; 27:84-91.
14. Imai S, Fukui M, Kajiya S. Effect of eating vegetables before carbohydrates on glucose excursions in patients with type 2 diabetes. *Journal of clinical biochemistry and nutrition*. 2014; 54:7-11.
15. Meng H, Matthan NR, Ausman LM, Lichtenstein AH. Effect of macronutrients and fiber on postprandial glycemic responses and meal glycemic index and glycemic load value determinations. *The American journal of clinical nutrition*. 2017; 105:842-53.
16. Faber EM, van Kampen PM, Clement-de Boers A, Houdijk E, van der Kaay DCM. The influence of food order on postprandial glucose levels in children with type 1 diabetes. *Paediatric Diabetes* 2018; 19:809-15.
17. Sonia S, Witjaksono F, Ridwan R. Effect of cooling of cooked white rice on resistant starch content and glycemic response. *Asia Pacific journal of clinical nutrition*. 2015; 24:620-5.
18. Boers HM, Seijen Ten Hoorn J, Mela DJ. A systematic review of the influence of rice characteristics and processing methods on postprandial glycaemic and insulinaemic responses. *The British journal of nutrition*. 2015; 114:1035-45.
19. Zhou Z, Robards K, Helliwell S, Blanchard C. Ageing of stored rice: changes in chemical and physical attributes. *Journal of Cereal Science*. 2002; 35:65-78.
20. Dipnaik K, Kokare P. Ratio of amylose and amylopectin as indicators of glycaemic index and in vitro enzymatic hydrolysis of starches of long, medium and short grain rice. *International Journal of Research in Medical Sciences*. 2017; 5:4502-5.
21. Longvah T, Anantan I, Bhaskarachary K, Venkaiah K. Indian food composition tables: National Institute of Nutrition. Indian Council of Medical Research. 2017.
22. Shukla AP, Iliescu RG, Thomas CE, Aronne LJ. Food Order Has a Significant Impact on Postprandial Glucose and Insulin Levels. *Diabetes Care*. 2015; 38:e98-9.
23. Moghaddam E, Vogt JA, Wolever TM. The effects of fat and protein on glycemic responses in nondiabetic humans vary with waist circumference, fasting plasma insulin, and dietary fiber intake. *The Journal of nutrition*. 2006; 136:2506-11.

24. Bell KJ, Smart CE, Steil GM, Brand-Miller JC, King B, Wolpert HA. Impact of fat, protein, and glycemic index on postprandial glucose control in type 1 diabetes: implications for intensive diabetes management in the continuous glucose monitoring era. *Diabetes Care*. 2015; 38:1008-15.
25. Smart CEM, King BR, Lopez PE. Insulin Dosing for Fat and Protein: Is it Time? *Diabetes Care*. 2020; 43:13-5.
26. Gupta L, Khandelwal D. Pragmatic selection of cooking oils. *JPMA The Journal of the Pakistan Medical Association*. 2017; 67:957-8.
27. Gulati S, Misra A, Pandey RM. Effect of Almond Supplementation on Glycemia and Cardiovascular Risk Factors in Asian Indians in North India with Type 2 Diabetes Mellitus: A 24-Week Study. *Metab Syndr Relat Disord*. 2017; 15:98-105.
28. Mohan V, Gayathri R, Jaacks LM, Lakshmi Priya N, Anjana RM, Spiegelman D, et al. Cashew Nut Consumption Increases HDL Cholesterol and Reduces Systolic Blood Pressure in Asian Indians with Type 2 Diabetes: A 12-Week Randomized Controlled Trial. *The Journal of nutrition*. 2018; 148:63-9.
29. Vecchio MG, Paramesh EC, Paramesh H, Loganesh C, Ballali S, Gafare CE, et al. Types of food and nutrient intake in India: a literature review. *The Indian Journal of Pediatrics*. 2014; 81:17-22.
30. Bharadva K, Mishra S, Tiwari S, Yadav B, Deshmukh U, Elizabeth KE, et al. Prevention of Micronutrient Deficiencies in Young Children: Consensus Statement from Infant and Young Child Feeding Chapter of Indian Academy of Pediatrics. *Indian pediatrics*. 2019; 56:577-86.
31. Parthasarathy LS, Chiplonkar SA, Khadilkar AV, Khadilkar VV. Dietary modifications to improve micronutrient status of Indian children and adolescents with type 1 diabetes. *Asia Pacific journal of clinical nutrition*. 2015; 24:73-82.
32. Association AH. Shaking the salt habit to lower high blood pressure. 2017.
33. Kapoor N, Lotfaliany M, Sathish T, Thankappan K, Thomas N, Furler J, et al. Obesity indicators that best predict type 2 diabetes in an Indian population: insights from the Kerala Diabetes Prevention Program. *Journal of Nutritional Science*. 2020; 9.
34. Kapoor N, Furler J, Paul TV, Thomas N, Oldenburg B. Normal weight obesity: an underrecognized problem in individuals of South Asian descent. *Clinical therapeutics*. 2019; 41:1638-42.
35. Kapoor N, Furler J, Paul TV, Thomas N, Oldenburg B. The BMI-adiposity conundrum in South Asian populations: need for further research. *Journal of biosocial science*. 2019; 51:619-21.
36. Khadilkar VV, Khadilkar AV. Revised Indian Academy of Pediatrics 2015 growth charts for height, weight and body mass index for 5-18-year-old Indian children. *Indian J Endocrinol Metab*. 2015; 19:470-6.
37. Khadilkar V, Yadav S, Agrawal KK, Tamboli S, Banerjee M, Cherian A, et al. Revised IAP growth charts for height, weight and body mass index for 5- to 18-year-old Indian children. *Indian pediatrics*. 2015; 52:47-55.
38. Lohiya N, Khadilkar V, Pawar S, Khadilkar A, Chiplonkar S, Jahagirdar R. Field Testing of IAP2015 Charts. *Indian journal of pediatrics*. 2018; 85:723-8.
39. Srivastava A, Chaturvedi S, Dabadghao P, Mathias A, Shukla U, Singh U, et al. Prevalence of celiac disease in Indian children with type 1 diabetes. *Indian journal of gastroenterology : official journal of the Indian Society of Gastroenterology*. 2016; 35:372-8.

40. Kumar P, Krishna P, Reddy SC, Gurappa M, Aravind SR, Munichoodappa C. Incidence of type 1 diabetes mellitus and associated complications among children and young adults: results from Karnataka Diabetes Registry 1995-2008. *Journal of the Indian Medical Association*. 2008; 106:708-11.
41. Bhatia E. Celiac disease & type 1 diabetes: A double burden. *The Indian journal of medical research*. 2019; 149:5-7.
42. Price S. Understanding the importance to health of a balanced diet. *Nursing times*. 2005; 101:30-1.
43. Ramakrishna BS. Celiac disease: can we avert the impending epidemic in India? *The Indian journal of medical research*. 2011; 133:5-8.
44. Makharia GK. Current and emerging therapy for celiac disease. *Frontiers in medicine*. 2014; 1:6.
45. Rajpoot P, Makharia GK. Problems and challenges to adaptation of gluten free diet by Indian patients with celiac disease. *Nutrients*. 2013; 5:4869-79.
46. Raju N, Joshi AKR. Gluten contamination in labelled and naturally gluten-free grain products in southern India. 2020; 37:531-8.
47. Kordonouri O, Riddell MC. Use of apps for physical activity in type 1 diabetes: current status and requirements for future development. *Therapeutic advances in endocrinology and metabolism*. 2019; 10:2042018819839298.
48. Kaur J, Kaur M, Chakrapani V. Effectiveness of information technology-enabled 'SMART Eating' health promotion intervention: A cluster randomized controlled trial. 2020; 15:e0225892.
49. Lockwood D, Frey ML, Gladish NA, Hiss RG. The biggest problem in diabetes. *The Diabetes educator*. 1986; 12:30-3.
50. Kalra S, Joshi S, Baruah M. Medical nutrition therapy for diabetes: The challenge in India. *Journal of Medical Nutrition and Nutraceuticals*. 2012; 1:3.
51. Kalra S, Das AK, Raghupathy P, Chowdhury S, Saboo BD, Dinakaran P, et al. Current Indicators of Nutritional Care in Children with Type 1 Diabetes in India: Do we Need a National Nutritional Guideline? *Indian J Endocrinol Metab*. 2017; 21:670-8.
52. Nam S, Chesla C, Stotts NA, Kroon L, Janson SL. Barriers to diabetes management: patient and provider factors. *Diabetes research and clinical practice*. 2011; 93:1-9.
53. Katam KK, Bhatia V, Dabadghao P, Bhatia E. High direct costs of medical care in patients with Type 1 diabetes attending a referral clinic in a government-funded hospital in Northern India. *The National medical journal of India*. 2016; 29:64-7.
54. Joseph M, Shyamasunder AH, Gupta RD, Anand V, Thomas N. Demographic details, clinical features, and nutritional characteristics of young adults with Type 1 diabetes mellitus-A South Indian tertiary center experience. *Indian journal of endocrinology and metabolism*. 2016; 20:799.
55. Joseph M, Gupta RD, Gangadhara P. Barriers to nutritional practices and dietary education in patients with type 1 diabetes mellitus in India. *J Global Diabetes Clin Metabol*. 2017; 6:2.
56. Johansson T, Keller S, Sonnichsen AC, Weitgasser R. Cost analysis of a peer support programme for patients with type 2 diabetes: a secondary analysis of a controlled trial. *European journal of public health*. 2017; 27:256-61.
57. Shyamasunder A, Kristal R, Mruthyunjaya M. Peer Support Group Model Improves Glycemic Control and Social well being in Type 1 Diabetes Mellitus in India. *of*. 2016; 6:2.

58. Foster C, Bellando J, Wang YCA. Diabetes control and adherence in adolescence. *Pediatric annals*. 2016; 45:e327-e31.
59. Shah VN, Kamdar PK, Shah N. Assessing the knowledge, attitudes and practice of type 2 diabetes among patients of Saurashtra region, Gujarat. *Int J Diabetes Dev Ctries*. 2009; 29:118-22.
60. Kaushik JS, Narang M, Parakh A. Fast food consumption in children. *Indian pediatrics*. 2011; 48:97-101.
61. Rathi N, Riddell L, Worsley A. Food consumption patterns of adolescents aged 14-16 years in Kolkata, India. *Nutrition journal*. 2017; 16:50.
62. Saboo B, Joshi S, Shah SN, Tiwaskar M, Vishwanathan V, Bhandari S, et al. Management of Diabetes during Fasting and Feasting in India. *The Journal of the Association of Physicians of India*. 2019; 67:70-7.

Table 1: Common Indian meals and methods of lowering glycaemic index (GI)

Staple food and it's description	Modifications to lower GI
Most parts of India	
<i>Chapatti</i> (homemade flat bread made from ground refined or whole wheat flour and cooked on a griddle)	Add soya flour or bengal gram flour to whole wheat flour Do not sieve the flour to retain the bran Serve with curd/pulse/cottage cheese and vegetables
Steamed rice Polished white rice	Stored rice preferred as amylose content increases during the process of aging Use long grain rice or unpolished, brown rice as it has a lower GI.
Rice, potato, pasta	Cook and keep in refrigerator for 24 hours to cool. Do not reheat at high temperature. This results in formation of resistant starch which has lower GI
<i>Khichdi</i> (commonly made with rice and dal mixed in various proportions which varies from region to region) Recommended proportion is 4:1	Use millets, broken wheat (<i>daliya</i>) or unpolished rice combined with any pulse Increase the proportion of dal Add vegetables or consume <i>raita</i>) or <i>kadhi</i> (gravy made from curd and bengal gram flour).
Region - North India	

<i>Paratha</i> (shallow fried chapatti) <i>Puri</i> (deep fried chapatti made from refined wheat flour) <i>Makai ki roti</i> (maize flour chapatti)	Add soya flour or bengal gram flour to whole wheat flour. Serve with curd/ pulse/ cottage cheese and vegetables
<i>Aloo paratha</i> (stuffed with potato)	Stuff with <i>paneer</i> (cottage cheese)/ <i>sattu</i> (chickpea flour) and variety of vegetables -green leafy vegetable like fenugreek leaves, spinach, radish, cabbage, cauliflower
Region - West India	
<i>Bhakri</i> (Thick flat bread made from millets or rice flour and cooked on a griddle) <i>Thepla</i> (thin flatbread made from fresh fenugreek leaves and whole-grain flours)	Add pulse flour to the millet flour or serve with curd/ pulse and vegetables Add bengal gram flour to the flour and serve with curd
<i>Dhokla</i> (fermented and steamed savoury cake made from Bengal gram flour and curd)	Add finely chopped vegetables/ vegetable puree to the batter Use a combination of millet flour/ buckwheat (<i>kuttu</i>) flour and bengal gram flour/ green gram flour
<i>Khakhra</i> (thin cracker made from wheat flour and oil)	Make <i>khakhra</i> from pulse flour instead of wheat flour Consume vegetables, curd, curd dip or buttermilk along with it
<i>Poha</i> (rice flakes)	Add peanuts, vegetables or curd
<i>Upma</i> (salted wheat semolina pudding (also eaten in south India))	Add vegetables and sprouts or consume a protein source (curd, buttermilk or boiled egg) with it
Region - South India	

<i>Idli</i> (soft & fluffy steamed cake made of fermented rice & lentil batter)	Vegetable stuffed <i>idli</i> /mixed <i>dal idli</i> /millet <i>idli</i>
<i>Dosa</i> (pancake made from fermented batter of cereal flour and ground pulses)	<i>Pesarattu dosa</i> (made with green gram flour) OR mixed <i>dal dosa</i> (made with mixed pulse flour)
<i>Paniyaram</i> (ball shaped dumplings made by steaming fermented batter of cereal flour and ground pulses using a mould)	Idli and dosa are served with sambhar. Sambhar made with plenty of vegetables improves the GI
<i>Puttu</i> (steamed rice flour and coconut log)	Make the batter from pulses and add vegetables and buttermilk to the batter.
<i>Ragi Kanjee</i> (finger millet porridge)	Use unpolished rice or <i>ragi</i> flour. Consume with <i>kadala kari</i> (black chickpeas curry) to add protein.
<i>Ragi Dosa</i> (finger millet dosa)	Add curd to the <i>ragi</i> to improve the protein content and lower the GI
<i>Ragi</i> has a high GI of 84	Make a <i>ragi-urad dal</i> (black gram) <i>dosa</i> . Add butter milk to prepare <i>dosa</i> batter.
<i>Ragi mudde</i> (finger millet steamed balls)	Use variety of millet flour along with <i>dal</i> flour to make the balls and serve with <i>sambhar</i>
	Low to moderate GI millets such as <i>sanwa</i> (barnyard millet), <i>kangni</i> (foxtail millet), <i>bajra</i> (pearl millet), <i>kodon</i> (kodu), <i>sama</i> (little millet) and <i>jowar</i> (sorghum) must be included in the diet
Region – East India	

<i>Chuda Santula</i> : Roasted rice flakes upma with mixed veggies <i>Chura Dahi</i> : Curd, rice flakes and nuts mix <i>Savoury Paani pitha</i> : Pancake of wheat flour, salt and onion <i>Kathi roll</i> : kabab/cottage cheese/vegetables/egg wrapped in <i>paratha</i>	Add more vegetables Avoid sugar Add vegetables to the batter Use whole wheat flour for making the paratha. Use less oil. Add vegetables along with the protein source such as kabab, cottage cheese or egg

Ref: (10, 12-21)

Table 2. Low Carbohydrate snack/foods (0 to 5 g carbohydrate less than 10g total fat and 5 g saturated fat per serving)

Low carbohydrate snacks/foods	Serving Size
Egg: boiled, scrambled, poached or omelette	1 no.
Chicken: salad, grilled, sautéed, baked or tikka without cornflour/ flour/ breadcrumbs	100 g
Fish: rohu, Indian salmon (<i>ravas</i>), kingfish (<i>surmai</i>) or pomfret tikka, baked without cornflour/ flour/ breadcrumbs	100 g
Cottage Cheese: tikka, grilled, scrambled (<i>burjee</i>), sautéed	50 g
Curd/Unflavoured Yogurt	½ cup (100 g)
Cheddar Cheese, Mozzarella cheese, Parmesan cheese	25 g
Tofu	100 g
Unflavoured Soymilk	200ml
Unflavoured Almond milk	200ml
Non-Starchy Vegetables, Salads, Stir fry vegetables	100-150 g
Vegetable Soup (unstrained)	1 cup
Soy nuts	30 g
Nuts and Seeds (almonds, pistachios, walnuts, cashew nuts, peanuts, pine nuts, pumpkin seeds, sunflower seeds, watermelon seeds)	16g

Ref: (21)

Table 3. Gluten free food options in India.

Foods to include	Foods to exclude
Rice, rice flakes, jowar, bajra, ragi, corn, amaranth, jowar, quinoa, buckwheat, gluten free rolled or steel cut oats. Whole pulses and legumes, soybean Dairy products such as milk, <i>paneer</i> (cottage cheese), curd, buttermilk. Egg & poultry, fish Fruits and vegetables Nuts and seeds	Wheat and wheat products, rye, barley. Semolina (<i>rava</i>), <i>dalia</i> (broken wheat), wheat vermicelli Refined flour and products made from it like white bread, multigrain bread, pasta, biscuits, bakery products, crackers, toast, croutons, cake, cookies, pizza, burger etc Soy products. Beer Spices may be contaminated with gluten for eg: asafoetida (<i>hing</i>)

Minerva Access is the Institutional Repository of The University of Melbourne

Author/s:

Salis, S;Joseph, M;Agarwala, A;Sharma, R;Kapoor, N;Irani, AJ

Title:

Medical nutrition therapy of pediatric type 1 diabetes mellitus in India: Unique aspects and challenges

Date:

2020-08-10

Citation:

Salis, S., Joseph, M., Agarwala, A., Sharma, R., Kapoor, N. & Irani, A. J. (2020). Medical nutrition therapy of pediatric type 1 diabetes mellitus in India: Unique aspects and challenges. PEDIATRIC DIABETES, 22 (1), pp.93-100. <https://doi.org/10.1111/pedi.13080>.

Persistent Link:

<http://hdl.handle.net/11343/276131>