Original Article

Dietary modifications to improve micronutrient status of Indian children and adolescents with type 1 diabetes

Lavanya S Parthasarathy MSc, Shashi A Chiplonkar PhD, Anuradha V Khadilkar MD, Vaman V Khadilkar MR, CP

Hirabai Cowasji Jehangir Medical Research Institute, Jehangir Hospital, Pune, India

Introduction: Diet plays a crucial role for maintaining normal growth and development while optimizing glycemic control in children with diabetes. Dietary restrictions, in a diabetic child's diet may lead to micronutrient deficiencies. **Objectives:** To examine dietary nutritional deficiencies of Asian Indian children with Type 1 diabetes mellitus and develop micronutrient-rich recipes suitable for them. **Methods:** Anthropometry, diet (3-day recall) of 70 children with diabetes (24 boys) was recorded. Daily nutrient intakes and nutrient content of recipes were estimated using CDIET version 2.0. **Results:** Mean intake amongst children for energy was 79% of Indian Recommended Dietary Allowance (RDA), protein was 105% RDA, but fat intakes were high (143% RDA). Mean intakes of riboflavin, β carotene, zinc, iron were less than 50%, and thiamin and calcium were around 60% RDA suggesting a possible multiple micronutrient deficiency. Based on popularly consumed snacks, 20 healthy recipes were devised that can be incorporated in children's diet. Mean energy content of new recipes was similar to routine snacks (281±28 kcal/100 g vs 306±27 kcal/100 g cooked weight). However, the mean vitamin and mineral content of new recipes was significantly higher (p<0.01). There was a five-fold increase in total mineral content (zinc, calcium and iron) and twofold increase in total vitamin content (β carotene, vitamin C, vitamin B-1, B-2, and B-3) in new recipes compared with the routine snacks. **Conclusion:** Multiple dietary micronutrient deficiencies are observed in diabetic children. Addition of newly developed recipes in their everyday diet may help to enhance micronutrient intakes without increasing their energy load.

Key Words: diabetes mellitus, type 1, Asian Indian snacks, micronutrients, children

INTRODUCTION

Medical nutrition therapy forms an integral part of diabetes management and of diabetes education.[1] Diet in diabetic children plays a very crucial role in maintaining normal growth and development while optimizing glycemic control. One of the key challenges is to maintain the balance between carbohydrate intake and insulin dose.[2] Due to dietary restrictions thus levied, the diet of diabetic children is likely to become deficient in certain nutrients. Few earlier reports suggest that micronutrient deficiencies may be common in children with diabetes.[1] However, studies on the dietary intakes and micronutrient deficiencies in Asian Indian children with Type 1 diabetes are scarce; hence, there is a need to study diet of these children to assess their micronutrient status.

Micronutrient deficiencies are rampant in developing countries including India and are of serious public health concern.[3,4] Previous studies have shown that diabetes can have an effect on the nutritional status of patients.[5,6] Studies also suggest that the diet of children with diabetes may be deficient in micronutrients.[7] Also, the trace-metal urinary losses can be accentuated during uncontrolled hyperglycemia and glycosuria.[6] Hence, several mineral and vitamin supplementation studies have been carried out previously to assess effect of supplementation on glycemic control. Studies done previously suggest several micronutrients enhance insulin action and others offer promise in countering the untoward consequences of hyperglycemia.[8] Also deficiencies of certain minerals such as potassium, magnesium, and possibly zinc and chromium may predispose one to carbohydrate intolerance.[9] Despite the evidence of widespread nutrient deficiency among individuals with diabetes, no multi-nutrient intervention studies to improve the diet of the patients have been undertaken so far.[5]

The role of different micronutrients such as zinc, and vitamin C, for diabetics has been described in some earlier reports.[1,2,9-11] Moreover, adequacy of certain nutrients such as calcium and iron is essential for the optimal growth of these children. Our meals consist of a variety of foods with complex combinations of nutrients. Hence, if changes are made in children's daily meals, rather than giving single or multiple nutrient supplementation, sustainable improvements can be brought about in their micronutrient intakes.[12]

Corresponding Author: Dr Anuradha Khadilkar, Hirabai Cowasji Jehangir Medical Research Institute, Jehangir Hospital, 32 Sassoon Road, Pune. 411001, India.
Tel: + 912026141340; Fax: + 912026141340
Email: anuradhavkhadilkar@gmail.com
Manuscript received 12 November 2013. Initial review completed 18 March 2014. Revision accepted 25 June 2014.
doi: 10.6133/apjcn.2015.24.1.04

Most diabetic children are advised to have daytime and bedtime snacks as a part of their meal plan.[13] Most Asian Indian children have staple foods in the form of breakfast, lunch and dinner primarily composed of cereals and pulses, but snacks consist of varied items and are usually high in fat.[14] With a restriction on fat and simple sugars, snacks that can be offered to diabetic children are restricted. Thus, mothers of diabetic children face a challenge in providing healthy snack options to their children. Hence, assessing snacking patterns of children and devising healthy snack recipes using foods rich in micronutrients will provide options which fit a diabetic child's diet and may also improve their micronutrient status.

Thus, the aims of our study were: 1) to examine the dietary intakes of Asian Indian children and adolescents with type 1diabetes with special reference to micronutrient intakes, 2) to develop recipes rich in micronutrients to improve their micronutrient intakes.

MATERIAL AND METHODS

A cross-sectional survey was carried out between November 2011 and October 2012. All patients visiting the type 1 diabetes clinic at a tertiary care centre at Pune were approached for the study. This centre caters for patients from various rural as also urban parts of Maharashtra state coming from different socio-economic backgrounds. Over 200 children routinely attend the clinic for medical attention and education. Patients were selected randomly during the outpatient visits at the tertiary care centre. Ethical approval was granted by the institutional ethics committee.

Interviews with the mothers revealed similar dietary pattern of the children as per the doctor's advice for sugar control. Therefore a random sample of 70 children was selected by lottery method from rural as well as urban families to have better representation of food habits from different classes of people. Written informed consent from parents and assent from children was obtained.

A clinical examination was performed by a pediatrician for evaluating health status. Children with known co morbidities such as celiac disease, uncontrolled autoimmune thyroditis, eating disorders and type 2 diabetic children were excluded from the study. In all, 70 children (24 boys and 46 girls), mean age 10.6±3.7 years meeting the selection criteria were enrolled in the study.

Measurements were recorded in the morning between 8 and 10 am for all subjects. Standing height was measured to the nearest 1 mm using a stadiometer (Leicester Height Meter, Child Growth Foundation, UK, (range 60-207 cm). Weight was measured using an electronic weight scale to the accuracy of 100 g (Salter). Height (HAZ) weight (WAZ) and BMI for age Z (BAZ) scores were computed.[15] Glycosylated hemoglobin (HbA1C) was measured using HPLC method for assessing metabolic control.

Assessment of nutrient intake

Dietary food intakes were assessed by 24-h recall on three random days (non-consecutive) of a week, including one holiday. Each child was asked about the intake of food items during the day at breakfast, lunch, dinner and snacks, using standard cups and spoons by trained investigators through a face-to-face interview. The recipes of food items were also recorded. The portion size was obtained by the average of actual weights of one serving of each food item from their households. This was done for each of the food items consumed such as rice, vegetables, chapatti (unleavened wheat pancake), etc.

Daily nutrient intakes were calculated using CDIET version 2.0,[16] (which comprises of nutritive values of cooked foods)[17] and raw foods database of National Institute of Nutrition (NIN), India,[18] as also USDA.[19] The nutrient contents of the routine recipes have been estimated and reported previously.[17,20-22] Moisture and the nutrient contents of the newly developed recipes were estimated. Based on the moisture correction, nutrient contents for the modifications were estimated. Through the software CDiet, comparison of the intake was performed with the RDA for Indians as given by the Indian Council of Medical Research.[23]

Development of recipes

Based upon the knowledge of food preferences of the children, twenty different recipes, rich in micronutrients were developed for inclusion in the diet of diabetic children. To optimize the micronutrient contents of the recipes following criteria were adopted; i) selection of foods from nutritive value tables[18] which are rich in micronutrients i.e.: calcium and iron, vitamin C, B-1, B-2, B-3 and/or antioxidants like zinc, β carotene, ii) addition of small amounts of cumin seeds, pumpkin seeds, sesame etc. to enhance mineral contents and iii) ensuring that the carbohydrate load of recipes would not be high for enabling better sugar control. Weighing of the ingredients was performed using a digital scale. Cooking time taken for each recipe was also recorded, serving sizes were calculated according to amount of micronutrient to be supplemented through each portion, and the final recipe yields were tested by making different batches and testing for colour, texture and taste. Nutrient composition of the new recipes was assessed using CDiet version 2.0,[16] which considers the moisture content of the recipes and the nutritive value of raw ingredients.[18,19]

Sensory evaluation was carried out for acceptability of the newly developed micronutrient rich recipes. The sensory panel consisted of 25 diabetic children, their parents and 20 staff members at the research centre. The panel members were isolated from each other. Samples were presented in plastic dishes or bowl coded with random numbers and served in a randomized order to all the panel members. The samples were served at room temperature and analyses were performed under normal conditions. One sample was provided at a time, at an interval of 5 min. The panel members rinsed their palates with water before and between tasting.[24] The recipes were divided into two batches of 10 and 9 recipes to be tested per day per person. A nine-point hedonic scale for acceptance (with tick-boxes 9=like extremely, 8=like very much, 7=like moderately, 6=like slightly, 5=neither like nor dislike, 4=dislike slightly, 3=dislike moderately, 2=dislike very much and 1=dislike extremely) was used for the independent hedonic rating of appearance, texture, taste and overall acceptability of each sample.[25] Evaluation was performed at the institute under satisfactory conditions.

Statistical methods

All statistical analysis were carried out using the SPSS for Windows software program, version 12 (SPSS, Chicago, IL, USA). All outcome variables were tested for normality before performing any statistical analysis. Differences in means were tested using Student's t test. A p value of <0.05 was considered significant. Using the LMS [skewness (L), median (M), and the coefficient of variation (S) of the measurement distribution] values from the Indian contemporary data,[15] Z scores were calculated for each child for height or weight . The Z scores were calculated using the formula:

$$\text{SD-score}=\left(\frac{[\text{measurement}/M(t)]L(t)-1}{L(t)S(t)}\right)$$

Where, measurement is the child's measurement (height or weight) and L(t), M(t) and S(t) are values read from the smooth curves for the child's age t and sex.

RESULTS

General characteristics of the study group are described in Table 1. In boys, the mean HAZ was near normal, however 25% boys and 33% girls had HAZ below -2SD indicating need for improving their growth status. Mean and SD of HbA1C amongst boys and girls was 8.86%±1.81% and 8.86%±1.89% respectively. The mean energy intake amongst children was 79% of the Indian RDA, mean protein intake was adequate (105% of RDA) but fat intakes were greater than the RDA (143% of RDA) indicating children consumed excess fat. Intake of all micronutrients among children was less than RDA (Table 2). Zinc, riboflavin, β carotene and iron were consumed less than 50% of RDA while mean intakes of thiamin, calcium, vitamin C were around 60% of RDA suggesting severe dietary multiple micronutrient deficiencies.

The interviews revealed the meal pattern of the children; patterns were found to be very similar for most of the children which may be attributed to the fixed diet charts that children are asked to follow by the dietitian. The meal pattern included 6 meals per day- breakfast, mid-morning, lunch, mid-evening, dinner and bedtime. Breakfast, lunch and dinner mostly consisted of staple foods. Main variations noted were in the snacks consumed by these children. The most commonly consumed snacks were of four types; i) dry bakery foods like biscuits, toasts, and cookies, consumed by 80% children ii) dry snacks such as spiced puffed rice with peanuts (chivda), fried pulses with salt and chilli, chips, plain wheat thins etc, by 46% children, iii) fruits and salads including raw carrots, cucumber or tomato, by 70% children and iv) refreshments like instant refined flour noodles, fried potato balls with bread, steamed fermented mixture of rice-pulse (idli) or dumplings, pancakes or sandwiches by 70% children. Table 3 describes mean nutrient contents per 100 gm of the cooked weight of these different types of routine snacks consumed by the children. Majority of the snacks were low in micronutrients and considering that these would be consumed at mid-morning or evening times, total micronutrient intake would be less than the RDA. Thus, it was important to develop healthy snack options for these children which were rich in micronutrients.

Twenty recipes (Nineteen snacks and one accompaniment) rich in micronutrients were developed to provide healthy options for each of the above types. i) khakra (whole wheat thins) with mint, or red amaranth leaves,

Table 1. Characteristics of the study group

Characteristics	Boys (n=24)	Girls (n=46)	Total (n=70)
Age (yrs)	10.3±3.7	10.8±3.8	10.6±3.7
Height (cm)	137±20.7	131±18.8	133±19.6
Weight (kg)	33.7±13.1	28.4±12.7	30.5±13.0
BMI	17.0±2.5	15.8±3.1	16.3±2.9
WAZ	-1.4±1.4	-1.2±1.3	-1.2±1.3
HAZ	-1.0±1.1	-1.4±1.2	-1.3±1.2
BAZ*	-0.3±1.2	-1.0±1.4	-0.7±1.3

*Mean significantly different between boys and girls (p<0.05).

Table 2. Daily nutrient intakes of the study group

Nutrient	Boys (n=24)	Girls (n=46)	Total (n=70)
Energy (kcal)*	1725±465	1512±373	1595±421 (79)
Proteins (gm)*	47±15	39±9	27±4 (105)
Fat (gm)	45±16	39±12	26±6 (143)
Carbohydrates (gm)	284±78	250±72	165±14
Calcium (mg)	746±300	628±246	427±151 (62)
Carotene (mg)	1332±888	1218±1017	789±583 (26)
Vitamin C (mg)	38±25	33±22	21±13 (62)
Riboflavin	848±410	741±287	496±187 (31)
Thiamin*	939±496	732±154	507±187 (60)
Folic Acid	96±33	87±26	57±14 (67)
Zinc (mg)*	6±2	5±2	3±1 (49)
Iron (mg)*	11±5	8±4	5±2 (41)
Niacin (mg)*	13±4	11±3	7±1 (78)

*Mean significantly different between boys and girls (p<0.05).
In brackets are given the values for percent RDA.

Table 3. Average Nutrient contents of Routine snacks per 100 mg cooked weight

Nutrient	Biscuits & cookies (n=6)	Dry snacks† (n=10)	Fruits & raw salads (n=4)	Refreshments‡ (n=14)	All (n=34)
Energy (kcal)	467±17	449±20	75±18	202±18	306±27
Protein (gm)	6.6±1.1	12.7±2.3	0.83±0.25	4.9±0.40	7.0±1.0
Fat (gm)	14.8±3.4	17.5±3.2	0.04±0.03	4.1±0.55	9.5±1.6
CHO (gm)	81.4±4.5	60.5±2.8	17.7±4.5	36.3±3.7	49.2±4.0
Zn (mg)	0.35±0.03	1.1±0.44	0.13±0.07	0.36±0.04	0.54±0.14
ß Carotene (mg)	0.065±0.03	0.082±0.02	0.22±0.11	0.166±0.056	0.13±0.03
Vitamin C (mg)	1.2±0.58	1.1±0.42	10.5±4.4	9.0±1.9	5.4±1.1
Ca (mg)	34±10	67.4±17.2	29.7±9.4	37.3±7.2	42.7±6.7
P (mg)	145±53	179±43.2	60.3±32.3	101.1±18.8	102±18.2
Fe (mg)	0.65±0.02	4.9±1.2	0.27±0.15	1.3±0.47	2.1±0.50
Vitamin B-1 (mg)	0.032±0.003	0.15±0.03	0.057±0.02	0.11±0.02	0.10±0.01
Vitamin B-2 (mg)	0.022±0.005	0.034±0.008	0.02±0.001	0.04±0.007	0.032±0.004
Vitamin B-3 (mg)	0.1±0.01	2.5±0.68	0.22±0.13	1.3±0.21	1.3±0.26

Values are mean±SE.
†Spicy puffed rice, fried pulse balls, chips, plain wheat thins etc.
‡ Instant refined flour noodles, pancakes, fried potato balls with bread, idli, riceflakes, etc

spinach, or fenugreek leaves ii) spiced puffed rice with nuts, (chivda), spiced popped amaranth seeds (chivda), sesame seeds sweet balls (ladoo), popped amaranth seeds sweet balls (ladoo), iii) fruit-vegetable salad, iv) steamed Radish nuggets (Moothias), spinach soybean kebab, steamed spinach chickpea cakes (dhokla), steamed sprout bean cakes (idli), mixed flour pancake (dosa), finger millet unleavened pancake (thalipith), popped amaranth seeds porridge, soy-chickpea kebabs, spinach unleavened pancake (thalipith), kidney bean kebab, and an accompaniment spinach dip which may be used with the above mentioned recipes. Of these recipes, 13 recipes scored 7 and above on the nine point hedonic scale. Apart from these 13 snack recipes and the dip we also developed 'garam masala' (spice mix) which is a mixture of spices and oilseeds that can be added to all the above recipes to increase their micronutrient content. The 'garam masala' was made in the traditional way with mixing spices; the nutrient content was enhanced by adding sesame seeds, pumpkin seeds, fenugreek seeds and garlic. The garam masala may be added to the above mentioned recipe and also be used in the other foods consumed by the child. The recipes have been described in detail in Appendix 1. All the ingredients required to make snacks along with their quantities have also been mentioned.

Table 4 describes the nutrient content of each recipe per 100 g of the cooked weight of the recipe. Sesame seed sweet balls were the richest in zinc and calcium, red amaranth thin crackers were richest in β carotene and iron, and fruit-vegetable salad was rich in vitamin C. These recipes may be easily incorporated in the children's diet as the snacks they were already consuming may be replaced by the newly developed snacks. Biscuits may be replaced by these leafy vegetable thin crackers. The spiced puffed rice and fruit and salad have been made healthier by adding sesame seeds and pumpkin seeds to increase their mineral contents. The sandwiches may be made with the kebabs to make them wholesome and micronutrient rich.

Mean contents of β carotene, vitamin C, vitamin B-1, B-2 and B-3 and the mean mineral contents (zinc, calcium, iron) of the new recipes were significantly higher than the respective vitamin and mineral contents of the routine snacks (Table 3) ($p<0.01$). All types of the new recipes showed a higher vitamin and mineral contents over the average content of the routine snacks (Figures 1A and B). There was a fivefold increase in total mineral content; i.e. zinc, calcium and iron and twofold increase in total vitamin content i.e., beta carotene, vitamin C, vitamin B_1, B_2, and B_3 in the new recipes compared with the routine snacks. A combination of vitamin rich snacks and mineral rich snacks per day may help in attaining the recommendation for micronutrients amongst this population.

DISCUSSION

Our results indicate that diabetic children consume a diet deficient in micronutrients. The intake of β carotene, riboflavin (B-2), zinc, and iron was less than 50% of RDA. Meal patterns observed in all children were very similar and children primarily consumed three main meals with three small meals in between, but some of these snack options were very high fat and low in micronutrients (Table 3). As the main meals were composed of the staples, making changes in them would not have been acceptable, hence we developed recipes for snacks which would give more options and are more nutritious without increasing the energy or carbohydrate intake. Most recipes were very well accepted. The ingredients chosen to improve the micronutrient content of the recipes were easily available in the local markets and could be afforded easily.

Studies have also shown that adolescents with type 1 diabetes consume fewer calories from carbohydrates but more calories from fat and exceed the recommended levels of fat intake as seen in this study too.[26] Hence, it is necessary to make changes in their diet given the risk that type 1 diabetes poses for cardiovascular disease. Previous studies suggest that strategies such as fortification and supplementation have limitations and should not replace food based strategies.[27] Since food based strategies help in improving the dietary quality in general and also help in increasing the intake of the other micronutrients they can help in an overall improvement of the nutritional status.[27]

Recipes proposed in our study are based on ingredients

Table 4. Nutrient contents of the new recipes per 100 g of cooked weight

Cooked recipe	Energy (kcal)	Protein (g)	Fat (g)	CHO (g)	Zn (mg)	ß Carotene (mg)	Vit C (mg)	Ca (mg)	P (mg)	Fe (mg)	Vit B-1 (mg)	Vit B-2 (mg)	Vit B-3 (mg)	Fibre (g)
Sesame Seeds Ladoo	400	13.3	18.7	46.9	5.0	0.0	2.0	760	338	7.2	0.4	0.2	2.0	1.6
Fenugreek Thin Crackers	395	13.4	11.5	59.8	4.3	0.6	19.2	357	364	7.2	0.5	0.3	4.0	5.7
Spinach Thin Crackers	393	13.2	11.6	59.0	4.1	1.4	13.6	287	383	6.9	0.5	0.3	3.5	3.6
Mint Thin Crackers	391	13.6	11.4	58.6	4.1	0.5	13.1	311	386	10.2	0.5	0.3	3.5	3.1
Red Amaranth Thin Crackers	389	13.6	11.3	58.3	3.9	3.4	25.5	383	379	10.7	0.5	0.3	3.5	4.1
Kidney Beans Kebab	231	9.6	11.1	23.2	2.2	0.1	4.0	254	204	2.9	0.1	0.1	0.6	5.4
Soybean Chickpea Kebab	212	10.6	12.0	15.5	2.3	0.4	5.7	157	198	3.6	0.2	0.1	1.2	5.2
Popped Amaranth seeds Porridge	48.0	1.72	1.52	6.76	0.09	0.0	0.39	33.2	36.1	0.32	0.01	0.03	0.19	0.6
Spinach Unleavened Pancake	265	10.1	11.3	30.7	2.2	1.4	7.6	179	215	4.0	0.3	0.2	1.7	4.9
Popped Amaranth Seeds Ladoo	400	15.0	12.4	64.4	1.2	0.0	2.9	52.0	280	2.9	0.2	0.1	6.2	5.1
Puffed Rice Chivda	443	14.0	22.5	46.2	2.5	0.3	5.2	271	320	7.0	0.3	0.1	5.1	2.2
Popped Amaranth Seeds Chivda	394	15.2	17.6	51.4	1.8	0.2	5.0	198	326	3.9	0.2	0.1	3.8	5.3
Fruit-Vegetable Salad	112	2.4	7.2	9.5	1.1	0.2	42.6	125	111	2.8	0.2	0.1	0.6	2.64
Raddish Nuggets (Muthia)	423	14.4	21.1	43.9	3.41	0.2	12.9	381	335	6.09	0.43	0.24	2.38	9.4

a: average of all recipes except garam masala.

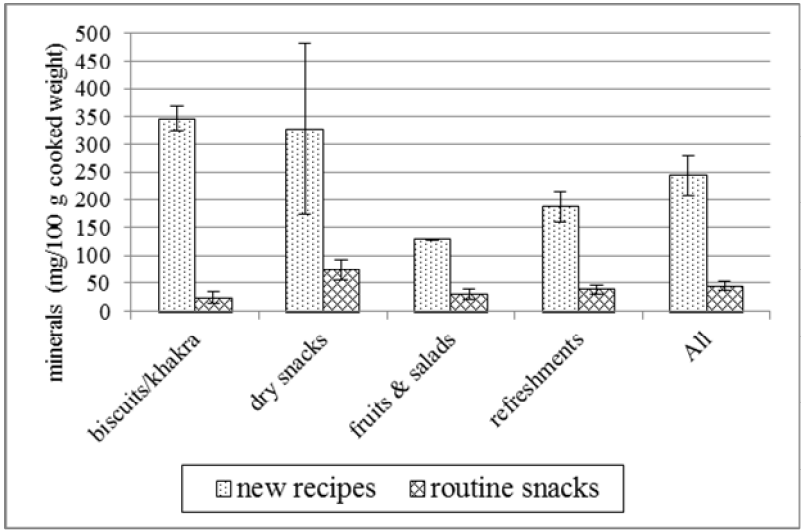

Figure 1A. Comparison of mean mineral contents of new recipes with routine snacks
** $p<0.01$, * $p<0.05$, NS: not significant ($p>0.1$).

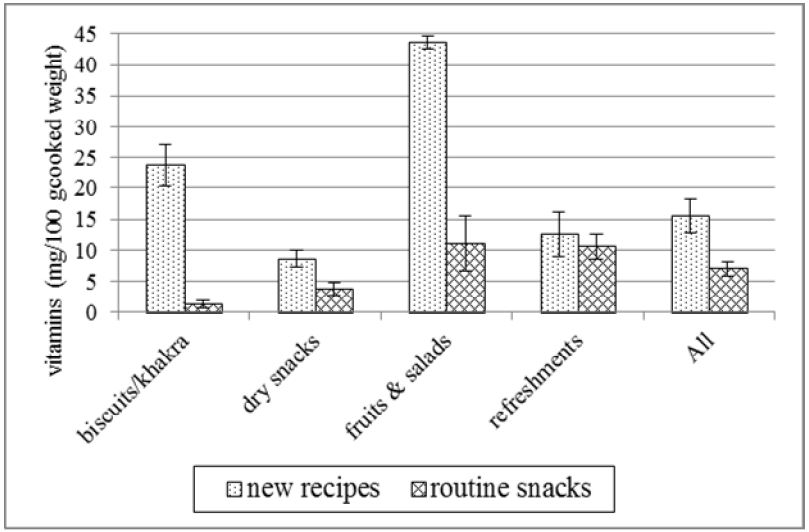

Figure 1B. Comparison of mean vitamin contents of new recipes with routine snacks

commonly available and hence can be adopted to improve the micronutrient status of different population groups. The basic ingredients which have helped in enhancing the recipes such as sesame seeds, pumpkin seeds, kidney beans, soybean, leafy vegetables etc are now available across the globe and can be incorporated in the local recipes to enhance the micronutrient content. Recipes using these key ingredients for the local population can be easily devised and incorporated in the daily eating pattern. Since all the recipes are devised with plant foods, they can provide food based intervention in countries like India where majority of the population is lacto-vegetarian.[28]

Though the 24 hour recall is a validated tool, it is possible that some patients may have under or over reported their intakes. This is one of the limitations of our study. Further, the use of estimated average requirement (EAR) is suggested for describing deficiencies in a group.[29]

However, Indian guidelines do not describe an EAR for the Indian population. We thus used the procedure described jointly by the FAO, WHO and UNA to calculate EAR from RDA (For a CV of 10%, the RDI would be 1.2 x EAR).[30] For most nutrients, except calcium, children's intakes still remained below the recommendations according to EAR.

Further, the long term acceptability of the recipes needs to be tested. If the recipes replace the daily consumed snacks and if mothers and care givers understand the replacements done and acquire them in everyday cooking, sustainable changes can be made. Studies need to be carried out to assess the sustainability of such modifications.

Strategies suggested in this study not only provide interesting food options, but also if consumed regularly may help in improving the micronutrient intakes in children with diabetes. In conclusion, micronutrient deficiencies are common in Asian Indian diabetic children; these can be alleviated through dietary snack modifications as proposed here.

ACKNOWLEDGEMENTS

We thank our department staff, diabetic children and their parents for participating in the sensory evaluation of developed food products. We would also like to thank Mr S Pancharatna, Chinchwad, Pune for funding the project. Ms Lavanya Parthasarathy thanks University Grants Commission (UGC), Government of India for the funding.

AUTHOR DISCLOSURES

None to declare on the conflict of interest.

REFERENCES

1. American Diabetes Association. Nutrition Principles and Recommendations in Diabetes: a position statement of the American Diabetes Association. Diabetes Care. 2006;29; 2140-57. doi: 10.2337/dc06-9914.
2. American Diabetes Association. Nutrition recommendations and interventions for diabetes: a position statement of the American Diabetes Association. Diabetes Care. 2008;31: 61-78. doi: 10.2337/dc08-S061.
3. Chakravarty I, Sinha RK. Prevalence of micronutrient deficiency based on results obtained from the national pilot program on control of micronutrient malnutrition. Nutr Rev. 2002;60:S53-8. doi: 10.1301/00296640260130740.
4. Srihari G, Eilander A, Muthayya S, Kurpad AV, Seshadri S. Nutritional status of affluent Indian school children: what and how much do we know? Indian Pediatr. 2007;44:199-203.
5. Walker AF. Potential micronutrient deficiency lacks recognition in diabetes. Br J Gen Pract. 2007;57:3-4.
6. Mooradian AD, Morley JE. Micronutrient status in diabetes mellitus. Am J Clin Nutr. 1987;45:877-95.
7. Randecker GA, Smiciklas-Wright H, McKenzie JM, Shannon BM, Mitchell DC, Becker DJ, Kieselhorst K. The dietary intake of children with IDDM. Diabetes Care. 1996; 19:1370-4. doi: 10.2337/diacare.19.12.1370.
8. Cunningham JJ. Micronutrients as nutriceutical interventions in diabetes mellitus. J Am Coll Nutr. 1998;17:7-10. doi: 10.1080/07315724.1998.10718729.
9. Chehade JM, Sheikh-Ali M, Mooradian AD. The role of micronutrients in managing diabetes. Diabetes Spectrum. 2009;22:214-8. doi: 10.2337/diaspect.22.4.214.
10. Kaneto H, Kajimoto Y, Miyagawa JI, Matsuoka TA, Fujitani Y, Umayahara Y, Hori M. Beneficial effects of antioxidants in diabetes: possible protection of pancreatic beta-cells against glucose toxicity. Diabetes. 1999;48:2398-406. doi: 10.2337/diabetes.48.12.2398.
11. Jain SK, Robert MV, Tiney S. Vitamin E supplementation restores glutathione and malondialdehyde to normal concentrations in erythrocytes of type 1 diabetic children. Diabetes Care. 2000;23:1389-94. doi: 10.2337/diacare.23.9.1389.
12. Tupe R, Chiplonkar SA. Diet patterns of lactovegetarian adolescent girls: need for devising recipes with high zinc bioavailability. Nutrition. 2010;26:390-8. doi: 10.1016/j.nut. 2009.05.018.
13. Kaufman FR, Devgan S. Use of uncooked cornstarch to avert nocturnal hypoglycemia in children and adolescents with type I diabetes. J Diabetes Complications. 1996;10:84-7. doi: 10.1016/1056-8727(94)00079-4.
14. Misra A, Khurana L, Isharwal S, Bhardwaj S. South Asian diets and insulin resistance. Br J Nutr. 2009;101:465-73. doi: 10.1017/S0007114508073649.
15. Khadilkar VV, Khadilkar AV, Cole TJ, Sayyad MG. Cross-sectional growth curves for height, weight and body mass index for affluent Indian children, 2007. Indian Pediatr. 2009;46:477-89.
16. C Diet: version 2. Xenios technology, 2012.
17. Chiplonkar SA, Agte VV. Extent of error in estimating nutrient intakes from food tables versus laboratory estimates of cooked foods. Asia Pac J Clin Nutr. 2007;16:227-39.
18. Gopalan, C, Ramasastri BB, Balasubramanyam SC. Nutritive value of Indian Food. Hyderabad; National Institute of Nutrition (Indian Council of Medical Research; ICMR): 1999.
19. U.S. Department of Agriculture, Agricultural Research Service, USDA Nutrient Data Laboratory. 2010. USDA National Nutrient Database for Standard Reference, Release 23. [cited 2012/5/4] Available from: http://www.ars.usda.gov/nutrientdata.
20. Sanwalka NJ, Khadilkar AV, Chiplonkar SA. Development of non-dairy, calcium rich vegetarian food products to improve calcium intake in vegetarian youth. Current Science 2011;101:657-63.
21. Chiplonkar SA, Kawade R. Effect of zinc- and micronutrient-rich food supplements on zinc and vitamin A status of adolescent girls. Nutrition. 2012;28:551-8. doi: 10.1016 /j.nut.2011.08.019
22. Kulkarni SA, Ekbote VH, Sonawane A, Jeyakumar A, Chiplonkar SA, Khadilkar AV. Beneficial effect of iron pot cooking on iron status. Indian J Pediatr. 2013;80:985-9. doi: 10.1007/s12098-013-1066-z
23. A report of the expert group of the Indian Council of Medical Research. Nutrient requirement and recommended die-

tary allowances for Indians, 2009, National Institute of Nutrition, ICMR. [cited 2012/8/16]; Available from: http://icmr.nic.in/final/RDA-2010.pdf.
24. Srilaxmi, Evaluation of food quality. In Food Science. New Delhi: New Age International (P) Limited; 2003. pp. 280-312.
25. Peryam DR, Pilgrim F. Hedonic scale method of measuring food preferences. J Food Technology. 1957;11:9-14. doi: 10.4327/jsnfs1949.14.215
26. Helgeson VS, Viccaro L, Becker D, Escobar O, Siminerio L. Diet of adolescents with and without diabetes: Trading candy for potato chips? Diabetes Care. 2006;29:982-7. doi: 10.2337/dc05-2197
27. Allen LH. To what extent can food-based approaches improve micronutrient status? Asia Pac J Clin Nutr. 2008;17: 103-5.
28. Tupe R, Chiplonkar SA. Diet patterns of lactovegetarian adolescent girls: need for devising recipes with high zinc bio-availability. Nutrition. 2010;26:390-8. doi: 10.1016/j.nut.2009.05.018
29. Institute of Medicine (US). Subcommittee on Interpretation, Dietary reference intakes: a report of the Subcommittees on Interpretation and Uses of Dietary Reference Intakes and the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board, Institute of Medicine. Applications in dietary assessment. Washington, DC: National Academy Press; 2000.
30. FAO/WHO/UNA (Food and Agriculture Organization of the United Nations/World Health Organization/United Nations Association). Energy and Protein Requirements. Report of a Joint FAO/WHO/UNA Expert Consultation. Technical Report Series No 724. Geneva: WHO; 1985.

Appendix. Food composition of the new recipes

No	Recipe name	Description†	Preparation method
1	Sesame Seeds Sweet Balls (Ladoo)	Sweet balls made of roasted sesame seeds (50) roasted poppy seeds (25) popped amaranth seeds (25) dates wet (50) dates dry (15) cardamom (10)	Roast sesame seeds and poppy seeds. Grind the dates and cardamom and add to it. Add the popped amaranth seeds to it and knead to make a mixture. Make three equal portions by rolling between your palms to make smooth round sweet balls.
2	Fenugreek leaves thin crackers (Khakra)	Thin unleavened crackers made of wheat flour (45) pearl millet flour (30) fenugreek leaves (25) green chili (5) garlic (10) sesame seeds (15) Spice mix* (5) salt (2.5) oil (2.5)	Make a paste of fenugreek leaves, green chilies, garlic, spice mix, and salt in a mixer. Add wheat flour, pearl millet flour, sesame seeds and the above mixture in a broad pan. Knead into smooth dough. Make 4 equal portions. Roll into thin crackers. Roast on a low flame on a pan till crisp.
3	Spinach thin crackers (Khakra)	Thin unleavened crackers made of wheat flour (45) pearl millet flour (30) spinach (25) green chili (5) garlic (10) sesame seeds (15) spice Mix* (5) salt (2.5) oil (2.5)	Make a paste of spinach, green chilies, garlic, spice mix, and salt in a mixer. Add wheat flour, pearl millet flour, sesame seeds and the above mixture in a broad pan. Knead into smooth dough. Make 4 equal portions. Roll into thin crackers. Roast on a low flame on a pan till crisp.
4	Mint thin crackers (Khakra)	Thin unleavened crackers made of wheat flour (45) pearl millet flour (30) mint (25) green chili (5) garlic (10) sesame seeds (15) spice Mix* (5) salt (2.5) oil (2.5)	Make a paste of mint leaves, green chilies, garlic, spice mix, and salt in a mixer. Add wheat flour, pearl millet flour, sesame seeds and the above mixture in a broad pan. Knead into smooth dough. Make 4 equal portions. Roll into thin crackers. Roast on a low flame on a pan till crisp.
5	Red amaranth thin crackers (Khakra)	Thin unleavened crackers made of wheat flour (45) pearl millet flour (30) red amaranth (25) green chili (5) garlic (10) sesame seeds (15) spice Mix* (5) salt (2.5) oil (2.5)	Make a paste of red amaranth leaves, green chilies, garlic, spice mix, and salt in a mixer. Add wheat flour, pearl millet flour, sesame seeds and the above mixture in a broad pan. Knead into smooth dough. Make 4 equal portions. Roll into thin crackers. Roast on a low flame on a pan till crisp.
6	Kidney bean kebab	Kebabs made of soaked kidney beans (50) cottage cheese (25) brown bread (15) onion (20) coriander leaves (10) green chilies (5) garlic (5) ginger (5) spice mix* (10) sesame seeds (15) salt (5) butter (10)	Blend in the mixer soaked kidney beans, onion, coriander, green chilies, garlic, ginger, spice mix and salt. Add shredded cottage cheese, sesame seeds and brown bread and make smooth dough. Divide into four portions and give it the shape you like. Roast on both sides on a low flame till golden brown adding butter to it. Serve with the spinach chutney.
7	Soybean-chickpeakebab	Kebabs made of soaked soybean (50) soaked chickpea (50) coriander leaves (10) mint (10) ginger (5) garlic (5) green chilies (5) sesame seeds (15) spice mix* (10) salt (5) butter (20)	Blend in the mixer soaked soybean, soaked chickpea, coriander, mint, green chilies, garlic, ginger, spice mix and salt. Add sesame seeds to it. Divide into four portions and give it the shape you like. Roast on both sides on a low flame till golden brown adding butter to it. Serve with the spinach chutney.
8	Popped amaranth seeds porridge	Porridge made with milk (150), dates (20), cardamom (5) and popped amaranth seeds (50)	Boil together milk, dates and cardamom. Add the popped amaranth seeds to it before serving.
9	Spinach unleavened pancake (Thalipith)	Unleavened pancake made of Sorghum flour (30) pearl millet flour (20) Bengal gram flour (15) soybean flour (15) rice flour (10) coriander seeds powder (5) spinach (50) ginger (5) garlic (5) green chilies (5) onion (5) sesame seeds (15) spice mix* (5) salt (5) oil (15)	Cut spinach in very thin strands. Make into paste- ginger, garlic, and green chilies. Dice onions finely. Mix all the flours, coriander seeds powder, spice mix, sesame seeds, salt, spinach, onion and the above ginger-garlic paste. Add water and make soft dough. Roll out as thin pancakes. Roast on a pan with oil.
10	Popped amaranth seeds sweet ball (Ladoo)	Sweet balls made of popped amaranth seeds (50) dry dates (10) wet dates (30) roasted groundnuts (20) cardamom (5)	Blend the dates with cardamom and groundnuts. Add this to the popped amaranth seeds. Knead to make dough like consistency. Press between palms and roll to make round sweet balls.
11	Spiced puffed rice (Chivda)	Chivda made of puffed rice (50) curry leaves (5) mustard seeds (2.5) cumin seeds (2.5) roasted bengal gram (15) turmeric powder (1.25) garlic (5) green chilies (5) roasted sesame seeds (15) roasted groundnuts (15) roasted pumpkin seeds (10) spice mix* (5) salt (2.5) oil (10)	Make a tempering of mustard seeds, cumin seeds, curry leaves, green chilies, spice mix, turmeric and salt. Add the roasted bengal gram, roasted pumpkin seeds, roasted sesame seeds and roasted ground nuts. Add the puffed rice and toss well so that all ingredients mix well.

† Numbers in the brackets in the description column give the grams of the ingredients required to make the recipe.

Appendix. Food Composition of the new recipes (cont.)

No	Recipe name	Description†	Preparation method
12	Spiced popped amaranth seeds (Chivda)	Chivda made of popped amaranth seeds (100) curry leaves (5) mustard seeds (2.5) cumin seeds (2.5) green chilies (5) garlic (5) turmeric powder (1.25) roasted Bengal gram (15) roasted sesame seeds (15) salt (2.5) spice mix* (5) oil (10)	Make a tempering of mustard seeds, cumin seeds, curry leaves, garlic, green chilies, spice mix, turmeric and salt. Add the roasted Bengal gram, roasted sesame seeds and roasted ground nuts. Add the popped amaranth seeds and toss well so that all ingredients mix well.
13	Fruit-vegetable salad	Salad made of guava (20) watermelon (30) pomegranate (20) apple (20) tomato (30) carrot (10) capsicum (10) lemon (5) roasted sesame seeds (10) mustard seeds (5) oil (5) black salt (2.5)	Make a salad dressing by tempering of mustard seeds and sesame seeds. Add the cut fruits and vegetables and salt and toss together.
14	Raddishnuggets (Muthia)	Steamed nuggets made of radish (30), bengal gram flour (30), pearl millet flour (20), curd (15), coriander (15), lemon (5), ginger (5) garlic (5), green chilies (5), salt (5), spice mix (5). Tempering made of sesame seeds (15), asafetida (1), oil (10)	Combine together Bengal gram flour, pearl millet flour, curd, ginger, garlic, green chilies, salt and spice mix together to make dough and divide into 3 equal parts and shape each portion into a cylindrical roll. Place the rolls on a greased steaming dish and steam for 10 to 12 minutes till firm. Remove, cool and cut into thick slices. Make a tempering of sesame seeds and asafetida. Add the nuggets and sauté. Add lemon and coriander for garnishing.
15	Spinach-soya kebab	Kebabs made of soybean (50), spinach (25), coriander (20), green chilies (5), garlic (5), roasted Bengal gram flour (30), sesame seeds (15), salt (5), spice mix (5), oil (10)	Blend in the mixer soaked soybean, spinach, coriander, green chilies, garlic, roasted Bengal gram flour, spice mix and salt. Add sesame seeds to it. Divide into four portions and give it the shape you like. Roast on both sides on a low flame till golden brown adding oil to it. Serve with the spinach chutney.
16	steamed chickpea cakes (dhokla)	Steamed cakes made of chickpea flour (50), fenugreek leaves (25), spinach (25), ginger (5), green chilies (5), salt (5), spice mix (5), cooking soda (5). Tempering made of sesame seeds (15), asafetida (1), oil (5).	Mix together to make a batter of chickpea flour, chopped fenugreek flour, chopped spinach, ginger, green chilies, salt and spice mix. Add the cooking soda and pour into a greased steaming dish and steam for 10-12 minutes. Make a tempering of sesame seeds and asafetida and pour over the steamed chickpea cakes.
17	steamed bean sprout cakes (idli)	Steamed cakes made of bean sprouts (50), bengal gram flour (15)carrots (10), cabbage (10), French beans (10), coriander (10), sesame seeds (15), ginger (5), green chilies (5), cooking soda (5), salt (5)	Make a batter of ground bean sprouts, Bengal gram flour and add finely chopped carrots, cabbage, French beans, coriander, ginger, green chilies, sesame seeds and salt. Add the cooking soda and pour into a greased steaming dish and steam for 10-12 minutes.
18	Mixed flour pancake (dosa),	Pancakes made of rice flour (30), black gram flour (10), soya flour (10), cumin seeds (10), black pepper (5), onions (15), green chilies (5), curry leaves (5), salt (5)	Make a thin batter of all the flours and add cumin seeds, ground pepper, chopped onions, green chilies, curry leaves and salt. Make thin pancakes on a flat pan.
19	finger millet unleavened pancake (thalipith),	Unleavened pancakes made of finger millet flour (30), pearl millet flour (20), sorghum flour (20), bengal gram flour (10), soybean flour (5), rice flour (5), sesame seeds (15), coriander leaves (10), fenugreek leaves (10), garlic (5), green chilies (5), spice mix (2.5), salt (5), oil (15)	Cut fenugreek leaves in very thin strands. Make a paste of garlic, and green chilies. Mix all the flours, coriander leaves, spice mix, sesame seeds, salt, fenugreek leaves, and the above garlic- chilies paste. Add water and make soft dough. Roll out as thin pancakes. Roast on a pan with oil.
20	Spinach dip (Chutney)	Dip made of spinach (25) coriander leaves (10) garlic (10) ginger (5) green chilies (5) roasted groundnut (10) spice mix* (5) lemon (5) salt (2.5)	Blenderize together all the ingredients and add lemon before serving.
21	Garam masala (spice mix) *	Roasted and ground together pumpkin seeds (15) til (10) black pepper (2.5) cumin seeds (2.5) fenugreek seeds (2.5) cardamom (2.5) garlic (15) coriander seeds (5) turmeric powder (2.5) red chili powder (2.5)	Roast the pumpkin seeds, sesame seeds, black pepper, cumin seeds, fenugreek seeds, cardamom, coriander seeds and garlic. Add turmeric powder and chili powder to it. Grind together to make smooth powder.

†Numbers in the brackets in the description column give the grams of the ingredients required to make the recipe.

Original Article

Dietary modifications to improve micronutrient status of Indian children and adolescents with type 1 diabetes

Lavanya S Parthasarathy MSc, Shashi A Chiplonkar PhD, Anuradha V Khadilkar MD, Vaman V Khadilkar MR, CP

Hirabai Cowasji Jehangir Medical Research Institute, Jehangir Hospital, Pune, India

通过调整饮食改善印度儿童和青少年 1 型糖尿病患者微量元素状况

引言：对糖尿病患儿来说，饮食在优化控制血糖同时还会对儿童正常生长发育至关重要。糖尿病儿童的饮食限制可能会导致微量元素缺乏。目的：探讨亚洲的印度 1 型糖尿病儿童的膳食营养缺乏和开发适合他们含有丰富微量元素的食谱。**方法：**记录了 70 名糖尿病患儿（24 名男童）人体测量学参数及 3 天饮食回忆。用 CDIET 2.0 估计每日营养素摄入量及食谱的营养素含量。**结果：**儿童平均摄入的能量是印度推荐膳食供给量（RDA）的 79%，蛋白质为 RDA 的 105%，而脂肪较高（RDA 的 143%）。而核黄素、β 胡萝卜素、锌、铁的平均摄入量低于 RDA 的 50%，硫胺素和钙分别在 RDA 的 60%左右，提示多种微量元素缺乏。基于流行消费的零食，新设计的 20 种健康食谱可纳入儿童的饮食。新食谱的平均能量含量于常规食谱相似（281±28 kcal/100 g 、306±27 kcal/100 g 熟重）。而新食谱的平均维生素和矿物质含量都明显高于常规小吃（p<0.01）。与传统配方相比，总矿物质含量（锌、钙、铁）增加 5 倍，总维生素含量（β 胡萝卜素、维生素 C、维生素 B-1、B-2 和 B-3）增加了两倍。**结论：**糖尿病儿童的饮食中缺乏多种微量元素。新食谱可以在不增加他们能量负担的同时增加微量元素摄入量。

关键词：糖尿病、1 型、亚洲的印度食谱、微量元素、儿童