

# Diet-cariogenicity and Health-fullness Index (DCHI) - a Novel, Comprehensive Index for Children; Rational and Development

Raghavendra Shanbhog (✉ [drraghu.kiddoc@gmail.com](mailto:drraghu.kiddoc@gmail.com))

Department of Pediatric and Preventive Dentistry, JSS Dental College and Hospital, JSSAHER, Mysuru, Karnataka, India <https://orcid.org/0000-0002-7115-8417>

Chanchala HP

Department of Pediatric and Preventive Dentistry, JSS Dental College and Hospital, JSSAHER, Mysuru, Karnataka, India

Srilatha KT

Department of Pediatric and Preventive Dentistry, JSS Dental College and Hospital, JSSAHER, Mysuru, Karnataka, India

Madhushree B

Department of Public Health and Preventive Medicine, JSS Medical College and Hospital, JSSAHER, Mysuru, Karnataka, India

Manjunatha SN

Department of Public Health and Preventive Medicine, Mysuru Medical College and Hospital, Mysuru, Karnataka, India

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## Research article

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## **Abstract**

Background:

Tailored, realistic dietary advice plays a vital role in Preventive Dentistry. Appropriate diet analysis forms the bases for precise dietary advice. Analysis of diet for its cariogenicity is a complex process. Performing meaningful diet analysis is a challenge in routine clinical practice. Currently, a very few tools are available for researchers or clinicians to assess children's diet, as it relates to caries risk. To best of our knowledge an index that helps clinician to reduce composite diet dairy information to a simple quantifiable interpretation is lacking. The current scientific paper presents a novel index that assesses the cariogenicity and health-fullness of child's diet objectively and guides the professional to achieve pragmatic diet modification in prevention of Dental caries.

Methods:

A team comprised of specialist from Division of Pediatric dentistry, Community medicine and Diet and Nutrition along with a pilot parent-child population of number 50 were involved in initial structuring of Diet-Cariogenicity and Health-fullness Index. To obtain cut off values for cariogenicity of diet score a study was carried out with sample of 774 children correlating diet dairy with caries status. The receiver operating characteristic curve closest to the ideal of 100% sensitivity and 100% specificity was applied for statistical analysis.

Results:

Receiver Operating Characteristic curves plotted was 22.5 for diet scores for its cariogenicity. The sensitivity, specificity, and area under the curve of these cut-off values were 70 and 95.

Conclusions:

The current scientific paper presents a novel Diet-Cariogenicity and Health-fullness Index that assesses the cariogenicity and health-fullness of child's diet objectively so as to guide the professional to achieve pragmatic diet modification.

## **Background**

Diet is the sum of food consumed by a person and a balanced diet is the one which provides all the nutrients in required amounts and proportions.<sup>1</sup> Dietary habits and selections play an important role in human health. Eating nutrient-dense foods and balancing energy maintains the health essential at all stages of life. Unbalanced consumption of food high in energy and low in essential nutrients contributes to chronic diseases including Dental caries.<sup>2</sup>

Dental caries, a major global public health concern.<sup>3,4</sup> The harmful consumption of fermentable carbohydrates is recognized to be an essential etiological cause particularly among children from the lowest socio-economic groups.<sup>5-8</sup> So tailored pragmatic diet modification aimed at reducing fermentable carbohydrate and improving healthfulness of diet forms a key in prevention of Dental caries.

Analysis of diet for its cariogenicity is a complex process because fermentable sugars are often consumed in combinations. Also the properties of food like retention time, frequency, nutrient composition, and potentiality to stimulate saliva makes it further difficult to recognize its cariogenic potential.<sup>9,10,11</sup> Currently, however, few tools are available to experts to assess children's diet, as it relates to caries risk, and demonstrate how it can be successfully modified to reduce caries risk.

In 2002 American Academy of Paediatric Dentistry (AAPD) developed and advocated Caries risk assessment tool (CAT), which counts the frequency of in-between-meal sugar attacks and bedtime exposure from bottles.<sup>12</sup> In 2004 dental health diet score<sup>13</sup> was discussed that gave points earned as a result of an adequate intake of food from each of the food groups essential for achieving and maintaining dental health. However this index does account for physical properties of food, also will not explain the guidelines for dietary modification. In the 2009 University of Iowa, The United States of America designed 'The Diet Assessment of Caries Risk tool' to help dental practitioners to identify dietary factors contributing to caries risk.<sup>14</sup> This collects information on frequency, amount, timing and manners of intake and supplemented with specific responses represented as low, moderate or high caries risk. However, it is subjective in nature. Further in 2013 cariogenicity index was explained, however, the author concluded that because of the multifactorial nature of caries only liquid cariogenicity index has considerable potential in clinical settings.<sup>15</sup> In 2016 Moynihan P in contradiction to World Health Organization (WHO) issued guidelines (free sugars  $\leq 10\%$ ) recommended intake of  $\leq 5\%$  free sugars to protect dental health throughout life.<sup>16</sup>

So to best of our knowledge an index that helps clinician to reduce composite diet dairy information to a simple quantifiable interpretation is lacking in literature. The current scientific paper presents a novel index that assesses the cariogenicity and health-fullness of child's diet objectively and guides the professional to achieve pragmatic diet modification in prevention of Dental caries.

## **Methods**

### **Structuring of DCHI**

A team comprised of specialist from Division of Pediatric dentistry, Community medicine and Diet and Nutrition along with a pilot parent-child population of number 50 were involved in initial structuring of DCHI.

The first challenge was to collect a meaningful and near infallible diet history from child parent duo which helps specialist to convert the gathered information rationally in to a numerical data for objective outcome. Based on information gathered from literature, present variations reported among Indian urban and

rural scenario and opinion from team member's different diet dairy formats were prepared and were circulated among pilot population. Based on the inference of the pilot data it was decided to adopt 4 day (including a week end) prospective diet history collection method with added time component, detailed description of the food including dressings/dips, quantity of consumption and post-diet oral rinsing.

The next task was to convert the gathered information rationally in to a numerical data. Globally diet consists of a wide variety of regional and traditional cuisines native to the region. These cuisines vary substantially from each other in method of preparation and consumption. Based the composition and method of preparation food items prepared using the same base ingredient will pose different cariogenic potentials; listing each food item and assigning a score becomes an impossible task. The earlier attempts made to resolve above said task have achieved partially in categorizing subjectively to either cariogenic or non-cariogenic ignoring healthfulness of diet. The health-full ness of foods is determined by its nutrient composition whereas the cariogenic potential of foods and beverages is determined by the potential of food to decrease the plaque pH which in turn depends upon the form of the food, fermentable carbohydrate, hidden sugars, retention time, and frequency, quantity, between meals, near bedtime, prolonged exposure, and sequence. So the diet which is rich in nutrient might be cariogenic and should not be judgmental as a harmful diet. So it was decide to independently score each and every intake for its cariogenicity and healthfulness which aid in meaning fully modifying the food item during diet counseling phase.

Considering above said facts it was decided to categorize each and every intake based on food group and scored based on its form, additives (hidden sugar), retention time, frequency, between meals, near bedtime and sequence. The details for scoring criteria are explained in detail with illustrations in **Diet's Cariogenicity and Health-fullness Index** section. Cut off values for cariogenicity of diet score was estimated in yet another pilot study that was carried out with sample of 1500 children correlating diet dairy with caries status. The details of the same are explained in resultsection.

The decision of health fullness of diet for each food groups as consumed by the child was calculated based on average servings for individual food group and considered health full if it is equal or above the indicated serving by Food Guide Pyramid (FGP) for moderate calorie level (2002).

Final phase was the diet counseling. Here the challenge was to guide the parent and child for a balanced diet which is less cariogenic. Question is who is the right person to counsel? As the present indices evaluates both cariogenic and healthfulness; the team felt that both dentist and dietitian in combination can modify the child's diet in an appropriate manner and can counsel the child and parent duo with a positive outcome.

### **Diet's Cariogenicity and Health-fullness Index**

The index consist of 3 phases

#### *Phase 1: Collection of Diet history*

The child and parent duo should be provided with a diet diary template (Figure 1) along with verbal and written instructions to help them complete the diary along with examples of completed diaries. They have to be instructed to maintain a real-time record of what they drink and eat for 4 consecutive days including one weekend in the template provided to them. The diet diary template has made provision to record the time of consumption, alongside to describe the item consumed in detail (especially for the platter of multiple types), the amount in a household measuring systems and post-diet oral-cavity cleansing (rinsing).They should provide details of each dietary intake such as the name of the food, brand names if any, additional items (sugar or sauces) as well as any medicine if consumed. Children should be instructed and encouraged to keep the diary with them all the time to instantly record any dietary intakes and avoid using atypical days that might be complicated by travel, illness, or unusual circumstances.

#### *Phase 2 A: Analysis of diet dairy for assessment of cariogenicity*

From the information collected through diet history, every intake of the child should be analyzed by the clinician and scored as follows.

#### **Step 1 (Figure 2)**

1. Identify Food items consumed by the child at any given point of time, whether the single type or a platter of multiple types?
  - a. If it is a Single type, check if it is a part of Miscellaneous from Table 2; if yes; assign score as per table 2. If no; proceed to step 2
  - b. If it is a platter of multiple types, check if it contains any food items belonging to Miscellaneous; if yes; give a single score of 3.5 for the entire platter of multiple types. If no; from the platter of multiple types identify major one food item and proceed to step 2

Example for Single type: Biscuit, Pasta, Veg biryani

Example for Platter of multiple types: Biscuit with milk, Pasta with potato chips, Lunch (2 Indian bread, 1 cup rice, 2 curries, 1 sweet, 1 vegetable)

#### **Step 2 (Figure 3)**

2. Identify the food, is it natural or processed\*\*?

- a. *For natural food items,*
    - i. Identify which food group it belongs to?

Scoring: For food groups: Grain, Fruit or dairy assign score 0.5

For food groups: Protein or vegetable assign score 0

ii. Identify whether food is in solid, semisolid or liquid state?

Scoring: For solid add score 1, for semisolid add score 0.5 and for liquid add score 0

iii. Identify the nature of the food, sticky or non-sticky?

Scoring: If sticky add score 1 If non-sticky add score 0

b. *For processed food items,*

i. Based on its major ingredient identify which food group it belongs to?

Scoring: For food groups: Grain, Fruit or dairy assign score 1.5

For food groups: Protein or vegetable assign score 0.5

ii. Identify whether external sugar has been added ?<sup>#</sup>

Scoring: If yes add score 1, If no add score 0

iii. Identify whether food is in solid, semisolid or liquid state?

Scoring: For solid add score 1, for semisolid add score 0.5 and for liquid add score 0

iv. Identify the nature of the food, sticky or non-sticky?

Scoring: If sticky add score 1 If non-sticky add score 0

- \*\*Processed food is defined as food that has had some sort of chemical or industrial treatment in order to cook it, preserve it, or improve its taste or appearance:
- # Food item with added sugar or food belonging to miscellaneous food item consumed consecutively within 60 minutes interval then add 1 for the later score.
- If child after every intake does not follow or is inconsistent in following the oral hygiene regime then add a score of 2 to per day diet score. If the child consumes food item with added sugar just before bed and skips oral hygiene regime add another score of 2 to per day diet score.

Based on the above criteria each intake of child should be scored and added to obtain a cumulative score of four days.

The child's diet cariogenicity score should be computed as follows

**Child's Diet cariogenicity score = 4 day cumulative score /4**

#### **Inference**

A score of 23 and above should be considered cariogenic, and a score below 23 is to be considered non-cariogenic (based on Receiver Operating Characteristic curves results obtained in pilot work)

*Phase 2 B:Analysis of diet dairy for its health-fullness (Figure 3)*

Identify Food items consumed by the child at any given point of time, whether the single type or a platter multiple types?

a. If it is a Single type, check if it is a part of Miscellaneous (Table 1)

**Scoring** if yes, assign score 0 for *five basic food groups*.

if No Identity which *one of the five basic food groups the intake* belongs to and quantify the intake in terms of servings\*\*\* and note under respective food group.

b. If it is a platter of multiple types, check if it contains any food items belonging to Miscellaneous?

**Scoring** For food items belonging to Miscellaneous assign score 0 for *five basic food groups*.

For the rest of the food, for each food items identify which *one of the five basic food groups the intake* belongs to and Quantify the intake in terms of servings.\*\*

\*\*\*- Convert house hold measurements written in diet dairy in to serving using table 3

Based on the above criteria each intake of child should be scored and the servings under each food group consumed by the child should be added for 4 consecutive days added to obtain a cumulative four day score.

**Average servings score for each food group = 4 day cumulative score for each food group /4**

## Inference

Calculated average servings for individual food group; if is equal or above the indicated serving by FGP (2002) for moderate calorie level (2200 calories- Indicated for Children)<sup>17</sup> consider the child is consuming health full diet. Even one of the five food groups do not fulfill the indicated serving by FGP consider the diet as non-healthful.

**Based on the inference of Phase 2 A and B, child's diet can be classified into one of the following categories,**

- **Category I-Non-cariogenic, Health full**
- **Category II-Cariogenic, Health full**
- **Category III- Non-cariogenic, Non-health full**
- **Category IV- Cariogenic, Non-health full**

## Illustration for Diet diary analysis Table 6

### Phase 3 -Diet counseling

Children falling in **Category I**, need no counseling, instead, reinforcement for good diet practice and follow-up is needed. For children falling in **Category II**, counseling by the Dentist is advised; For **Category III and IV** counseling by a dietitian in collaboration with the Dentist is advised.

#### Guideline for diet counseling from the cariogenic point of view of the diet for Dentist

For every child educate oral hygiene protocols to be followed using age-appropriate oral hygiene aids needs to be provided. Every intake should follow oral rinsing.

From diet diary received,

- Step1: *Aim: To reduce miscellaneous food items to the maximum extent possible.*

To do: Identify and mark all the dietary intakes by the child that are not associated with food groups but sweetened by the addition of sugars (miscellaneous food).eg: Chocolates, candy, pastry, chips and sweetened medicine

Correction: Child and parents should be made aware of the findings and instructed to reduce the frequency of above-said intakes. They are asked to club the intake of miscellaneous food with either lunch or dinner and absolutely refrain these intakes just before bed. If possible sugared medicines changed to artificially sweetened ones. Whenever they consume miscellaneous food oral rinsing should be compulsory.

- Step 2: *Aim: To reduce the intake of fermentable sugar as much as possible without disturbing intake of food group servings.*

To do: Identify and mark all the dietary intakes by the child that are associated with basic five food groups but sweetened with the addition of sugars.

eg: milk with sugar, bread with jam, Chapati with ghee and sugar

Correction: Child and parents should be made aware of the effect of the addition of sugars and advised on a realistic type of correction. Each day one food item is considered for correction starting from the first meal of the day, Breakfast. The parents are instructed to wean the added sugars without disturbing the main food group ingredient. Parents can substitute's sugar, with honey or jiggery. Try to substitute sugar with no-sugar or permitted artificial sugar-based products without affecting the intake of the main course associated with food groups. This is expected to be followed for 4 weeks consecutively and advised on a recall follow up. Whenever they consume miscellaneous food oral rinsing should be compulsory

- Step 3: *Aim: To improve the intake of health-full diet.*

To do: Identify and mark all the dietary intakes by the child that are associated with basic five food groups.

Correction: Child and parents consuming adequate quantity of health-full diet should be appreciated and encouraged for consuming diet of a varied selection that contains an adequate quantity of the nutrients.

Illustration depicted in **Table 7** shows post diet counseling modifications suggested for day1 diet dairy of child. Modification has been done in the time of intake and emphasizing on the oral hygiene instructions without omitting the miscellaneous diet of the child and converting the cariogenic diet score to non-cariogenic score. The healthfulness of diet was also improved by adding varied food groups to the diet that were lacking.

#### Diet cariogenicity score cut-off value methodology and results

To confirm the cut-off values of Diet score for predicting cariogenicity score of diet a cross-sectional study was carried out. The study plan was approved by the institutional ethical committee. Permission to visit the schools and examine the children to collect data regarding Children's diet and dental caries was obtained from concerned Government & the school authorities. A total of 1500 school-going children aged 8-10 years were screened for selection criteria. The children were screened and clinically assessed by two trained, calibrated examiners. Inter and intra-examiner reliability were measured and a kappa value of 0.8 was observed, which indicated good agreement. The Dental caries of children was assessed using lifelong cumulative disease index the Decayed, Missing,

Filled, (DMF) and decayed extracted filled (def). Based on findings 450 children with low and 450 children with high DMF index values were selected for diet evaluation. The child and parent duo of 900 selected children were provided with 4 days diet diary template and asked to fill as explained above.

Of 900 diet dairy format distributed 774 formats were completed and returned yielding a response rate of 86 %. The diet scores of each child were calculated as explained above. The receiver operating characteristic curve analyses were performed to determine the optimal cut-off values for cariogenicity of diet scores in relevance to dental caries. The optimal cut-off values were obtained from the point on the receiver operating characteristic curve closest to the ideal of 100% sensitivity and 100% specificity.

To confirm the cut-off values for diet scores for their cariogenicity, a Receiver Operating Characteristic curves was plotted and area under the curve was calculated. As shown in, the receiver operating characteristic curve optimal cut-off value was 22.5 for diet scores for its cariogenicity. The sensitivity, specificity, and area under the curve of these cut-off values were 70 and 95. **Figure 4 and Table 5**

## Discussion

Diet affects oral health both systemically and topically. Of both, the latter plays a key etiological role in the causation of dental caries.<sup>18</sup> Although, implementing lifestyle interventions that promote healthier eating has been recommended in many international oral health promotion guidelines and policy documents yet they are not being followed. To ensure effectiveness of these guidelines, the Interventional dietary advice needs certain modifications such as more realistic, comprehensive, and tailored to patients' needs.<sup>19-21</sup>

Primarily, Collection of typical eating habits forms a requisite for a convincing diet analysis. There have been retrospective and prospective 7 days, 3 days, and 24 hours diet diaries that have been discussed in literature with their advantages and disadvantages. Retrospective diet diary methods even though were considered ideal for older children with low literacy, is time-consuming. This leads to recall bias and may not be a representative of either usual eating habits or typical eating habits.<sup>22, 23, 24</sup> Prospective diet diaries with the elimination of memory bias were considered to be of higher validity due to their expected accuracy and representativeness of habitual dietary intake.<sup>22, 25-28</sup> Among all prospective 3-day diet diary emerged as the most reliable tool for dietary assessment<sup>22, 25, 28</sup> However, in the recent past globalization has brought many changes in the lifestyle of both parents and children. Now the weekend consists of 2 days being Saturday and Sunday unlike the past and as a result eating pattern of both child and parent varies on both the days from that of a routine. Thus the 3-day diet dairy including weekend may not represent typical eating habits of the child. So in the present study, we have proposed a 4-day prospective diet dairy including at least one weekend that balances above-said variability by including 2 working days with 2 holidays to record both the typical and atypical eating patterns. The present study diet diary was designed to collect information on the quantity and timing of food consumption and oral hygiene maintenance protocols of the child.

Over the years analysis of diet for appropriate diet counseling using complex diet dairy has been a challenging issue. Studies have shown that dentists' analysis and judgments of diet dairy information are influenced by their knowledge, values, and beliefs as well as available treatment.<sup>29-33</sup> To nullify this bias, in the present study a simple yet comprehensive analytical method based on the scientific background was developed and explained.

The cariogenic potential of foods and beverages is determined by the potential of food to decrease the plaque pH which in turn depends upon the form of the food, fermentable carbohydrate and sugar including hidden sugars, retention time, and frequency of consumption, amount/quantity, in between meals, near bedtime, prolonged exposure, and sequence. The health-full ness of foods is determined by its nutrient composition.<sup>34-38</sup>

In the present study the first step of diet analysis was to investigate the form of the food whether it is natural or processed. Second and third steps will investigate regarding the food group to which the diet belonged to and information on addition of fermentable carbohydrate and external sugars. Later steps explores on the retention time based on information about the consistency of the food and the tackiness. Retentiveness of food is determined by its physical as well as chemical properties such as consistency, particle size, solubility, tackiness, cohesiveness and adhesiveness to the tooth surface.<sup>40-42</sup> There is a variation in the clearance time for each and every individual food as they exhibit different retentive properties.<sup>43</sup> Literature reports higher rates of dental caries incidence to be associated with the consumption of refined carbohydrates in the retentive form (sticky).<sup>44-48</sup>

Frequency and amount of dietary sugar is another important aspect that determines cariogenicity of diet. Continuous exposure to refined carbohydrates prolongs the duration of a pH drop below the critical level and that it also limits the buffering capacity of dental plaque and saliva by draining their reserves of minerals.<sup>22, 49-52</sup> Of frequency and amount of dietary sugar, targeting the frequency of sugar consumption rather than the amount may be a more realistic approach when addressing at an individual level.<sup>51</sup> So, in the present study dietary analysis will check frequency of food with added sugar consumed within 60 minutes interval between the meals, an additional score of 1 to diet score.

In the present indices, the baked and processed foods with the combination of sugar and starch (high-starch snacks) like Deep Fried Fruits, vegetables, Legumes, Pulses, refined grains/ cereals, bakery items were categorized to miscellaneous group and assigned a higher score as in past literature it is found that high-starch snacks was associated with an increased cariogenicity.<sup>46, 52</sup>

In the present indices, the food items like Medicines in liquid or semi-solid forms with added sugar either sucrose or fructose or with a combination of fructose and sorbitol and Carbonated drinks with artificial flavors produced a marked and long term drop in plaque pH. The cariogenic potential of pediatric liquid medications is due to high concentration of fermentable carbohydrates and their acidogenicity. Various authors have expressed concern over the presence of fermentable carbohydrates in syrup medications and their adverse effects on the oral health of children on a long term.<sup>53-55</sup>

The decision of health fullness of diet for each food groups as consumed by the child was calculated based on average servings for individual food group and considered health full if it is equal or above the indicated serving by FGP for moderate calorie level (2002)<sup>17</sup> As per the FGP protocol a total calories 2,200 is right for children, as the amount of calories depends on how many calories you need and is inter dependent on the age, sex, size and how active the person/child is.<sup>56-57</sup>

Based on the inference availed post diet analysis the children were categorized as discussed previously. Children assigned in **Category I**, need no counseling, instead, reinforcement for good diet practice and follow-up is needed. For children falling in **Category II**, counseling by the Dentist is advised; For **Category III and IV** counseling by a dietician in collaboration with the Dentist is advised.

In the previous literature, diet counseling was planned to primarily reduce the intake of fermentable sugar as much as possible without considering the nutritive value of the intake of food groups. Therefore, the diet counseling was carried out in a swift manner aiding in reducing the caries. In the present study, the diet consumed by the child is segregated in terms of the basic ingredient, method of preparation/processing, addition of external sugars etc to aid in the etiology of the dental caries. In this process the concentration is primarily focused only on the caries and its causation and absolute negligence towards the healthfulness of the diet. Therefore, in the category III and IV the diet would definitely consist of more cariogenic food and if these food items are advised to be weaned off or eliminated from the food plate it would also hamper the nutritive component of the child's diet. Considering the healthfulness of the diet it is important to consume a balanced diet to facilitate the satisfactory growth and development. Another important aspect being the time constraints by the dentist to evaluate the details of the diet completely in cases of advanced diet counseling for children. The need for the dietitian has a vital role in systematic, feasible and achievable goal to make the child caries resistant without affecting the nutrition.

#### **Validity and reliability of the DCHI**

An index should be valid, reliable, and pragmatic in its use and results should be easily reportable. Validating and testing the index's reliability are underway. Results will be presented in future.

#### **Limitations**

The cut off scores computed for cariogenicity of diet in present study are applicable only for the Indian population and therefore it is suggested that further research from different regional and traditional locations based on their diet practices to be validated considering the same protocol to execute the cutoff values of diet score.

#### **Conclusion**

The current scientific paper presents a novel Diet-Cariogenicity and Health-fullness Index that assesses the cariogenicity and health-fullness of child's diet objectively so as to guide the professional to achieve pragmatic diet modification.

#### **Abbreviations**

DCHI - Diet-Cariogenicity and Health-fullness Index

AAPD - American Academy of Paediatric Dentistry

CAT - Caries risk assessment tool

WHO - World Health Organization

FGP - Food Guide Pyramid

DMF - Decayed, Missing, Filled

Def- decayed extracted filled

#### **Declarations**

##### **Ethics approval and consent to participate**

Written informed consent was obtained from parents and assent from children and the study protocol was approved by the institute's committee on human research.

Full name of the ethics committee- JSS Dental College & Hospital Institutional Ethics Committee

#### Consent to publish

Not applicable

#### Availability of data and materials

The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

#### Competing interests

The authors declare no Competing interests

#### Funding

Nil

#### Authors' Contributions

Conception and design of the indices were done by R.S., C. HP, M.B., and M.SN Analyzing the data was done by M.B., M.SN. and KT.S. Writing the manuscript was done by R.S. and C. HP.

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## Tables

Table 1 Diet Diary Template

Dentist assessment form										
Time	Food	Amount	Rinse	Description	Score	Grain	Protein	Fruit	Milk	Vegetable
Saturday										
Sunday										
Any week day										
Any week day										

Amount should be expressed in Slices, pieces, tea spoon, table spoon, tumbler/Glass, cup and bowl, Scoop

Table 2 Miscellaneous food items with scores

While scoring for following food items assign scores as follows

1. Medicines in liquid or semi-solid forms with added sugar - assign score 4.5
2. Direct intake of Honey, Sugarcane - assign score 2
3. Food products with the main ingredient that has not been included in basic food groups like flower, if consumed naturally score 0 will be assigned, if with addition of sugar - assign score 4 (eg-Gulkand)
4. Bakers' confectionery, Sweet condiments, sweets deserts, Sugary sweets- assign score 4.5
5. Carbonated drinks with artificial flavours and added sugar- assign score 4.5
6. Deep Fried Fruits, vegetables, Legumes, Pulses, refined grains/ cereals - assign score 4.5

Note:

1. Above mentioned miscellaneous food item if is part of platter of multiple types or consumed along with meal slash 1 from above mentioned scores
2. Food item with added sugar or food belonging to miscellaneous food item consumed consecutively within 60 minutes interval then add 1 for the later score.

Table 3 One serving in household measurements for given food groups

Food Group	One serving in house hold measurements
Grains & Cereals	1 slice bread 1 medium sized chapathi, Dosa, Idli ½ cup cooked cereal, rice or pasta
Vegetable	1 cup chopped raw leafy vegetables ½ cup chopped other vegetables raw or cooked ¾ cup vegetable juice
Fruit	1 medium apple, banana or orange ½ cup chopped fruit or canned fruit ¾ cup fruit juice
Milk Yogurt and Cheese	1 cup or ½ glass milk or Yogurt 1/8 <sup>th</sup> cup cheese 2/8 <sup>th</sup> cup cheese
Meat Poultry Fish	3/8 <sup>th</sup> cup cooked lean meat, poultry or fish ½ cup cooked bean 2-3 eggs 2 table spoon peanut butter
	1 Glass=2Cups 1Bowl=4 cups 2Table spoon = 1 Ounce 1 Tablespoon = 3 Teaspoons

Table 4 Average servings for individual food group serving for Children with moderate calorie level (2200 calories) given by FGP (2002)<sup>17</sup>

Food Group	For 2200 calories
Grain group servings	9
Vegetable group servings	4
Fruit group servings	3
Milk group servings	3
Meat group servings	6

Table 5 Illustration for Diet diary analysis Day

Day 1									
Time	Food	Quantity	OHR	Description	Score	Grain	Protein	Fruit	M
7.00 am	Milk with Sugar	1 Glass		Step 1  Single type  Not a part of Miscellaneous  Step2  Processed,  Belongs to Milk group= 1.5  External sugar added =1  Liquid=0  Non sticky=0	2.5				2
8.15am	Uppit & kesari bath	1 cup +1/2 cup	Y	Step 1  Platter of multiple types  One food item is a Part of Miscellaneous=3.5	3.5	3			
9.30 am	Chocolate	1		Step 1  Single type  Part of Miscellaneous=4.5	4.5	0			
10.15am	Cake	2		Step 1  Singe type  Part of Miscellaneous=4.5  Two Miscellaneous items consumed within 60 min interval =1	5.5	2			
12.45pm	Lunch –spiced rice with chicken with jamoon	1 Bowl+1piece	Y	Platter of multiple types  One food item is a Part of Miscellaneous=3.5	3.5	4	1		
6.00pm	Chats with Ice cream	1cup + 1 scoop		Platter of multiple types  One food item is Part of Miscellaneous=3.5	3.5				1
8.00pm	Dinner-Cheese Vegetable Pizza and Pasta	2slice + 1cup	Y	Step 1  Platter of multiple types  No food item is Part of Miscellaneous  Step 2  Processed  Major food item Pizza belongs to grain group = 1.5  External sugar not added =0  Solid=1  Sticky=1	3.5	3			1
8.30pm	Banana	1		Step 1  Single type  Not Part of Miscellaneous  Step 2  Natural  Fruit group = 0.5  Solid=1	1.5				1

Non sticky=0

Child is inconsistent in following the oral hygiene regime.					2					
Day 1 score					30	12	1	1	1	2
<b>Day 2</b>										
Time	Food	Quantity	OHR	Description	Score	Grain	Protein	Fruit	M	N
7.00am	Milk with malt	1 Glass		Step 1  Singe type  Not a part of Miscellaneous  Step 2  Processed  Belongs to Milk group= 1.5  External sugar added =1  Liquid=0  Non sticky=0	2.5					2
8.15am	Idli sambar	2 pieces + 1 cup	Y	Step 1  Singe type  Not a Part of Miscellaneous  Step 2  Processed  Grain group= 1.5  External sugar not added =0  Solid=1  Non Sticky=0	2.5	2	1			
9.30am	Dry fruits	2 Table spoon		Step 1  Platter of multiple types  Not a Part of Miscellaneous  Step 2  Processed  Fruit group= 1.5  External sugar not added =0  Solid=1  Sticky=0	2.5					1
10.15 am	Jelly with cream	1 slice+ 1 scoop		Step 1  Platter of multiple types  Both food item belonging to  Miscellaneous =4.5	5					1
12.45pm	Lunch –rice and lentil curry with salt lassi	1 Bowl +1 cup+1cup	Y	Step 1  Platter of multiple types  Does not contain food item belonging to Miscellaneous  Step 2  Processed  Grain group= 1.5  External sugar not added =0  Solid=1  Non Sticky=0	2.5	4	1			1

6.00 pm	Sweet milk & biscuit	1glass+2		Step 1 Platter of multiple types One food item is a Part of Miscellaneous=3.5	3.5	1	2		
8.00pm	Dinner- Panner stuffed chapati rolls	2	Y	Step 1 Platter of multiple types Does not contain food item belonging to Miscellaneous Step 2 Processed Grain group= 1.5 External sugar not added =0 Solid=1 Non Sticky=0	2.5	2	1		
8.30 pm	Chocolava cake	1		Step 1 Singe type, Part of Miscellaneous=4.5	4.5	1			
				Child is inconsistantin following the oral hygiene regime.	2				
				child has consumed food item with added sugar just before bed and skipeds oral hygiene regime	2				
				Day 2 score	29.5	10	2 1 7		
				<b>Day 3</b>					
Time	Food	Quantity	OHR	Description	Score	Grain	Protein	Fruit	N
7.00am	Milk with malt	1 Glass		Step 1 Single type Not a part of Miscellaneous Step2 Processed, Belongs to Milk group= 1.5 External sugar added =1 Liquid=0 Non sticky=0	2.5				2
8. 15am	Aloo paratha with butter	1+2 table spoon	Y	Step 1 Platter of multiple types, Does not contain food item belonging to Miscellaneous Step 2 Processed Grain group= 1.5 External sugar not added =0 Solid=1 Non Sticky=0	2.5	1			1
9.30 am	Chips	1 pack		Step 1 Singe type, Processed Part of Miscellaneous=4.5	4.5				
10.15am	Coke	1-200 ml		Step 1 Singe type	5.5				

					Part of Miscellaneous=4.5				
					Two Miscellaneous items consumed within 60 min interval =1				
12.45am	Lunch-chapati with vegetables and fruits	2+1 cup+1 cup	Y		Step 1  Platter of multiple types  Does not contain food item belonging to Miscellaneous	2.5	2	2	
					Step 2  Processed  Grain group= 1.5  External sugar not added =0  Solid=1  Non Sticky=0				
6.00am	Vegetable sandwich	2	Y		Step 1  Single types  Does not contain food item belonging to Miscellaneous	2.5	2		
					Step 2  Processed  Grain group= 1.5  External sugar not added =0  Solid=1  Non Sticky=0				
8.00am	Dinner- Rice with lentil curry	1 bowl +1cup			Step 1  Platter of multiple types  Does not contain food item belonging to Miscellaneous	2.5	4	1	
					Step 2  Processed  Grain group= 1.5  External sugar not added =0  Solid=1  Non Sticky=0				
8.30am	Banana	1	Y		Step 1  Single type  Not Part of Miscellaneous	0.5		1	
					Step 2  Natural  Fruit group = 0.5  Solid=1  Non sticky=0				
Child is inconsistent in following the oral hygiene regime.					2				
Day 3 score					25	9	1	3	
<b>Day 4</b>									
Time	Food	OHR	Quantity		Score	Grain	Protein	Fruit	Milk
7.00am	Badam milk		1 Glass	Step 1  Single type	3				2

				Not a part of Miscellaneous			
				Step2			
				Processed,			
				Belongs to Milk group= 1.5			
				External sugar added =1			
				Liquid=0			
				Non sticky=0			
8.15am	Idli sambar	Y	2 pieces+ 1 cup	Step 1  Singe type  Not a Part of Miscellaneous	2.5	2	1
				Step 2  Processed  Grain group= 1.5  External sugar not added =0  Solid=1  Non Sticky=0			
9.30 am	Fruit juice		1Glass	Step 1  Single type  Not Part of Miscellaneous	2.5		2
				Step 2  Processed  Fruit group = 1.5  External sugar added =1  Liquid=o  Non sticky=0			
10.15am	Biscuits		3 pieces	Step 1  Single type  Part of Miscellaneous= 3.5	3.5	1	
12.45pm	Lunch- mixed vegetable rice	Y	1 bowl	Step 1  Single type  Does not contain food item belonging to Miscellaneous	2.5	4	
				Step 2  Processed  Grain group= 1.5  External sugar not added =0  Solid=1  Non Sticky=0			
6.00pm	Corn flakes with milk		1 cup + 1 Glass	Step 1  Platter of multiple types	3	1	2

				Does not contain food item belonging to Miscellaneous		
				Step 2		
				Processed		
				Grain group= 1.5		
				External sugar added =1		
				Semi Solid=0.5		
				Non Sticky=0		
8.00pm	Dinner-chapati with curry	Y	2+1 cup	Step 1  Platter of multiple types	2.5	2
				Does not contain food item belonging to Miscellaneous		
				Step 2		
				Processed		
				Grain group= 1.5		
				External sugar not added =0		
				Solid=1		
				Non Sticky=0		

Child is inconsistent in following the oral hygiene regime.	2					
Day 4 score		21.5	10	1	2	4
<b>Diet Score</b>						
Day 1 score		30				
Day 2 score		29.5				
Day 3 score		25				
Day 4 score		21.5				
Cumulative score		106				
<b>Child's Diet cariogenicity score=</b> Cumulative diet score/4		106/4				
<b>Child's Diet cariogenicity score</b>		26.50				
<b>Reference Score</b>		23#				

Final inference: **Child's Diet cariogenicity score = 26.50= Cariogenic**

	Grain	Protein	Fruit	Milk	Vegetable
Day 1 score	12	1	1	4	1
Day 2 score	10	2	1	7	2
Day 3 score	9	1	3	3	6
Day 4 score	10	1	2	4	3
Cumulative score	41	5	7	18	12
<b>Average servings score for each food group = Cumulative score for each food group /4</b>	41/4	5/4	7/4	18/4	12/4
<b>Average servings score for each food group</b>	10.25	1.25	1.75	4.50	3.00
<b>Reference Score</b>	9*	6*	3*	3*	4*
<b>Average servings scores of protein, fruit and vegetable is less than reference=Non health full diet</b>					
<b>Classification of child, diet=Category IV- Cariogenic, Non-health full</b>					

#As per ROC curve derived from present study on Indian children,

\*Indicated serving by FGP for moderate calorie level (2200 cal)

\$\$Even one of the five food groups do not fulfill the referencescores consider the diet as non-healthful

**Table 6 Illustration for post diet counselling modifications suggested**

Day 1											
Time	Food	Quantity	OHR	Diet counseling	Score		Grain	Protein	Fruit	Milk	Vegetable
					Before	After					
7.00 am	Milk with Sugar	1 Glass		Advised oral hygiene regime	2.5	2.5				2	
8.15am	Uppit & kesari bath	1 cup +1/2 cup	Y	Advised to eat 1 egg	3.5	3.5	3+2	1			
9.30 am	Chocolate	1		Advised to combine with breakfast and oral hygiene regime	4.5	0	0				
10.15am	Cake	2		Advised to combine with breakfast and oral hygiene regime  Instead of cake Advised to eat 1cup sliced raw vegetables	5.5	0	Shifted to breakfast			2	
12.45pm	Lunch –spiced rice with chicken with jamoon	1 Bowl+1piece	Y	Advised oral hygiene regime  Advised to eat 1cup sprouts and 1/2 cup vegetable	3.5	3.5	4	1+2		1	
6.00pm	Chats with Ice cream	1cup + 1 scoop		Advised oral hygiene regime  Advised to eat 1cup fruit	3.5	3.5		2	1		
8.00pm	Dinner-Cheese Vegetable Pizza and Pasta	2slice + 1cup	Y	Advised oral hygiene regime  Advised to eat 1cup cooked bean	3.5	3.5	3	2	1	1	
8.30pm	Banana	1		Advised oral hygiene regime	1.5	1.5			1		
Child is inconsistent in following the oral hygiene regime.					2	0					
Day 1 score					30	16					
					Before		12	1	1	4	
					After		12	6	3	4	
										4	

**Table 7 Sensitivity and 1 - specificity for diet cariogenic score at various dental caries cut-off points in children**

Diet cariogenic score	Sensitivity	1 - Specificity		
14.0000	1	1		
15.5000	0.972	0.894		
16.5000	0.93	0.621		
17.5000	0.907	0.451		
18.5000	0.899	0.291		
19.5000	0.894	0.186		
20.5000	0.894	0.175		
21.5000	0.85	0.119		
22.5000	0.707	0.095		
23.5000	0.637	0.082		
24.5000	0.456	0.062		
25.5000	0.422	0.059		
26.5000	0.386	0.054		
27.5000	0.352	0.052		
28.5000	0.319	0.046		
30.5000	0.285	0.041		
32.5000	0.249	0.036		
33.5000	0.14	0.021		
34.5000	0.07	0.01		
36.0000	0.036	0.005		
38.0000	0	0		
Caries	N	Area	Std. Error <sup>a</sup>	Asymptotic Sig. <sup>b</sup>
Positive	386	0.869	0.014	0.001
Negative	388			

## Figures

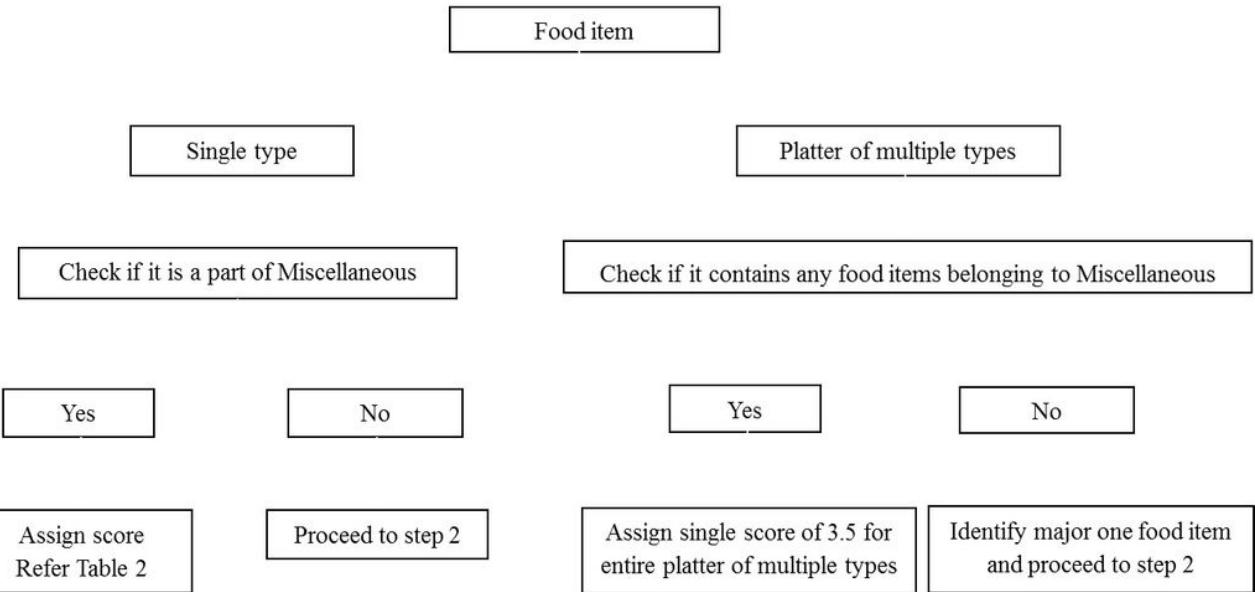


Figure 1

Analysis of diet dairy for assessment of cariogenicity- Step 1

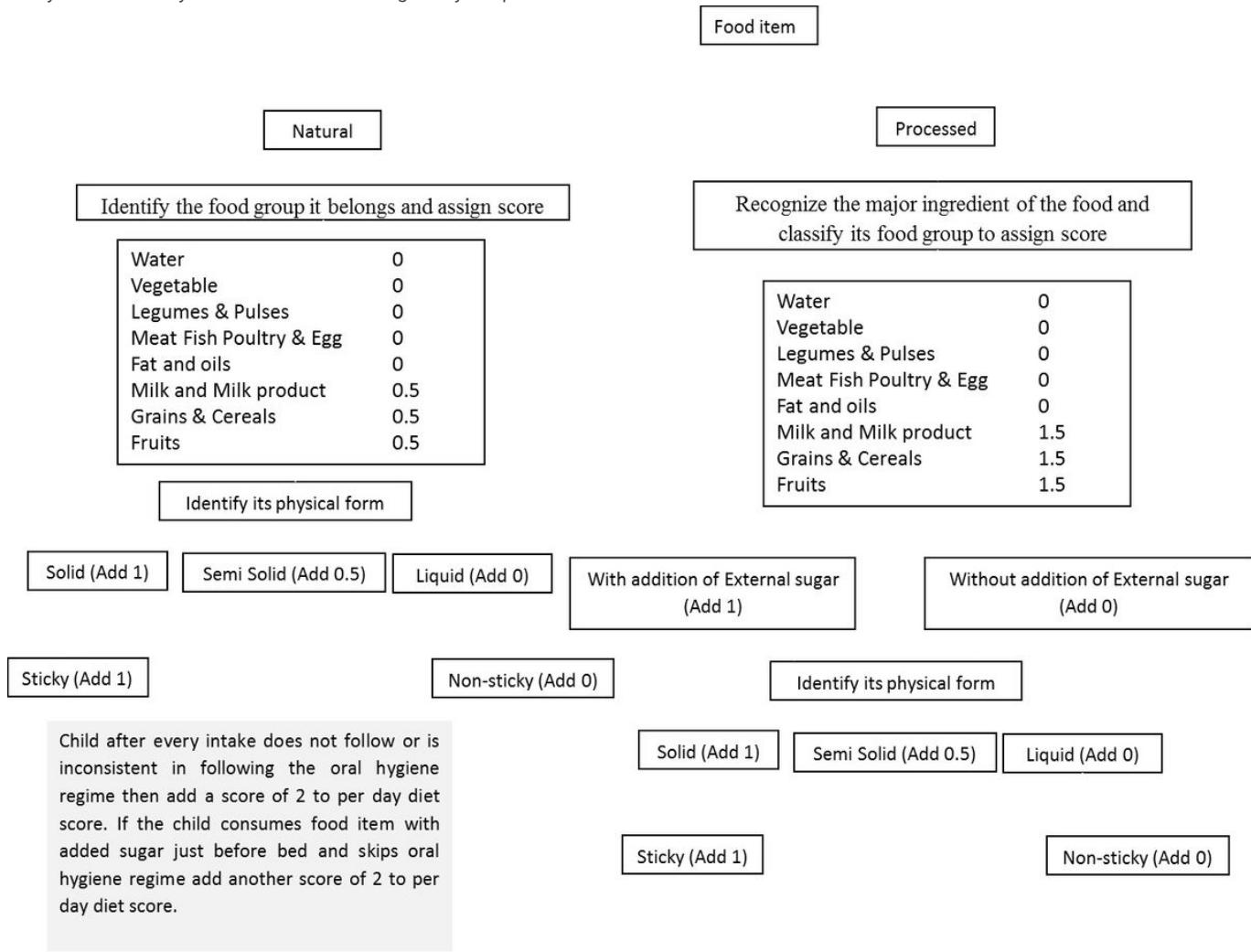
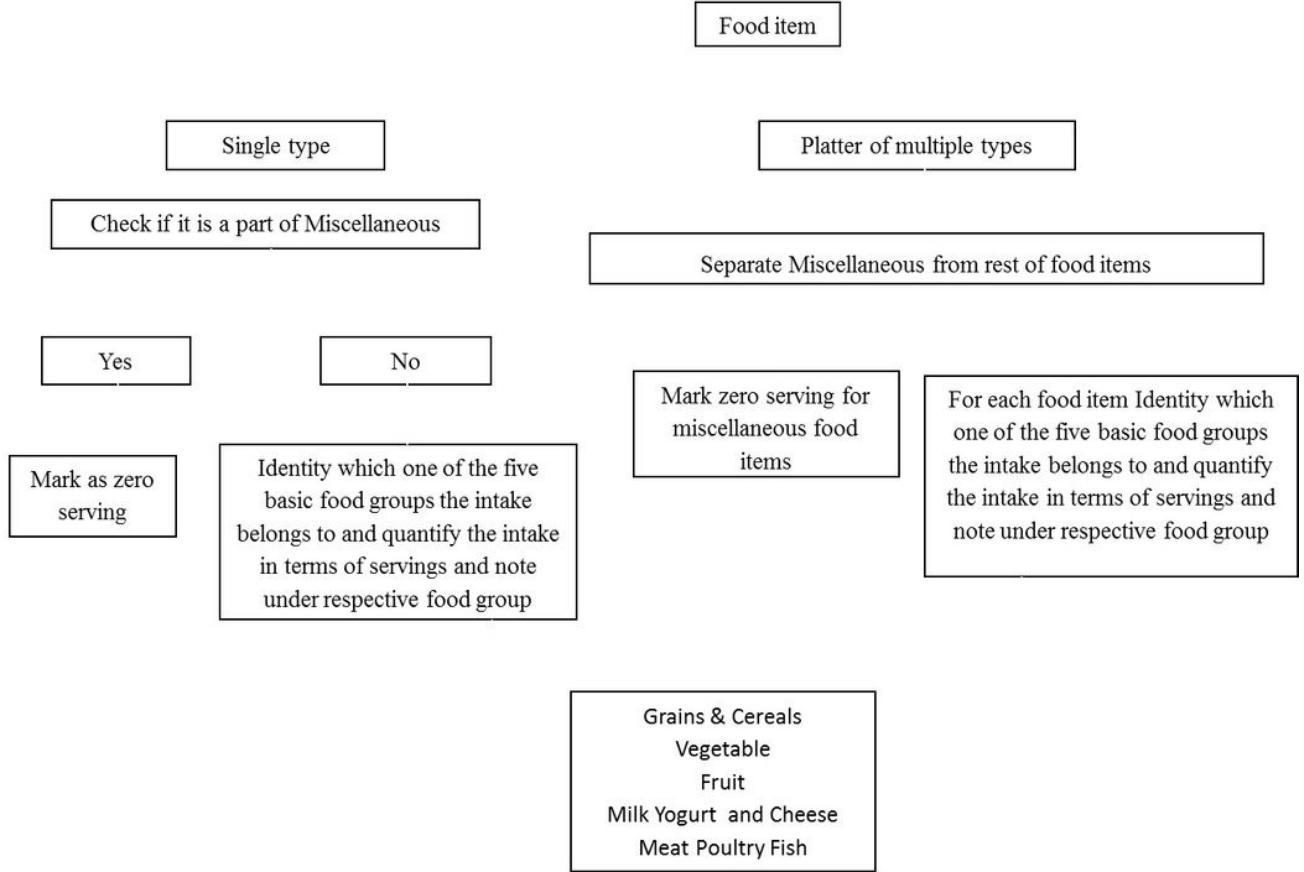


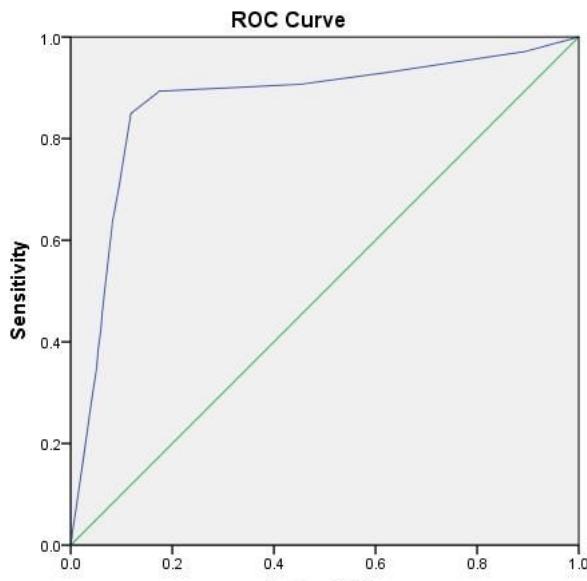
Figure 2

Analysis of diet dairy for assessment of cariogenicity- Step 2



**Figure 3**

Analysis of diet dairy for its health-fullness



Diagonal segments are produced by ties.

**Figure 4**

Receiver operating characteristic curve comparing Dental caries and Diet cariogenic score for children