ORIGINAL ARTICLE

Nutritional status and breath hydrogen test with lactose and lactulose in Terena Indian children

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Abstract

Objective: to evaluate the nutritional status, absorption and tolerance of lactose and the occurrence of small-bowel bacterial overgrowth.

Methods: a cross-sectional study including all 264 Terena Indian children younger than 10 years from two tribes (Limão Verde and Córrego Seco) in Mato Grosso do Sul. The nutritional status was assessed based upon weight and height, using NCHS data as reference. The breath hydrogen test after an oral lactose (18g) administration was used for evaluation of lactose absorption and tolerance. The occurrence of bacterial overgrowth was evaluated using the breath hydrogen test after the administration of lactulose (5g).

Results: the median z scores of weight-for-age, weight-for-height and height-for-age were, respectively, in infants under 1 year (n=34): -0.66, +0.60 and -0.85. Between 1 and 5 years (n=111), the values were: -0.50, +0.28 and -1.17. Between 5 and 10 years (n=119), these anthropometric values were, respectively: -0.09, +0.50 and -0.60. Deficient lactose absorption or malabsorption was verified only after the fourth year of age in 89.3% of the 197 evaluated children. Lactose intolerance was found in 37.1% of them. Small-bowel overgrowth was detected in 11.5% of the Terena Indian children (n=252).

Conclusions: the prevalence of recent malnutrition was low, but the median height-for-age was lower than the NCHS reference. The prevalence of ontogenetic lactase deficiency was high. Bacterial overgrowth may be considered as evidence of the occurrence of nonsymptomatic environmental enteropathy in Terena Indian children.


Introduction

The health status of a given population depends on the expression of its genetic characteristics in interaction with several environmental factors. In children, nutritional status and growth are classically considered some of the most important health status indicators. In specific populations, these aspects are of paramount importance, since they allow comparing groups with different lifestyles. This applies to Brazilian indigenous populations which, especially in the last fifty years, have undergone social changes due to their contact and interchange with the nonindigenous society. With regard to the Brazilian indigenous population, there are some publications on Caiapós,2 Indians from Alto Xingu,3-5 from the Amazon region6 and Xavantes, from Mato Grosso.7
It is widely known that eating habits play a vital role in the health status of a community. However, the ontogenetic deficiency of lactase may influence the formation of eating habits in a wide variety of ethnic groups around the globe. In Brazil, the high prevalence of ontogenetic lactase deficiency was determined by assessing the blood glucose curve in young adults,8 9 schoolers from a large Brazilian urban center,9 and in Indian children from Alto Xingu10 after lactose overload. A recent study, which used lactose concentration close to that observed in usual eating patterns, revealed lesser frequency of lactose malabsorption in a group of students living in the countryside of the state of São Paulo, by using the breath hydrogen test.11 It is extremely important that the prevalence of ontogenetic lactase deficiency and lactose intolerance be taken into consideration when nutritional intervention programs are designed.

On the other hand, tropical enteropathy may appear as a result of inadequate environmental and basic health conditions, causing functional and morphological small bowel disorders.12,13 In this case, there might be digestive disorders and abnormal nutrient uptake.

Tropical enteropathy is normally associated with the excessive proliferation of bacteria in the proximal small bowel, which may be detected by a noninvasive method known as breath hydrogen test, after the oral intake of lactulose.14

Considering the importance of the variables described above, the aim of this study was to assess the nutritional status, absorption and tolerance of lactose and small-bowel bacterial overgrowth in indigenous children from the Terenas tribe, from two villages located in Aquidauana, state of Mato Grosso do Sul.

Patients and methods

Indians from the Terenas tribe

The study was carried out in the Terenas villages of Limão Verde and Córrego Seco, located in Aquidauana, state of Mato Grosso do Sul. The initial estimate of the total population of these villages was 1,500 inhabitants in 1995. The contact of these Indians, who speak a language of the Aruak family, with our civilization was made in the mid-nineteenth century. These Indians participated in the Paraguayan War. Their land was marked off in the early twentieth century. There have been conflicts over land among these Indians from that time on. In the villages, the buildings used by the community (administration, health center, school) are made of brick, have electricity (supplied by the public electric network) and a water main that delivers water from an artesian well. The walls of the houses are made of tree trunks and mud and the roof is covered with buriti palm leaves. The houses do not have electric power or a water system. The Terenas grow corn, beans, rice, cassava, and fruit, and sell the surplus at the town market.

Patients

A cross-sectional study was conducted with Indian children from two villages (Limão Verde and Córrego Seco). During the first stage of the study, in 1995, the only inclusion criteria consisted in studying the largest possible number of children aged less than 10 years. All children (264) in this age group were included (125 males and 139 females). The children’s weight and height were recorded. Later on, according to operational availability, the following tests were performed: 244 (92.4%) stool tests for the detection of intestinal parasites, 251 (92.4%) tolerance and lactose absorption tests based on breath hydrogen and 252 (95.1%) respiratory tests after lactulose intake for detection of bacterial overgrowth in the proximal small bowel. Less than 10% of the target population submitted to anthropometric assessment did not do the stool test for detection of intestinal parasites and the lactose and lactulose breath hydrogen tests for operational reasons, since no exclusion criteria were established. If the child had episodes of acute diarrhea, was using antimicrobial medication or had no other infectious disease that might interfere with the respiratory test, the exam was performed at least one month after the child’s rehabilitation. The field work continued until March 1997. At the time of respiratory tests, the median age (25th and 75th percentiles between parentheses) of children was: 6 years and 8 months (4 years and 6 months; 9 years and 6 months) for lactose (n=251) and 6 years and 8 months (4 years and 4 months and 9 years and 1 month) for lactulose (n=252).

Methods

Anthropometric assessment

Weight and height measures for community studies were obtained as recommended by Jelliffe (1968)1. Two mechanical scales (Filizola) were used to measure weight: one for infants and the other one for older children. The children were weighed without their clothing. For height measurement, children up to the age of two years were kept on the supine position, and those older than two years were on the upright position. Two anthropometers were used. The children who were in the standing, upright position should keep their spinal column and legs straightened. Z scores and the weight-for-age, weight-for-height, and height-for-age ratios were calculated by EPI-Info version 6.2,15 taking into consideration the values of the National Center for Health Statistics (NCHS).16 The value of -2.0 standard deviations was used as cutoff point for malnutrition, based on Z scores, as recommended by the World Health Organization.17

The nutritional status of children aged less than 60 months was evaluated by Gomez classification system, which is based on the weight-for-age percentage.18 The birthdate was obtained from the birth certificate of each Indian child.


**Hydrogen breath testing**

Lactose and lactulose hydrogen breath tests were done in the morning, after an 8-12 hour fasting period. For breast-fed infants (n=29), the minimum fasting period was four hours.

**Lactose overload**

Each child was given a single 18-gram dose of lactose in aqueous solution at 10%. Breath samples were collected for determining hydrogen concentration immediately before (basal sample or fasting sample) and at 30, 60, 90 and 120 minutes after lactose administration. The test was interpreted according to the recommendations found in the literature, considering the increase in breath hydrogen concentration in any of the samples in relation to the basal value: adequate lactose absorption - increase less than 10 ppm (parts per million); suspected lactase deficiency - increase between 10 and 20 ppm; and lactase deficiency - increase higher than 20 ppm (parts per million). Lactose intolerance was characterized on the three subsequent days after the intake of 18 grams of lactose, when the child had one or more of the following symptoms: flatulence, abdominal pain and diarrhea.

These symptoms were assessed by one of the researchers by means of health monitors available from the community.

**Lactulose overload**

The lactulose breath test was used for the detection of excessive proliferation of bacteria in the proximal small bowel (bacterial overgrowth). In this case, five grams of lactulose in aqueous solution at 50% were administered after fasting breath hydrogen measurement. New samples were collected at 20, 40, 60, 90 and 120 minutes after the administration of lactulose. Excessive proliferation of bacteria in the proximal small bowel was characterized by a transient hydrogen peak with a minimum increase of 10 ppm in relation to the basal value, in samples collected at 20, 40 or 60 minutes. Based on the results of this test, children were classified as producers and nonproducers of hydrogen if they had an increase in hydrogen concentration greater than, less than or equal to 10 ppm in relation to the basal value, in any of the five samples collected after lactulose intake.

Breath samples were made with a one-way valve mask (Ambu®), connected to a 60-ml syringe using a three-way faucet. Hydrogen concentration was measured by a gas chromatograph (Quintron, model CM2). The equipment was calibrated before and during the analyses using a mixture of 100 ppm hydrogen and synthetic air as standard.

**Stool test**

Stool samples were collected and homogenized in plastic flasks containing merthiolate-iodine-formalin solution. For the stool test, Faust and Hoffman´s concentration techniques were used.

The statistical analysis included the Kruskal-Wallis test to compare the Z scores of the anthropometric data according to three age groups (0-11, 12-59 and 60-120 months).

This test was complemented by Dunn’s multiple comparison of means, which revealed statistically significant difference. The chi-square test was used to assess the association between qualitative variables. The calculations were made by SigmaStat program.

The research project was analyzed and officially approved by Brazil’s National Indian Foundation. A verbal consent was obtained after the explanation of the objectives of the field work. The present study was also analyzed and approved by the Ethics Committee of the Escola Paulista de Medicina, Universidade Federal de São Paulo.

**Results**

During the assessment period, the children did not show any symptoms associated with gastrointestinal involvement for at least 30 days. The initial assessment of results revealed that there was no difference between the studied variables as far as gender was concerned.

Table 1 shows the Z scores of weight for age, weight for height, and height for age according to the following age groups: those younger than 12 months, those between 12 and 60 months, and those between 60 and 120 months. Weight medians of weight for age and height were negative, indicating that the values of the assessed group are lower than those in the NCHS table. The weight for height median is positive; this means that the assessed group presents greater weight for a given height in relation to the reference table. By comparing the three age groups, we observed statistical difference in weight for age (lower in children aged between 12 and 60 when compared to children aged between 60 and 120 months). The height for age deficiency was greater in children aged between 12 and 60 months than in those aged between 60 and 120 months. No statistical difference was found by comparing the Z scores of gender (results not shown).

Table 2 shows the number of children regarded as malnourished (Z score lower than -2.0 standard deviations). There is greater weight for age and height deficiency among children between the ages of 12 and 60 months.

Table 3 shows the nutritional status of children aged less than 60 months, according to Gomez classification system.

Table 4 shows the lactose absorption capacity, assessed by the breath hydrogen test, of Indian children of the Terenas tribe according to age less than, greater than/equal to 4 years. Suspected malabsorption of lactose and inadequate lactose absorption occurred in respectively 54.8% and 34.5% of 197 children with age greater than or equal to 4 years. Lactose intolerance occurred in 73 (37.1%) of 197 children with age greater than or equal to 4 years.
Table 5 shows the relationship between lactose absorption capacity and lactose intolerance. Lactose intolerance occurred in 9 (8.3%) of 108 children with suspected lactose malabsorption and in 64 (94.1%) of 68 children with lactose malabsorption. Looking at Table 5, we observe that children with suspected malabsorption of lactose (n=108) and those with lactose malabsorption (n=68) (all of them older than 4 years, as shown in Table 4), the intolerance rate is statistically higher ($\chi^2=122.9; P<0.001$) among children with lactose malabsorption (64/68; 94.1%) than among children with suspected malabsorption of lactose (9/108; 8.3%).

The breath hydrogen test after the administration of lactulose showed that 29 (11.5%) of 252 children had bacterial overgrowth in the proximal small bowel, that is, an increase greater than 10 ppm in the breath hydrogen concentration when compared with the basal fasting sample. Bacterial overgrowth in children aged less than 4 years was 8.6% (5/58) and 12.4% (24/194) in children with age greater than or equal to 4 years. This difference was not statistically significant ($\chi^2 =0.303; P=0.58$).

The most commonly intestinal parasites detected by the stool test of 244 children were: *Giardia lamblia* in 74 (30.3%) children, *Hymenolepsis nana* in 26 (10.6%),...

Table 1 - Z scores (median and percentiles 25 and 75 between parenthesis) of weight for age, weight for height and height for age of Terenas children according to the age group

<table>
<thead>
<tr>
<th></th>
<th>0 — 12 m (n = 34)</th>
<th>12 — 60 m (n = 111)</th>
<th>60 — 120 m (n = 119)</th>
<th>P’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight-Age</td>
<td>-0.66 (-1.19 +0.63)</td>
<td>-0.50 (-1.27 +0.13)</td>
<td>-0.09 (-0.73 +0.45)</td>
<td>0.004*</td>
</tr>
<tr>
<td>Weight-Height</td>
<td>+0.60 (-0.42 +1.40)</td>
<td>+0.28 (-0.56 +0.92)</td>
<td>+0.50 (-0.12 +1.25)</td>
<td>0.096</td>
</tr>
<tr>
<td>Height-Age</td>
<td>-0.85 (-1.21 -0.55)</td>
<td>-1.17 (-2.05 -0.56)</td>
<td>-0.60 (-1.22 -0.23)</td>
<td>&lt; 0.001*</td>
</tr>
</tbody>
</table>

Dunn multiple comparison test

<table>
<thead>
<tr>
<th></th>
<th>Weight-Age</th>
<th>Height-Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 — 12</td>
<td>12 X 12 — 60: P &gt; 0.05</td>
<td>0 — 12 X 12 — 60: P &gt; 0.05</td>
</tr>
<tr>
<td>12 — 60</td>
<td>60 X 60 — 120: P &lt; 0.05</td>
<td>12 — 60 X 60 — 120: P &lt; 0.05</td>
</tr>
<tr>
<td>0 — 12</td>
<td>12 X 60 — 120: P &gt; 0.05</td>
<td>0 — 12 X 60 — 120: P &gt; 0.05</td>
</tr>
</tbody>
</table>

† Kruskal-Wallis test * statistically significant

Table 2 - Number and percentage of Terenas children with deficit of weight for age, weight for height, and height for age according to Z scores (<-2.0 standard deviations) and age group

<table>
<thead>
<tr>
<th></th>
<th>0 — 12 (n=34)</th>
<th>12 — 60 (n=111)</th>
<th>60 — 120 (n=119)</th>
<th>Total (n=264)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight-Age</td>
<td>0 (0.0%)</td>
<td>8 (7.2%)</td>
<td>1 (0.8%)</td>
<td>9 (3.4%)</td>
<td>0.015*</td>
</tr>
<tr>
<td>Weight-Height</td>
<td>1 (2.9%)</td>
<td>1 (0.9%)</td>
<td>2 (1.7%)</td>
<td>4 (1.5%)</td>
<td>0.682</td>
</tr>
<tr>
<td>Height-Age</td>
<td>1 (2.9%)</td>
<td>29 (26.1%)</td>
<td>7 (5.9%)</td>
<td>37 (14.0%)</td>
<td>0.000*</td>
</tr>
</tbody>
</table>

Chi-square distribution:

<table>
<thead>
<tr>
<th></th>
<th>Weight-Age</th>
<th>Height-Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 — 120 X 0 — 12 and 60 — 120</td>
<td>12 and 60 — 120</td>
<td></td>
</tr>
<tr>
<td>60 — 120 X 12 and 60 — 120</td>
<td>12 and 60 — 120</td>
<td></td>
</tr>
</tbody>
</table>

* statistically significant
Necator americanus in 10 (3.3%), Strongyloides stercoralis in 8 (3.3%), Ascaris lumbricoides in 4 (1.6%) and Taenia sp in 1 (0.4%).

Discussion

With the description of Z scores and the adoption of the NCHS (National Center for Health Statistics) table as international reference in 1977,21 the World Health Organization has validated such choice16,17 and has recommended the use of -2.0 standard deviations as cutoff point, below which we have inadequate weight for age, weight for height, and height for age ratios. In Table 1, we observe that the medians of the Z score of weight for age and height for age are negative and, for that reason, they indicate that the distribution of these variables present a leftward deviation while the weight for height is skewed rightward. The global deficit ratio (<-2.0 standard deviations) was 3.4% for weight for age, 1.5% for weight for height, and 14.9% for height for age. As far as Brazilian Indians are concerned, these data are similar to those obtained in 1992 in Alto Xingu with Indian children in the same age group.5 In this case, inadequate height for age was present in 19.8% of the children, whereas no child presented inadequate weight for height. With regard to Indian children from Alto Xingu, there was low prevalence of acute malnutrition in the 1970's3,4 according to the age-independent anthropometric criteria that had to be used, since the precise age of those children was not known at that time. Taking the NCHS table into consideration, other Indian groups in Brazil,6,7 Latin America22 and North America23 have the same anthropometric pattern, showing higher prevalence of inadequate height for age than weight for height. The prevalence of malnutrition among children aged less than 5 years was 40.0%, according to Gomez classification system; 37.2% of these children presented first-degree malnutrition. Gomez classification system was used with the aim of comparing the results of the present study with those previously obtained in our country, whether or not there was inadequate height for age ratio.24 Therefore, in Brazil, the prevalence of malnutrition in Terenas children, using the same Gomez classification system, was similar to that observed in children in the same age group, living in rural regions of Brazil, with similar lifestyle of Terenas children.24

Table 3 - Nutritional status of Terenas children according to Gomez classification system

<table>
<thead>
<tr>
<th>Age group</th>
<th>No PCM*</th>
<th>PCM I</th>
<th>PCM II</th>
<th>PCM III</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0  12 m</td>
<td>19 (55.9%)</td>
<td>14 (41.2%)</td>
<td>1 (2.9%)</td>
<td>0 (0.0%)</td>
<td>34</td>
</tr>
<tr>
<td>12  60 m</td>
<td>68 (61.3%)</td>
<td>40 (36.0%)</td>
<td>3 (2.7%)</td>
<td>0 (0.0%)</td>
<td>111</td>
</tr>
<tr>
<td>Total</td>
<td>87 (60%)</td>
<td>54 (37.2%)</td>
<td>4 (2.8%)</td>
<td>0 (0.0%)</td>
<td>145</td>
</tr>
</tbody>
</table>

* PCM = protein-caloric malnutrition
Without possibility of statistical analysis

Table 4 - Lactose absorption capacity, assessed by breath hydrogen test of Indian children of the Terenas tribe according to age

<table>
<thead>
<tr>
<th>Age group</th>
<th>Tolerance (n=178)</th>
<th>Intolerance (n=73)</th>
<th>Total (n=251)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good absorption</td>
<td>75 (42.1%)</td>
<td>0 (0.0%)</td>
<td>75 (29.9%)</td>
</tr>
<tr>
<td>Suspected malabsorption</td>
<td>99 (55.6%)</td>
<td>9 (12.3%)</td>
<td>108 (43.0%)</td>
</tr>
<tr>
<td>Malabsorption</td>
<td>4 (2.3%)</td>
<td>64 (87.7%)</td>
<td>68 (27.1%)</td>
</tr>
</tbody>
</table>

Environmental factors may influence the expression of genetic potential of growth. In this sense, tropical enteropathy may be an aggravating factor of growth in children who live in poor health conditions. Tropical enteropathy may potentially hinder the diet, which is usually inadequate in terms of quantity and quality in these communities. The analysis of small-bowel bacterial overgrowth by breath hydrogen test after the intake of 10 grams of lactulose was recently carried out in a study conducted in the interior of the state of São Paulo.11 The study included children from the rural and urban areas, in addition to children living in slums. The lactulose breath test was positive in 6 (30.0%) of 20 children who lived in slums, and in none of the 63 children who did not live in slums; the difference was statistically significant. Among Terenas children, small-bowel bacterial overgrowth, according to the breath test after the intake of 5 grams of lactulose, occurred in 11.5%
of the 252 studied children. The 5-gram single dose of lactulose was chosen to facilitate field work and to reduce the possible risk of side effects during the test, which could compromise the completion of the field work, conducted in a closed community.

Theoretically, due to the administration of a 5-gram dose of lactulose, these data might be underestimated when compared to the values obtained by Reis et al.11 This result may be considered an indicative sign of asymptomatic tropical enteropathy in Terenas children, reflecting the unfavorable conditions of their environment. Another aspect that indicates unfavorable environmental conditions is the high prevalence of asymptomatic giardiasis, found in 30.3% of the studied children. Ascariasis and whipworm infection are not frequent in this community.

In Brazil, symptomatic tropical enteropathy was first described in 1980 in children aged less than 4 years who suffered from chronic diarrhea. One of the functional abnormalities included secondary malabsorption of lactose, found in 50% of the patients.12,25

On the other hand, there is some information that in Brazil and in other countries as well, the ontogenetic deficiency of lactase is quite common. Lactase deficiency causes primary malabsorption of lactose in children older than 4 years, adolescents and adults.8-11 The statistical analysis of small-bowel bacterial overgrowth in Terenas children aged less than 4 years (8.6%), age group without lactose malabsorption, was similar to that of children older than 4 years (12.4%). After the age of 4 years, there was lactose malabsorption in 89.3% of Terenas children. Lactose intolerance and lactose malabsorption (94.1%) were more frequent among children who were older than 4 years than among those with suspected malabsorption (8.3%). In this case, there was some statistically significant difference.

These data are compatible with previous studies based on the blood glucose curve carried out in our country.8-10 The hydrogen breath test is considered the most precise indirect method for the assessment of lactose absorption. The only article published in Brazil that used this technique reflects the bowel’s absorptive capacity. However, because of the overload, the dose does not accurately reflect the possible intolerance to the habitual intake of milk which, theoretically, may be better assessed when the dose is closer to the physiological one, similar to the dose used in the present study and in that study conducted in the interior of the state of São Paulo.11 With regard to the field work, the selection of a fixed dose of lactose and lactulose was crucial, allowing us to dispense with the individual measurements of carbohydrate and water levels for the preparation of the solutions used in the hydrogen breath tests.

We conclude that Terenas children do not have current malnutrition; on the other hand, their height for age distribution is skewed leftward if we compare it to the values shown in the NCHS table. These results are similar to those found in other indigenous groups from Latin America and North America. The prevalence of ontogenetic lactase deficiency in Terenas children serves as an example for other population groups of our country. Some of the children show evidence of asymptomatic tropical enteropathy, which may be an indicative sign that environmental conditions where this community lives have to be improved.

References


15. Dean AG. Epi-Info version 5.1: a word processor, database and statistics program for epidemiology on micro-computers. Georgia, Center for Disease Control; 1990.


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