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LACTOSE INTOLERANCE AMONG INFANTS AGED 3 TO 6 MONTHS IN ADJENGRE, SOTOUBOUA 2 MUNICIPALITY NORTHERN TOGO)

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ABSTRACT

Background: Lactose intolerance in infants is frequently suspected in clinical practice, yet epidemiological data remain limited in sub-Saharan Africa, particularly in Togo. Misinterpretation of digestive symptoms may lead to inappropriate milk restriction, with potential adverse nutritional consequences. **Objective:** This study aimed to assess lactose digestive tolerance among infants in the the Sotouboua 2 Municipality (Togo) through the combined analysis of fecal biochemical parameters, clinical signs, and infant feeding practices. **Methods:** A cross-sectional descriptive and analytical study was conducted among infants. Fecal pH and reducing sugar levels were measured, while digestive clinical signs and type of feeding were collected through caregiver interviews. Multivariate analyses were performed to explore relationships between biological, clinical, and anthropometric parameters. **Results:** The majority of infants (74.42%) exhibited parameters consistent with normal lactose digestion, despite biological variability without clinical expression. A proportion of 9.30% fell within a suspected lactose intolerance category, while 16.28% showed profiles compatible with probable or confirmed lactose intolerance. Exclusive breastfeeding was associated with better digestive tolerance and milder symptoms, whereas mixed feeding was more frequently associated with digestive disturbances. Most abnormalities reflected transient phenomena related to enzymatic immaturity rather than chronic intolerance. **Conclusion:** These findings highlight the importance of an integrated diagnostic approach to improve infant nutritional management and to prevent unnecessary milk restriction in the Togolese context.

KEYWORDS: Lactose intolerance; Infant; Breastfeeding; Fecal parameters; Togo.

INTRODUCTION

Lactose intolerance (LI) is a common digestive disorder in the global population, resulting from lactose malabsorption due to a deficiency of the enzyme lactase. This deficiency causes symptoms such as diarrhoea, bloating, abdominal pain and flatulence after ingesting foods containing lactose. There are three types of lactose intolerance: primary intolerance, linked to the genetic non-persistence of lactase; secondary intolerance, resulting from damage to the intestinal mucosa (particularly during gastroenteritis); and the rare congenital form, observed from birth. In infants aged 3 to 6 months, congenital forms are exceptional; most cases of LI observed at this age are secondary, usually resulting from digestive infections or malnutrition, which temporarily alter the brush border of enterocytes and reduce lactase activity (Heyman, 2006; Heine et al., 2017).

In infants, breast milk is the main source of lactose, accounting for up to 7% of its composition. Exclusive breastfeeding (EBF) during the first six months of life is recommended by the WHO and UNICEF to promote growth, strengthen immunity and reduce infectious morbidity (WHO, 2017; American Academy of Paediatrics, 2022; WHO, 2025). In Togo, the results of

the Multiple Indicator Cluster Survey (MICS-6, 2017) indicate that approximately 64% of children aged 0 to 6 months are exclusively breastfed, which reflects significant progress (INSEED/UNFPA/UNICEF, 2029). However, disparities persist across regions and socio-economic conditions; in rural areas such as the Prefecture of Sotouboua (Central Region), episodes of diarrhoea remain frequent and can compromise lactose tolerance and continued breastfeeding (Kimani-Murage et al., 2011).

In this context, identifying lactose intolerance in infants aged 3 to 6 months is of major clinical and nutritional importance. In the absence of a precise differential diagnosis, many children with non-specific digestive symptoms (diarrhoea, colic, bloating) are referred to so-called 'lactose-free' infant formulas or elimination diets, at the risk of prematurely interrupting breastfeeding. However, at this age, primary intolerance is unlikely and digestive symptoms are often secondary to reversible enteric infections. Furthermore, the frequent confusion between LI and cow's milk protein allergy (CMPA) complicates management (Darma et al., 2024), although the two conditions are based on different pathophysiological mechanisms: the former results from an enzyme deficiency, the latter from an immunological reaction (Heine et al., 2017; Vandenplas et al., 2024).

In the municipality of Sotouboua 2 (Adjengré), characterised by a high proportion of households practising non-exclusive breastfeeding and limited access to biological diagnosis (hydrogen breath test, stool pH or faecal glucose measurement), clinical recognition of IL is based primarily on empirical observation of symptoms. This empirical approach, although practical, may lead to overdiagnosis and inappropriate use of industrial milk, resulting in high economic costs and destabilisation of infant feeding patterns. It is therefore crucial to better document the actual prevalence of lactose intolerance in infants aged 3 to 6 months in this rural context and to identify its determinants.

The proposed study aims to assess the prevalence of lactose intolerance among infants aged 3 to 6 months in Adjengré (Sotouboua 2 municipality) in the Prefecture of Sotouboua, analyse the associated factors and contribute to better clinical guidance between LI and CMPA. The results should make it possible to improve the management of digestive disorders in infants, limit unjustified interruptions in breastfeeding, and strengthen the capacity of health facilities to adopt a rational approach adapted to the local context.

MATERIAL AND METHODS

1. Type, Setting, and Period of the Study

This was a descriptive and analytical cross-sectional study conducted in the municipality of Sotouboua 2 in Adjengré, located in the Central Region of Togo. Data collection was carried out between May and October 2025 at the Adjengré Medical and Social Centre (CMS).

The choice of Adjengré, located in the Prefecture of Sotouboua, was justified for several epidemiological, socio-nutritional and logistical reasons. Adjengré is a rural area with a high density of mothers and children, where the majority of households live off subsistence farming and have modest sanitary and nutritional conditions. Data from the Sotouboua Health District indicate a high incidence of diarrhoeal and digestive disorders in children, particularly in infants under six months of age, often linked to suboptimal feeding practices (early introduction of foods).

Furthermore, this locality does not have advanced diagnostic infrastructure, making it a relevant site for assessing the feasibility of a simplified clinical and biochemical approach to screening for lactose intolerance in a resource-limited setting. Adjengré is therefore a representative model of rural Togo, where the determinants of child health are strongly influenced by dietary practices, hygiene conditions and access to primary care. Furthermore, the proximity of community health facilities and the availability of local health personnel facilitated the mobilisation of mothers and the collection of samples in ethical and safe conditions, reinforcing the practical validity of the study.

2. Study Population

2.1. Inclusion Criteria

The study included all children aged 3 to 6 months, of both sexes, who were seen at the Adjengré Medical and Social Centre (CMS) in the municipality of Sotouboua 2, with or without digestive symptoms suggestive of lactose intolerance (chronic or recurrent diarrhoea, bloating, abdominal pain, flatulence, persistent colic) and accompanied by their consenting mothers or legal guardians.

2.2. Exclusion Criteria

The following were excluded:

- infants with a known digestive disorder of other origin (intestinal malformation, confirmed allergy to cow's milk protein, suspected coeliac disease, etc.) ;
- children undergoing antibiotic or antiparasitic treatment in the seven days prior to the survey;
- mothers who refused to participate or were unable to provide reliable information.

2.3. Sample Size and Sampling Method

The sample size was not determined using a statistical formula, as the study adopted exhaustive sampling. All infants aged 3 to 6 months residing in Adjengré (Sotouboua 2 commune) and meeting the inclusion criteria were recruited during the survey period. This approach made it possible to cover the entire available target population, ensuring that the results were representative of this locality.

This method was chosen because of the limited size of the population concerned and the desire to obtain comprehensive and accurate data on the prevalence and

characteristics of lactose intolerance in this rural setting. Children were included as they presented at the CMS, until all cases recorded during the study period had been reached.

3. Data Collected

Data were collected using a structured questionnaire administered to mothers/guardians and a clinical examination form completed by a trained health worker.

3.1. Socio-Demographic Variables

- age of the infant;
- feeding method (exclusive or non-exclusive breastfeeding, mixed feeding, formula milk);
- history of diarrhoea, intestinal infections, or recent treatments.

3.2. Clinical Variables

The main signs investigated were: stool frequency and consistency, bloating, colic, vomiting, fever, weight loss and signs of dehydration. Persistent diarrhoea was defined as liquid stools ≥ 3 times a day for more than 14 days (WHO, 2021).

3.3. Additional Tests

Fresh stool samples (approximately 5 g) were collected in sterile containers for measurement of faecal pH and faecal reducing sugars (lactose levels) (Costa et al., 2024).

3.3.1. Measurement of Faecal pH

Faecal pH was measured using a pH meter. One gram (1 g) of stool was diluted in 10 mL of distilled water and then centrifuged at 4000 rpm for 10 minutes. The collected supernatant was used to determine the pH using a PSD1 pH meter (range 0.0–14.0) with an accuracy of ±1% operating on direct current. A pH < 5.5 was considered indicative of excessive lactose fermentation (Heyman, 2006).

3.3.2. Determination of Reducing Sugars

The measurement of faecal reducing sugars was performed using the 3,5-dinitrosalicylic acid (DNS) colorimetric method, after prior deproteinisation with trichloroacetic acid (TCA), in order to improve the accuracy of the quantification of reducing sugars in stool samples.

Sample Preparation and Deproteinisation

One gram (1 g) of fresh stool was collected using a sterile spatula and homogenised in 10 mL of distilled water to obtain a 10% (w/v) faecal suspension. The suspension was left to stand for 10 minutes, then centrifuged at 3000 rpm for 10 minutes.

The supernatant obtained was then subjected to deproteinisation by adding 10% (m/v) TCA, at a ratio of 1 volume of TCA to 4 volumes of supernatant. The mixture was homogenised and then left to stand for 10 minutes at room temperature to allow complete protein precipitation. A second centrifugation was carried out under the same conditions, and the clear deproteinised supernatant was recovered for analysis.

Principle and Analytical Procedure

In a test tube, 1 mL of the deproteinised supernatant was mixed with 1 mL of DNS reagent, then homogenised. The reaction mixture was heated in a boiling water bath for 5 minutes, then left to cool to room temperature. After cooling, 10 mL of distilled water was added to dilute and stabilise the developed colour. The mixture was then homogenised and left to stand for 15 minutes before spectrophotometric reading to allow complete stabilisation of the colour resulting from the reduction of DNS to aminonitrosalicylic acid. This phase was necessary to ensure stable and reproducible absorbance, limiting variations related to reaction kinetics and temperature effects.

Standard Range and Spectrophotometric Reading

A standard range between 0.02 and 0.20 g/L was prepared from a 2 g/L lactose stock solution and treated under the same conditions as the samples. The optical density (OD) was measured at 540 nm using a UV-visible spectrophotometer, against a blank prepared with 1 mL of distilled water instead of the sample.

The concentrations obtained from the standard curve were expressed in g/L, then converted to g/100 g of stool (%), taking into account the mass of stool initially collected.

These tests were carried out on site immediately after sampling at the Adjengré CMS (30 minutes to 2 hours after sampling), in accordance with standard procedures (AFNOR/WHO, 2022) in order to avoid post-emission biochemical transformations and increase the reliability of the results.

3.4. Clinical Identification of Lactose Intolerance

Lactose intolerance has been defined by the combination of at least two of the following criteria (Maffei & Paula, 1979):

- Recurrent digestive symptoms after ingesting milk or milk formula;
- Faecal pH < 5.5;
- Presence of reducing sugars in stools at a rate ≥ 0.5%.

Cases of cow's milk protein allergy (CMPA) were ruled out based on the absence of skin (eczema, urticaria) and respiratory symptoms, and improvement with hydrolysed milk.

3.5. Data Analysis

The data were entered using Microsoft Excel 2019 spreadsheet software and then cleaned to remove duplicates and any errors. Statistical analyses were performed using R software (version 4.4.3). Quantitative variables were described by the mean ± standard error of the mean (SEM), while qualitative variables were

expressed as proportions, calculated based on the total sample size (N = 43). Principal component analyses (PCA) were performed to explore the relationships between clinical, nutritional and biological variables. The significance threshold was set at $p < 0.05$. Finally, Pearson correlations between clinical, nutritional and biological variables were examined to identify factors potentially associated with lactose intolerance, with a significance level of 5%.

4. Ethical Considerations

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki (World Medical Association, 2013).

Authorisation was obtained from the Bioethics Committee for Health Research (CBRS) of the Togo Ministry of Health under number 011/2024/CBRS.

Free and informed consent was obtained verbally and in writing from mothers or guardians prior to inclusion. Anonymity and confidentiality of data were guaranteed throughout the research.

RESULTS

1. Faecal Biochemical and Clinical Indicators of Lactose Malabsorption in Infants

1.1. Hydrogen Potential (pH)

The results presented in Table 1 show that the majority of infants (67.44%) have a faecal pH above 5.5, indicating normal digestive function and no lactose malabsorption. However, 11.63% of children had a pH between 5 and 5.5, which is considered abnormal and may suggest partial or transient lactose maldigestion. Furthermore, 20.93% of infants have a pH strictly below 5, which is a strong indicator of lactose fermentation and, consequently, a very suggestive argument for lactose intolerance. This significant proportion highlights the existence of a subgroup of children requiring further clinical evaluation.

Table 1. Faecal pH Values and Clinical Interpretation of Suspected Lactose Intolerance in Infants.

pH classes	Number	Proportion (%)	Interpretation
pH < 5	9	20.93	Highly suggestive of intolerance
pH [5 ; 5.5]	5	11.63	Abnormal / suggests lactose malabsorption
pH > 5.5	29	67.44	Normal

1.2. Reducing Sugar (SR) Content

The results presented in Table 2 show that nearly half of the infants studied (44.19%) have a reducing sugar content of less than 0.25%, indicating overall normal lactose digestion. However, 23.25% of infants had values between 0.25% and 0.50%, suggesting mild or transient lactose malabsorption, possibly related to functional factors or immaturity of the digestive system. Furthermore, a significant proportion of infants (32.56%) have concentrations above 0.50%, a threshold generally considered indicative of significant lactose malabsorption. This relatively high frequency highlights a notable prevalence of probable lactose intolerance in the study population, warranting special attention during the clinical and nutritional assessment of the infants concerned.

Table 2: Fecal Reducing Sugar Content and Clinical Interpretation of Suspected Lactose Intolerance in Infants.

Classification according to [SR]	Number	Proportion (%)	Interpretation
SR < 0.25%	19	44.19	Normal
SR [0.25% ; 0.50%]	10	23.25	erately elevated or possible transient malabsorption
SR > 0.50%	14	32.56	cant lactose malabsorption (probable intolerance)

Note: SR refers to reducing sugars.

1.3. Clinical Signs Observed and/or Reported

Analysis of the results presented in Table 3 shows that the majority of infants (65.11%) do not exhibit any symptoms suggestive of lactose intolerance, indicating overall satisfactory digestive tolerance. However, 11.63% of infants mainly present with gas, corresponding to moderate symptoms that may reflect simple digestive sensitivity rather than true malabsorption. Finally, 23.26% of infants present more severe and characteristic clinical signs, such as vomiting, bloating or diarrhoea, suggestive of lactose intolerance or significant digestive malabsorption, which warrants special clinical attention.

Table 3: Clinical Signs Suggestive of Suspected Lactose Intolerance in Infants.

Clinical signs	Number	Proportion (%)	Interpretation
No signs	28	65.11	No suggestive signs
Gas	5	11.63	Moderate signs
Vomiting	5	11.63	Severe and typical clinical signs
Bloating, diarrhoea	5	11.63	Severe and typical clinical signs

2. Types of breastfeeding

The majority of infants in the study (67.44%) are exclusively breastfed, while 32.56% already receive complementary foods. This distribution suggests that the majority of the population studied is breastfed. Conversely, 32.56% of infants were receiving complementary foods despite being under six months of age (Table 4).

Table 4: Distribution of Infants According to Type of Breastfeeding.

Types of breastfeeding	Number of children	Proportion (%)
Exclusive (AME)	29	67.44
No Exclusive (AMNE)	14	32.56

Notes : EBF = Exclusive Breastfeeding ; **AMNE** = No-Exclusive Breastfeeding

3. Variation in the Age and Weight of the Infants Considered

The age of the infants in this study ranged from 3.00 to 5.50 months, with a median of 3.50 months and a mean of 3.80 ± 0.30 months, indicating a relatively homogeneous population. In terms of weight, the values range from 3.70 to 6.60 kg, with a median of 4.60 kg and an average of 4.80 ± 0.31 kg. These values correspond to the current weight of the infants and are consistent with measurements taken between 3 and 6 months, a period when weight gain is particularly rapid. This profile therefore reflects a population with an overall satisfactory weight status for this age (Table 5).

Table 5: Age and Weight Distribution of Infants Included in the Study.

Variables	Minimum	Maximum	Median	Mean ± SEM
Age (months)	3.00	5.50	3.50	3.80 ± 0.30
Weight (kg)	3.70	6.60	4.60	4.80 ± 0.31

4. Correlations Between Vectors (pH, SR, Weight and Age of Children), Type of Breastfeeding and Clinical Signs in Infants

4.1. Relationships Between Vectors, pH, Reducing Sugar (RS) Content, Weight and Age of Infants

A strong positive correlation was observed between age and weight, with their vectors being very close and oriented in the same direction. Conversely, the reducing sugar content shows a negative correlation with age and mass, as its vector is oriented in the opposite direction. An increase in the mass and age of infants is therefore linked to a decrease in the reducing sugar content. On the other hand, the pH is almost orthogonal to these three vectors, suggesting that there is no significant correlation between pH and these variables.

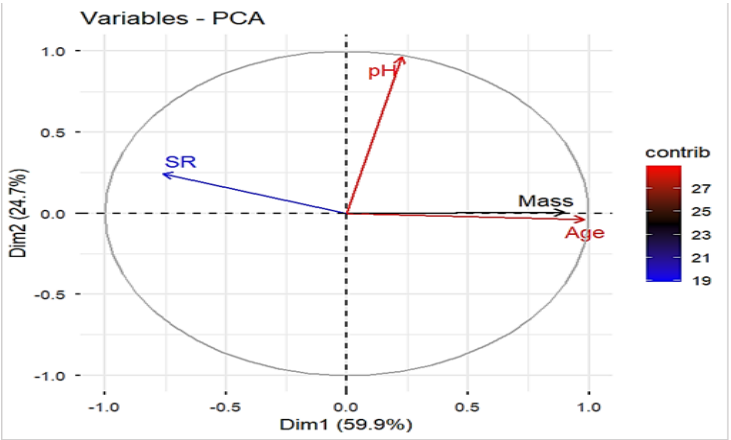

Figure 2: Correlations Between pH, Reducing Sugar Levels, Weight and Age of the Infants Studied.
Note: SR refers to reducing sugars.

4.2. Correlation Between Vectors (pH, Reducing Sugar Content, Weight and Age of Infants) and Type of Breastfeeding

Examination of the biplot (Figure 3) reveals a clear distinction between the two breastfeeding groups (exclusive and non-exclusive). Infants who are exclusively breastfed are mainly grouped in the negative part of axis 1 (Dim1) with the reducing sugar rate and opposite to the vectors, age and weight of the infants. The exclusive breastfeeding group is therefore characterised by higher reducing sugar rates and lower age and weight. Conversely, children who are not exclusively breastfed are mainly located in the positive part of axis 1 with the vectors, age and weight of infants, suggesting that non-exclusive breastfeeding is mainly associated with older and heavier individuals in this study population.

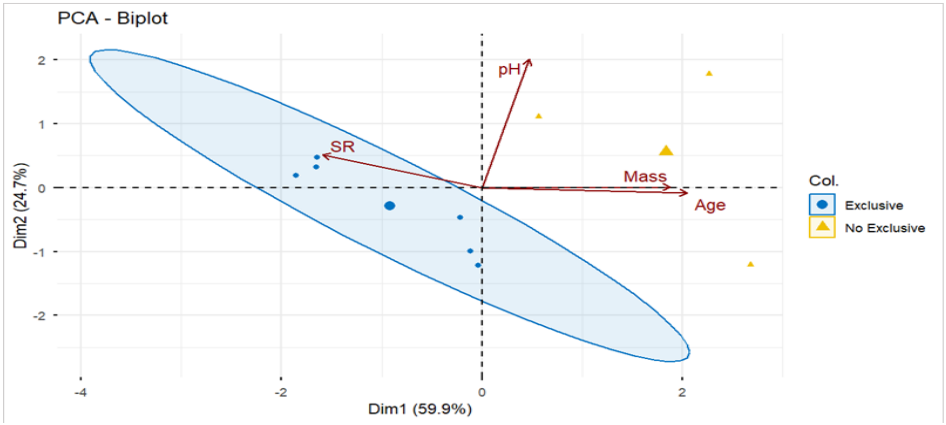

Figure 3: Relationships Between Vectors (pH, SR, Mass and Age of Infants) and Type of Breastfeeding.
Note: SR refers to reducing sugars.

4.3. Correlations Between Vectors (pH, SR, Mass and Age of Infants) and Clinical Signs

Biplot analysis (Figure 4) reveals a consistent pattern of clinical signs based on pH, SR, mass and age vectors. The absence of clinical signs (None) defines a specific profile in the youngest and lightest subjects, characterised by high SR scores and acidic pH. This profile is consistent with moderate lactose malabsorption. On the other hand, vomiting is clearly associated with individuals with high age and mass values, suggesting that this profile is characteristic of older and heavier infants. Finally, mild digestive symptoms (bloating, gas) fall within an intermediate range, as they are not strictly linked to the extremes of the factors measured. This means that they are not strictly determined by extreme values for age, weight or pH. These symptoms occur in individuals whose characteristics are around the average for these factors.

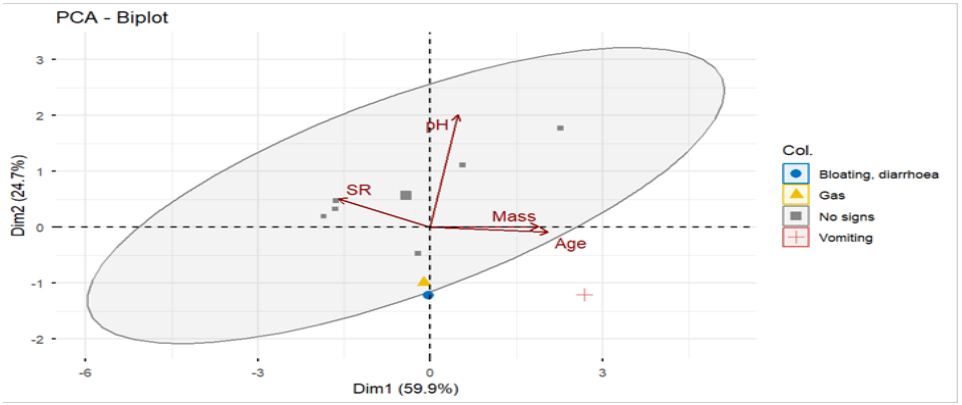

Figure 4. Correlation Between Vectors (pH, SR, Mass and Age of Children) and Clinical Signs.
Note: SR refers to reducing sugars.

4.4. Pearson Correlation Between Stool Mass, Stool pH, Reducing Sugar Content and Children's Ages

Analysis of Pearson's correlation matrix (Table 5) reveals a strong, highly significant positive correlation between age and body mass in children (r = 0.907***), confirming that body mass increases proportionally with age. These two variables also show a moderate and significant negative correlation with the reducing sugar content (r = -0.678 and r = -0.438, respectively), indicating a decrease in reducing sugar content in older and heavier children. On the other hand, pH is considered independent of the other variables, showing low correlation coefficients with mass (r = 0.147), reducing sugar content (r = -0.028) and age (r = 0.167).

Table 5: Pearson Correlation Matrix Between Children's Weight, Stool pH, Reducing Sugar Content and Age.

Parameters considered	Mass	pH	SR	Age
Mass	1	0.147	-0.438*	0.907***
pH	0.147	1	-0.028	0.167
SR	-0.438*	-0.028	1	-0.678*
Age	0.907***	0.167	-0.678*	1

Note: SR refers to reducing sugars.

5. Clinical and Biological Profile of Lactose Intolerance in the Infants Studied

Table 6 shows that the majority of infants (74.42%) have parameters compatible with normal lactose digestion, despite biological variability with no clinical significance. However, 9.30% are in a suspected intolerance zone, combining acidic faecal pH, moderate elevation of reducing sugars and digestive symptoms. Finally, 16.28% have a profile consistent with proven lactose intolerance, characterised by marked faecal acidification, abnormalities in reducing sugars and suggestive clinical signs. These results highlight the value of an integrated approach combining biological indicators and clinical manifestations to refine the diagnosis in infants.

Table 6: Clinical and Biological Profile of Lactose Intolerance in Children.

Intolerance category	Indicators for screening for lactose intolerance	Number of infants (%)
Infants without significant signs of lactose intolerance, **32 (74.42 %)**	- SR< 0.25% - pH >5.5 - Absence of clinical signs	10 (23.25)
	- SR > 0.5% - pH > 5.5 - Absence of clinical signs	17 (39.54)
	- SR [0.25% ; 0.50%] - pH >5.5 - Absence of clinical signs	5 (11.63)
Infants with suspected lactose intolerance	- SR [0.25% ; 0.50%] - pH < 5 - Presence of clinical signs (bloating, diarrhoea)	4 (9.30)
Infants with probable lactose intolerance, **7 (16.28 %)**	- SR< 0.25% - pH < 5 - Presence of clinical signs (vomiting)	5 (11.63)
	- SR< 0.25% - pH [5 ; 5.5] - Presence of clinical signs (gas)	2 (4.65)

DISCUSSION

1. Faecal and Clinical Biochemical Indicators of Lactose Malabsorption in Infants

1.1. Faecal Hydrogen Potential (pH)

The results of this study show that approximately one-fifth of infants have a faecal pH below 5, indicating increased colonic fermentation of undigested lactose (Macfarlane & Gibson, 1994). This biochemical profile is classically associated with lactose malabsorption, as reported by Heyman (2006) and Vesa et al. (2000), who consider stool acidification to be an indirect but relevant marker of colonic fermentation activity. However, these authors also emphasise the non-specific nature of this parameter, which must be interpreted in light of the clinical (Shafi & Husain, 2022) and nutritional context. Erickson et al. (2020) confirm that faecal pH, taken in isolation, does not allow a conclusion of proven intolerance to be drawn, particularly in infants whose intestinal enzyme maturity remains physiologically incomplete (Heine et al., 2017).

1.2. Faecal Reducing Sugars

In line with these observations, nearly one-third of infants have reducing sugar concentrations above 0.50%, indicating incomplete lactose hydrolysis. This association between elevated reducing sugars and faecal acidification is frequently described as suggestive of lactose malabsorption (Heyman, 2006; Erickson et al., 2020). However, the variability observed between infants reflects the influence of several factors, including the amount of lactose ingested, the fermentative capacity of the microbiota, and the degree of maturity of intestinal lactase (Misselwitz et al., 2013). Heine et al. (2017) point out that these biochemical abnormalities are most often transient, particularly after digestive infections, and do not necessarily indicate chronic intolerance.

1.3. Clinical Signs

Clinically, the majority of infants do not present with marked digestive symptoms, a finding consistent with the epidemiological data reported by Nancey et al. (2013). When symptoms are observed, they mainly manifest as bloating, diarrhoea and gas, which are the functional signs most frequently associated with excessive colonic fermentation (Mion et al., 2014). These manifestations, which are generally dose-dependent, are most often transient (Nancey et al., 2013). The presence of vomiting, which is rarer, may, however, indicate a more significant digestive disorder, as pointed out by Misselwitz et al. (2019). All of these factors highlight the need for a joint interpretation of biological and clinical parameters.

2. Influence of Breastfeeding Type on Lactose Digestive Tolerance

In this context, the type of feeding appears to be a major

determinant of digestive tolerance. Exclusive breastfeeding promotes intestinal enzyme maturation and optimal lactose digestion, in particular through the stimulation of bifidogenic microbiota by oligosaccharides in breast milk (Rakotomanana et al., 2024). Emile et al. (2024) show that continuing breastfeeding for up to six months is associated with better growth and a reduction in functional digestive disorders. Conversely, non-exclusive breastfeeding or the early introduction of complementary foods exposes infants to greater enzymatic variability and an increased risk of malabsorption, as observed by Banti et al. (2016). Heine et al. (2017) specify that exposure to non-hydrolysed lactose contained in certain milk formulas may increase colonic fermentation. These data confirm the protective role of exclusive breastfeeding against early digestive disorders.

3. Relationships Between Biological, Clinical and Anthropometric Parameters

3.1. Multivariate Analysis and Correlations

Principal component analysis highlights structural relationships between age, body mass, faecal parameters and type of breastfeeding. The positive correlation between age and mass reflects normal physiological growth (WHO, 2008), while the negative correlation between these variables and the reducing sugar content reflects a gradual improvement in lactose digestion as the intestine matures. These results are consistent with those of Victora (2016) and Michaelsen (2017), who show that exclusive breastfeeding, which is more common in young infants, is associated with better carbohydrate metabolism.

Furthermore, the negative correlation between reducing sugar levels and weight/age suggests a gradual decrease in malabsorption with advancing age, a phenomenon already described by Agostoni (2010) in relation to the stabilisation of intestinal pH and the evolution of the microbiota. Digestive symptoms, particularly diarrhoea and bloating, are preferentially grouped with high levels of reducing sugars, confirming their link with enzymatic immaturity (Black et al., 2013). In African contexts, Gruénais and Pourtier (2000) reported that these dynamics are strongly influenced by dietary practices.

3.2. P rofiles According to Breastfeeding Type and Symptoms

Cross-analysis shows that exclusively breastfed infants, who are younger and have a lower body weight, have a more acidic faecal pH and higher reducing sugar levels, reflecting physiological lactic fermentation rather than pathology. Vandenplas et al. (2015) and Benninga et al. (2016) indicate that this profile may be accompanied by colic or moderate diarrhoea without major clinical repercussions. In contrast, older infants, who are often not exclusively breastfed, present a more diverse range of symptoms, including vomiting, linked to digestive adaptations induced by dietary diversification (Cascales et al., 201; Panza et al., 2021). These results illustrate a progressive dynamic of digestive maturation.

4. Clinical and Biological Profile of Lactose Intolerance in Infants

The majority of infants studied have sufficient lactase activity to ensure lactose hydrolysis, which corresponds to a normal physiological situation at this age (Germain, 2025). Indeed, true lactose intolerance remains rare before the age of five, with most cases being transient or secondary (Heyman, 2006). Erickson et al. (2020) caution against interpretations based exclusively on faecal markers in the absence of clinical correlation.

The pathophysiology is based on the arrival of undigested lactose in the colon, where it is fermented by the microbiota, producing gases and short-chain fatty acids responsible for digestive symptoms and faecal acidification (Montalto et al., 2006; Windey et al., 2015; Darma et al., 2024). Forms associated with very acidic pH, high reducing sugar levels and severe symptoms, particularly vomiting, require increased vigilance, as they may reflect hypolactasia secondary to more severe enteropathy (Vesa et al., 2000; Misselwitz et al., 2013). In these situations, a rigorous diagnosis is essential in order to avoid unjustified milk restrictions, which may increase the risk of malnutrition (Black et al., 2013; Heine et al., 2017).

The results as a whole show that lactose digestion in infants is part of a physiological continuum closely linked to intestinal enzyme maturation, type of feeding and age (Szilagyi, 2015). The biochemical abnormalities observed in faeces, particularly acidification and elevated levels of reducing sugars, most often reflect physiological lactic fermentation or transient malabsorption rather than proven intolerance (Darma et al., 2024). Digestive symptoms appear to be modulated by these parameters, with generally moderate manifestations in exclusively breastfed infants and more variable manifestations in non- exclusive breastfeeding or dietary diversification.

These results highlight the major benefit of an integrated approach combining biological parameters, clinical signs and nutritional data to refine the diagnosis of lactose intolerance in infants. Such an approach makes it possible to identify situations requiring increased monitoring while avoiding unjustified restrictive dietary measures, thus contributing to appropriate and safe nutritional management.

CONCLUSION

This study provides original and contextual data on lactose digestion in infants in an environment where scientific information remains limited, particularly in the Sotouboua prefecture of Togo. By integrating faecal biochemical indicators, clinical manifestations and breastfeeding practices, the results show that the majority of infants have physiological lactose tolerance. The anomalies observed are mainly transient

phenomena linked to intestinal enzyme immaturity and feeding practices, rather than proven intolerance.

From a public health perspective, these results are of major importance, as they help to prevent unjustified milk restrictions that could compromise nutritional intake during a critical period of growth. In this sense, this study is fully in line with Sustainable Development Goal 2 (SDG 2), which aims to eliminate hunger and all forms of malnutrition by providing scientific evidence to promote appropriate and safe feeding practices for infants. Furthermore, highlighting the protective role of exclusive breastfeeding supports national and international strategies to promote breastfeeding, which are essential for improving infant nutrition.

With regard to Sustainable Development Goal 3 (SDG 3), relating to good health and well- being, this study highlights the value of an integrated diagnostic approach, combining clinical signs and simple biological indicators, accessible to peripheral healthcare facilities. Such an approach can improve the quality of care for infant digestive disorders, enhance nutritional advice to families and reduce the risk of preventable nutritional complications.

These findings help to fill a knowledge gap in sub-Saharan Africa and provide a relevant scientific basis for the development of nutrition policies adapted to the local context. They call for the strengthening of infant nutrition programmes, the training of health workers and the integration of appropriate diagnostic tools into maternal and child health strategies, thereby contributing to the sustainable achievement of SDGs 2 and 3 in Togo and in comparable contexts.

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