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Original Article

Clinical Assessment and Demographic Insights of Lactose Intolerance Among Diarrheal Children at Hyderabad, Pakistan

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ABSTRACT

Lactose intolerance is common among diarrheal children due to compromised gut health. Diarrhea can damage the intestinal lining, reducing lactase enzyme production responsible for lactose digestion. Consequently, lactose, a sugar found in dairy products, remains undigested, leading to abdominal discomfort, bloating, and increased bowel movements. **Objective:** To assess the clinical characteristics of Lactose intolerance (LI) as well as its relationship with demographic factors among diarrheal children below five years of age. **Methods:** A cross sectional study was conducted enrolling 50 diarrheal patients in equal proportion by gender. The present study was conducted over children suffering from profuse diarrhea admitted to the Pediatrics ward at LUMHS and CIVIL hospital Hyderabad, Pakistan during July 2018 to January 2019. The questionnaire-based analysis was conducted to gather information regarding dietary index and manifestation of symptoms after milk consumption. Clinical analysis was performed using lactose tolerance test, Stool pH and reducing substance respectively. The obtained results were analyzed using SPSS. **Results:** 20 children were found to be suffering from lactose intolerance. The clinical symptoms observed among individuals affected by LI included loose motion, weight loss, abdominal distention, and the presence of pus cells in stool indicating the signs of infection. T-test showed statistical significance (p-value < 0.05) over physical attributes such as height and number of pus cells among LI patients as compared to lactose tolerant (LT) patients. The finding of pus cells in the stool simultaneous to the strong statistical correlation between relieve in symptoms with increasing age also affirmed the existence of secondary type hypo-lactasia. The study also highlighted the demographic aspects contributing to the prevalence of the condition. **Conclusions:** Secondary lactose intolerance was found with shortened heights of patients and increased number of pus cells in stool.

INTRODUCTION

Lactose intolerance is a condition characterized by the impairment to digest lactose either due to the complete absence of an intestinal brush border enzyme "lactase" or because of its very low secretion that might occur due to damage to the intestinal membrane by an infection [1]. Upon ingestion the sugar gets absorbed in the jejunum and ileum while getting hydrolyzed into its respective monomeric units (i.e., glucose and galactose) by a "β-lactase phlorizin – hydrolase", also commonly referred to as Lactase [2]. The deficiency of Lactase leads to malabsorption resulting in diarrhea, vomiting, abdominal distention, flatulence, abdominal pain, and other clinical symptoms, the condition is known as lactose intolerance [3]. The undigested lactose enters the colon and get catabolized by intestinal flora by bowel movements producing lactic acid, short-chain fatty acids (SCFA's) and hydrogen gas etc. as by-products. The catabolized lactic acid and short-chain fatty acid eventually lead to diarrhea if the respective load of lactose exceeds the capacity of the colonic micro-biota for fermentation which alters the intestinal pH of stool making it more acidic (PH < 5.5) [4]. Based on the early onset of symptoms, lactose intolerance can be divided into two major types, such as primary and secondary lactose intolerance. Primary lactose tolerance

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(commonly known as adult lactose intolerance) is characterized as a condition where the patients present normal lactose expression after birth, which gradually declines during growing up. On the other hand, secondary lactose intolerance may develop in a person with a healthy small intestine during episodes of acute illness causing mucosal damage or from medications resulting from certain gastrointestinal disease. This type of lactose intolerance can occur in both infants and adults and is generally reversible [5]. A number of methods have been reported to assess the degree of lactose intolerance such as the hydrogen breath test, the milk tolerance test, and diet elimination protocol reducing sugar and stool pH detection test [6-8].

The present study was designed to evaluate the clinical characteristics present among children affected with lactose intolerance (i.e., signs of infection, comparative glucose levels, onset and severity of symptoms) along with demographic factors (i-e. daily wages, monthly incomes, availability to clean water and waste management).

METHODS

This study was conducted on children presenting with profuse diarrhea admitted to the Pediatrics ward at Liaquat University of Medical & Health Sciences (LUMHS) and CIVIL hospital Hyderabad, Pakistan during July 2018 to January 2019. It was a descriptive cross-sectional study comprising of 50 children under five years of age. We used probability sampling method that involved simple random sampling technique to collect samples randomly from 25 male and 25 female children admitted at Hyderabad hospitals. The low sample size (N=50) is due to selection of extreme age group as we wanted to evaluate the prevalence of LI in newborns and infants up to 5 years of age only. The sample size was calculated by using Dobson's formula: N = Z2 1- /2 P(1-P)/ d2 where N is the sample size, Z is the level of confidence (kept at 95% confidence interval), P is expected prevalence (~15%) (taking average of secondary type LI prevalence from the various previous worldwide findings) and d is precision or error rate (10%). The value of n was calculated as 48.98 or ~ 49. Children suffering from any organic disease (chicken pox, measles etc.) were excluded from the study. We also excluded children already taking lactose free diet from our study so as to avoid bias in results of the study. The study was designed based on the data obtained in the form of a questionnaire along with the clinical samples collected over the period of time. The study was conducted with the ethical approval of the ethical committee on 15-10-2018 at the Institute of Biochemistry, University of Sindh (Jamshoro) with a reference number IOB/125/2018. The patients were categorized into two groups Lactose tolerant (LT) and Lactose Intolerant (LI). In both groups the patients suffered from mild to severe diarrhea, however, the patients classified in LI group showed recurrence of symptoms after diet elimination protocol and lactose tolerance test. On the contrary, the patients in the LT group showed no such outcome. For lactose tolerance test, patients were allowed to ingest 500 mL approx. of lactose-containing milk followed by the measurement of their blood glucose levels prior to and later to the ingestion [9]. The blood was drawn from the capillaries and capillary blood glucose levels were measured by using Accu-chek® glucometer at the baseline of 30'and 60' minutes. Two sampled t-test was used to evaluate the statistical significance among LT and LI groups following lactose ingestion, where p-value < 0.05, was considered significant. Subsequently, the stool-reducing substance was performed with fresh stool samples taken in plastic containers. The samples were then diluted with distilled water in (1:2) proportion; out of which, 15 drops of the suspension were added into a sterile test tube. In addition, 5-6 mL of Benedict solution was poured into the suspension and the mixture was kept in a warm water bath to observe the apparent color change [10]. Likewise, stool acidity was assessed, based on measuring the stool pH from the freshly obtained stool samples. If excess lactose is fermented in the intestine by intestinal flora, a number of products including lactic acid are produced; turning stool acidic [11]. The diet elimination protocol commonly incurs the elimination of lactose-containing products (i.e. milk, yogurt etc.) from the daily diet of the patients and the severity of the symptoms was observed over time. Later, the lactose-containing diet was reintroduced and the patients were closely monitored for the symptoms. The test was supplemented with a lactose tolerance test for better assessment of the condition [12]. Statistical analysis was carried out by using box plot analysis via IBM SPSS® version 23.0 to assess the significant relationship among different varying parameters including mass, length, gender, and amount of pus cells (present in stool) in both groups. P-value < 0.05, obtained for each parameter, was considered significant. In demographic analysis, frequency and percentages were calculated for variables like age, residence, monthly income, consanguinity, and Marriage.

RESULTS

Fifty diarrheal children were evaluated for lactose tolerance status by a lactose tolerance test, fecal reducing substance, stool acidity and diet elimination protocol. The lactose tolerance test showed an insignificant increase in the level of glucose among 20 patients while presenting a substantial increase in the remaining subset of the population (Table 1). Thereby, the patients affected with LI had a very minor or no change at all in their blood glucose levels. The results were further analyzed by two-sampled t-

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test and the p-values obtained among LI and LT patients after 30 and 60 minutes. The glycemic index (glucose levels) showed significant correlation between two groups LI and LT after the intake of milk in comparison to baseline. This showed that glycemic index can be accounted as a reliable parameter in the assessment of lactose intolerance.

Table 1: Comparative analysis of blood glucose levels prior (baseline) and after the ingestion of lactose at different time intervals between LI and LT group.

Variables	LT (Lactose at different time intervals)	LI (Lactose intolerant)	p – value
	Mean ± SD	Mean ± SD	
Baseline	96.5 ± 16.3	92.9 ± 12.4	0.33
30 minutes	139.8 ± 26.2	105.8 ± 15.84	0.000017
60 minutes	134.8 ± 35.4	101.4 ± 12.24	0.00005

Presence of reducing sugar in stool was tested to categorize patients in two groups i-e lactose tolerant and lactose intolerant. Based on the test results, out of 50 patients, 17 patients were diagnosed as lactose intolerant. However, 03 patients showed negative results despite of the persistent symptoms of LI (Figure 1).

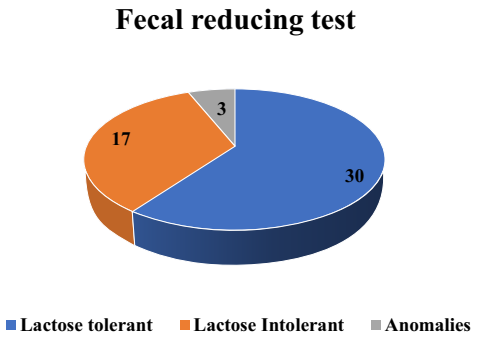

Figure 1: Prevalence of lactose intolerance on basis of fecal reducing substance.

Upon measurement of the stool pH of fifty patients, we found that the ones confirmed as lactose intolerant had a slightly acidic pH (5.5 - 5.9) compared to the lactose tolerant (7.0 – 7.5) patients. Moreover, in our assessment, the most prevalent symptoms observed in the LI case included Loose motion (L/M) with mucus, weight loss, vomiting and abdominal distention. The statistical analysis indicated a significant relationship between the LI condition and the height (L) and the number of pus cells (pc) found in the stool of the affected LI patients in comparison to lactose tolerant patients (Figures 2a-c). The obtained p-values were 0.03, 0.08, and 0.01 for height, body mass and the number of pus cells, respectively.

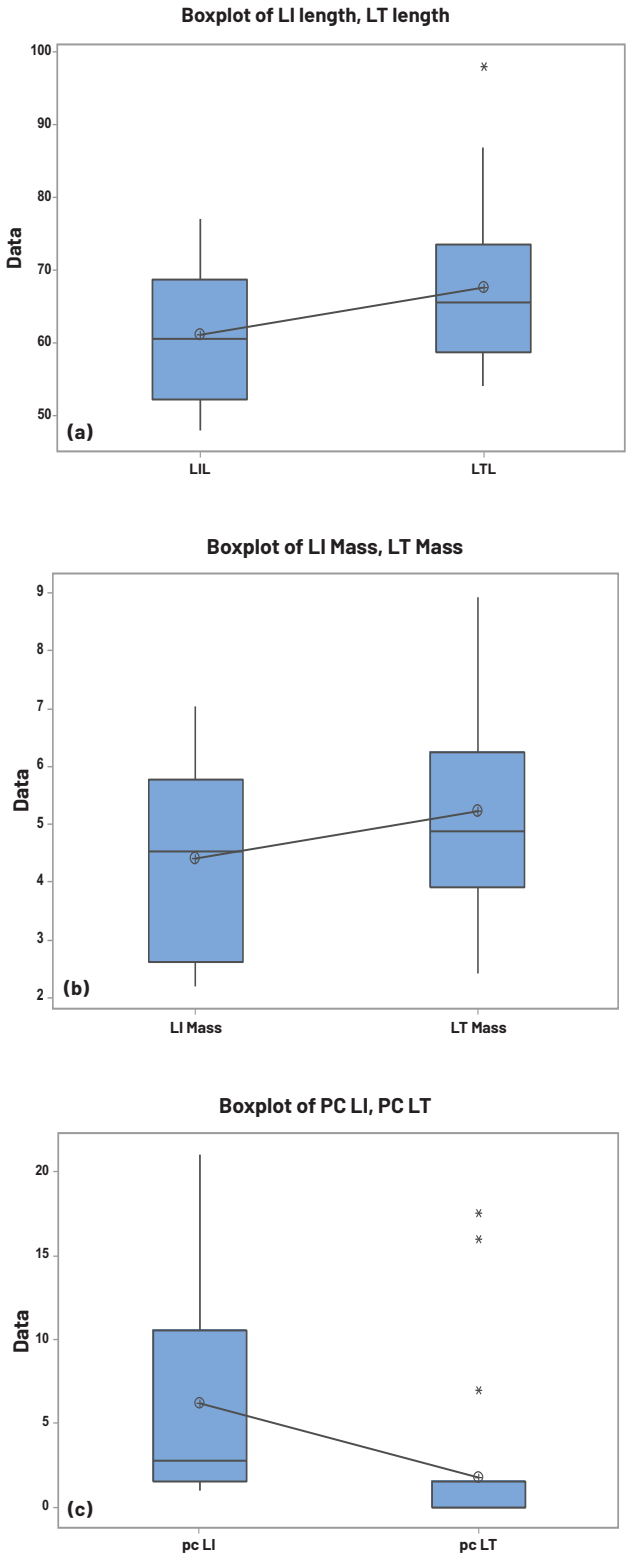

Figure 2: Statistical significance of physiological parameters

2a: Length, 2b: Mass and 2c: Presence of pus cells among LI and LT patients, respectively. p-value < 0.05 was considered as significant.

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Present study also highlighted the socio-economic status of the patient's families, as it has a direct relationship with standards of living as shown in demographic assessment (Table 2).

Table 2: Demographic characteristics of lactose tolerant and lactose intolerant groups.

Demographic Characteristics	Lactose Tolerant Group N (%)	Lactose Intolerant Group N (%)
Age Groups (months)		
01-10	10 (33%)	12 (60%)
11-20	11 (37%)	7 (35%)
21-30	4 (13%)	1 (5%)
31-40	01 (03%)	-
41-50	3 (10%)	-
51-60	1 (3.3%)	-
Residence		
Hyderabad	16 (53.3%)	9 (45%)
Others	14 (46.7%)	11 (55%)
Consanguinity Marriage		
Yes	20 (66.6%)	15 (75%)
No	10 (33.3%)	5 (25%)
Monthly Income (PKR)		
1000 – 10000	12 (40%)	6 (30%)
11000 – 20000	5 (23.3%)	8 (40%)
21000 – above	3 (10%)	2 (10%)
Drinking Quality Water and Proper Waste Disposal		
Not responded	8 (26.6%)	4 (20%)
Adequate Quality	02 (6.6%)	4 (20%)
Low Quality	28 (93.3%)	16 (80%)

DISCUSSION

The ability of lactase to convert lactose into glucose and galactose accounts for the increment of glucose levels; however, in the case of lactose intolerance, the enzyme deficiency causes an insignificant production of glucose [13, 14]. Thereby, table 1 showed that the patients affected with LI had a very minor or no change at all in their blood glucose levels. Fecal reducing substance (FRS) is a simple and non-specific method used for the detection of reducing sugars (mono and disaccharides) [10, 15]. On basis of fecal reducing test 17 patients were categorized as lactose intolerant. However, three samples characterized as false negatives (Fig.1) which can possibly be due to delayed collection causing bacterial growth and degradation of the respective sugars [16]. Considering, the limited credibility of the test it shall always be accompanied by secondary assessment such as including Stool pH, Lactose tolerance test, or H2 Breath test [7]. The acidic stool PH was noted for most of the lactose intolerant patients the reason for which lies in the absence or inability of lactase to metabolize lactose into its respective constituents. As per the literature, the severity of symptoms was also influenced by the degree of lactase deficiency and the dosage of lactose given to a patient [17, 18]. In the absence or deficiency of lactase, unabsorbed lactose caused an influx of fluid into the bowel lumen, due to osmotic pressure which served as the main cause of diarrhea. Correspondingly, the unabsorbed lactose entering the colon was used by the intestinal bacteria as their substrate producing gas as a by-product which caused symptoms such as flatulence, abdominal distention and vomiting amongst lactose intolerant individuals [19, 20]. In addition, the study proposes a correlation between the severities of lactose intolerance with respect to increasing age. Interestingly, the condition was predominant in neonates and the symptoms tend to alleviate with increasing age. Thus, providing a general perspective towards the type of the condition (i.e., secondary type) among the enrolled patients. However, contradictory to literature insignificant relationship was seen in the case of body masses (M) of two groups (Figure 2b). This might be due to the small sample size or preliminary stage of the condition. Table 2 shows the demographic assessment and reveals that most of the families were found to belong to a lower class with an income of 3000 to 8000 rupees per month, depriving them of necessities of living including clean water and electricity. In addition to their financial instability, the majority of the families didn't had access to clean water and the proper waste disposal system was also compromised. This led to the consumption of tap/ground water (a leading cause of various water-borne diseases including rotavirus and other infections) while only a few families have had access to filtered water.

CONCLUSIONS

The current study aimed to understand the clinical and demographic attributes among patients suffering from hypo-lactasia. The common symptoms included vomiting, abdominal distension, loose motion, and weight loss accompanied by the release of mucus in the stool of LI patients. The children suffering from such intolerance had shortened height and may present an increased number of pus cells in stool. In addition, the low socioeconomic status along with the unavailability of necessities of life had a direct relationship to the widespread of common infections which may lead to secondary hypo-lactasia. The symptoms of the condition were greatly alleviated by switching to lactose free diet.

Authors Contribution

Conceptualization: MY, BK
Methodology: MY, BK
Formal analysis: MY, MJC, FUK
Writing-review and editing: BK, MJC, AHM

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All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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