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Original Article

Lactose malabsorption based on breath hydrogen test in children with recurrent abdominal pain

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ABSTRACT

Background Recurrent abdominal pain (RAP) is common among school-age children. Previous studies found that lactose malabsorption has an important role in RAP in children. Up to date, data on the prevalence of lactose malabsorption in children with RAP in Indonesia has not been available.

Objective To elicit the prevalence of RAP and lactose malabsorption in children with RAP, and to determine associated foods that cause RAP in children with and without lactose malabsorption, the frequency of lactose intolerance during breath hydrogen test (BHT), and also the onset and duration of the symptoms after a lactose load.

Methods This was a cross-sectional study conducted on junior high school students who suffered from recurrent abdominal pain.

Results Of 1054 students screened, 157 (14.9%) fulfilled the Apley's criteria for RAP. Of 157, 85 children were enrolled and underwent BHT. Fifty five of them (65%) were girls. Lactose malabsorption was found in 68 (80%) subjects. Milk and yogurt were the most frequent products that cause symptoms of RAP in our subjects who mostly (80%) were malabsorber. Lactose intolerance during BHT was found in 69 (81%) children. Symptoms appeared in 30 minutes after lactose ingestion, and the most frequent symptom was abdominal pain (44%). Lactose intolerance symptoms disappeared in about 15 hours.

Conclusions The prevalence of RAP in children aged 12-14 years was 14.9%. The prevalence of lactose malabsorption in children with RAP was 80%. Milk and yogurt were the most frequent products that cause symptoms of RAP in our subjects who mostly were malabsorbers. The frequency of lactose intolerance during BHT was 81%, and the symptoms lasted within approximately 15 hours **[Paediatr Indones 2004;44:215-222].**

Keywords: *lactose malabsorption, recurrent abdominal pain, breath hydrogen test, schoolage children*

Recurrent abdominal pain (RAP) is a common problem affecting 10–15% of school-age children.[1-6] Children with RAP often have problems that affect their daily activities and prompt them to seek medical attention.[7-8] Of the children with RAP, 10–15% will have organic diseases, while the remaining will be considered to have functional disorders. However, with the advances of technology and medical science, more organic disorders have been documented in children with RAP. Therefore, the percentage of children with RAP who have no definable cause for their symptoms is rapidly dwindling.[3,5,9] Lactose malabsorption is one of the causative or contributing factors of RAP that occurs in 20% of children up to 5 years old.[10]

Lactose is the primary carbohydrate of milk produced by the mammary gland. Lactose comprises approximately 4% of cow's milk and 7% of breast milk.[11-13] Lactose malabsorption is the inability of small intestine to digest lactose due to lack of lactase enzyme. When an individual does not produce enough lactase to break down lactose into glucose and galactose, the lactose passes into the colon where the bacteria ferment the lactose into short fatty acids (butyrate, propionate, acetate) and gases. Osmotic imbalance creates diarrhea and the gases cause

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bloating, flatulence, borborygmi, and abdominal pain, which occur in a few minutes until 2 hours after lactose ingestion.

Breath hydrogen test (BHT) is the procedure of choice for determining the presence of lactose malabsorption.[9-10] Studies of lactose malabsorption as a contributing factor for RAP in children have been done in many countries and the results varied, depending on race.[14-22] In Indonesia, the prevalence of lactose malabsorption in children was increasing in accordance with age,[23-27] but so far there has been no study on the prevalence of lactose malabsorption in children with RAP in Indonesia. This study was designed to determine the prevalence of RAP, the prevalence of lactose malabsorption by BHT in children with RAP aged 12–14 years, associated foods causing RAP in children with or without lactose malabsorption, the frequency of lactose intolerance during BHT, and the onset time and duration of the symptoms after a lactose load.

Methods

This was a cross-sectional study on students of junior high school, namely SLTPN 216 Jakarta, in December 2003. Students aged 12-14 years who met Apley's criteria for recurrent abdominal pain i.e., three or more discrete episodes of pain occurring after consuming milk or other dairy products that severe enough to affect daily activities over a period of at least three months,[28] were enrolled in this study. All patients were evaluated by one of the authors. Students were excluded if they were undernourished; suffered from any illness that affected BHT such as pneumonia or diarrhea; consumed medications such as antibiotics, metoclopramide, acetyl salicylate, and laxatives; had suspected organic causes that have one or more of the RAP alarm symptoms; or refused to participate in this study. The study was already approved by the Ethics Committee of Medical School, University of Indonesia. Informed consent was obtained prior to the study.

The nutritional status was determined by body weight (BW) and body height (BH) in accordance to NCHS growth chart. The interpretation of nutritional status was based on BW according to BH.[29]

The alarm symptoms of RAP clued organic causes that should be recognized i.e.,[30-31] localization of the pain away from the umbilicus; pain associated with change in bowel habits, particularly diarrhea, constipation; pain awakening the child at night; repetitive emesis especially if bilious; constitutional symptoms, such as recurrent fever, loss of appetite or energy, loss of weight, organomegaly, localized abdominal terderness, bloody diarrhea, menstrual pain, perirectal anomalies (eg fissures, ulceration), joint swelling, redness or heat.

Lactose breath hydrogen test was used to determine lactose malabsorption in a non-invasive manner.[32-39] After an overnight fast (minimally 6 hours), breath samples were collected using a portable LCD 4 digit Lactometer version 1.0 CvO-HLMT (Hoek Loos, Netherlands) at 0, 30, 60, 90, and 120 minutes after ingestion of lactose (2 g/kg body weight: maximum 50g) given as 20% aqueous solution. Breath sample was taken twice, and the interpretation was made based on the highest result. Lactose malabsorption was defined as an increase in hydrogen concentration up to 10–19 ppm above the fasting average baseline value with any symptom of lactose intolerance, an increase to greater than 20 ppm above the fasting average baseline value at 60, 90, and 120 minutes.[38-39]

All students undergoing breath hydrogen test were given a symptom-response sheet to record any symptom occurring within 24 hours after lactose ingestion, such as abdominal pain, nausea, vomiting, bloating, borborygmi, flatulence, and diarrhea. The symptom sheet was returned on the next day. Data collected from the completely filled questionnaires were processed using SPSS 11.0 computer program.

Results

Recurrent abdominal pain

Of 1054 students of SLTPN 216 Jakarta, aged 12-14 years, 157 (14.9%) students suffered from RAP consisting of 105 female and 52 male (ratio 2:1). The suspected organic causes of RAP were found in 59 students. Food-related RAP symptoms were found in 98 students. Out of these 98 students, 13 students refused to join this study **(Figure 1).**

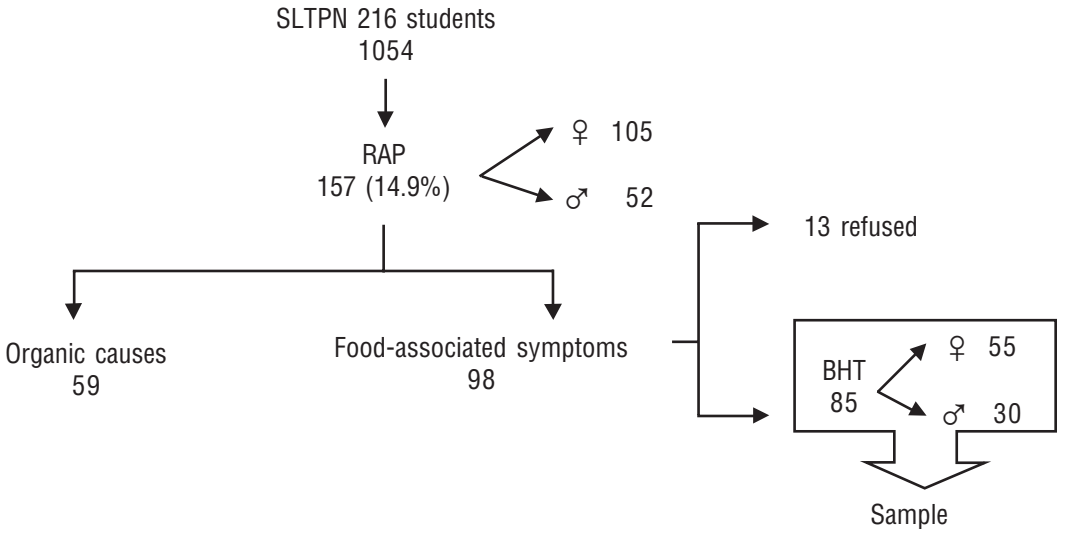


FIGURE 1. FLOWCHART OF PARTICIPANTS

Lactose malabsorption

BHT was performed in 85 students eligible for this study, 55 were female. Lactose malabsorption was detected in 68 (80%) students. More details of the subjects' characteristics can be seen in **Table 1**.

TABLE 1. CHARACTERISTICS OF SUBJECTS

Sex / Age (years)	Male	Female	Total
12	15	28	43 (50 %)
13	6	14	20 (23 %)
14	9	13	22 (25 %)
Total	30 (35%)	55 (65%)	85 (100 %)

Table 2 reveals the result of BHT in 85 students. Sixty-three out of eighty-five students (74%) showed breath hydrogen concentration of greater than 20 ppm and 5/85 (6%) students had a rise of 10-19 ppm accompanied by lactose intolerance symptoms. Four subjects had a rise greater than 20 ppm at 30 minutes (early peak).

TABLE 2. BREATH HYDROGEN CONCENTRATION

BH concentration (ppm)	n	Criteria	%
<10	17	Normal	20
10-19, symptoms –	0	Normal	0
10-19, symptoms +	5	Malabsorber	6
≥20	63	Malabsorber	74
Total	85		100

As elicited from history, dairy products mostly found as the cause of RAP in this study were milk and yogurt, followed by ice cream, chocolate, cheese, milk/chocolate candies, and biscuit. Most of the subjects who had history of food-associated RAP symptoms were malabsorber (**Table 3**).

TABLE 3. BREATH HYDROGEN CONCENTRATION AND RELATION TO FOOD-ASSOCIATED RAP SYMPTOM

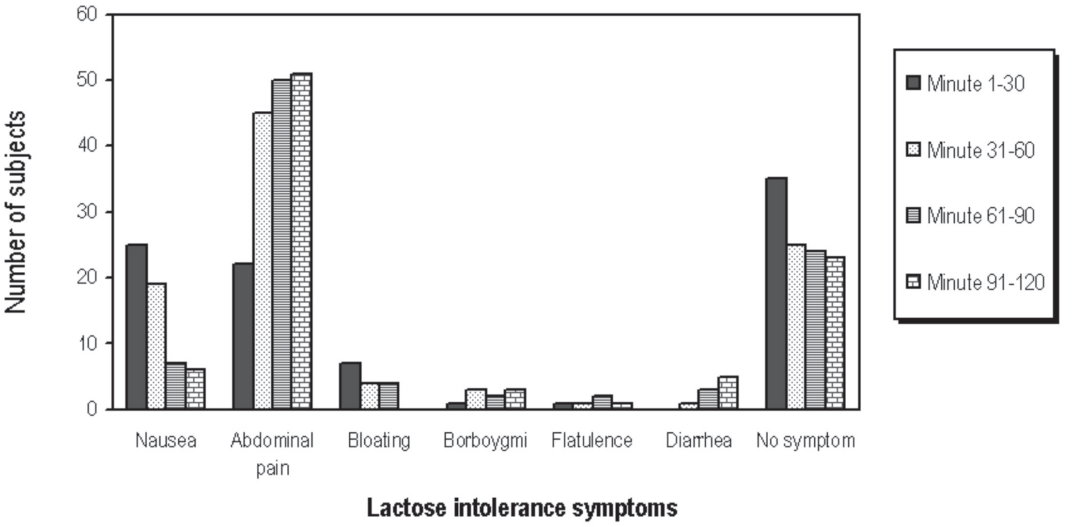
Dairy products*	Breath hydrogen concentration (ppm)		
	≥20	10-19, symptoms +	<10
Yogurt	23	4	7
Milk	25	0	9
Ice cream	15	1	4
Chocolate	11	0	1
Cheese	10	0	1
Milk/chocolate candy	8	0	2
Biscuit	4	0	0

* Dairy products suggested to cause of RAP as elicited from history

TABLE 4. BREATH HYDROGEN CONCENTRATION BASED ON LACTOSE INTOLERANCE SYMPTOMS*

Lactose intolerance symptoms	BH concentration (ppm)		
	≥20	10–19 (symptom +)	<10
Abdominal pain	50	5	4
Nausea	27	2	2
Bloating	8	0	1
Diarrhea	8	0	0
Borborygmi	7	0	0
Flatulence	4	1	0
Vomiting	0	0	0
No symptom	3	0	13

* 1 student could have more than one symptoms



* 1 student could have more than one symptom

FIGURE 1. FOOD-RELATED SYMPTOMS OF RAP IN CHILDREN WITH OR WITHOUT LACTOSE MALABSORPTION

Lactose intolerance

Lactose intolerance during BHT was found in 69 children (81%). The most frequent symptom was abdominal pain (in 56 children), followed by nausea, bloating, diarrhea, borborygmi, and flatulence. Many symptoms had already started at 30 minutes after lactose ingestion, especially nausea, bloating, and abdominal pain (**Figure 1**).

Table 4 shows that lactose intolerance occurred in 4 children with breath hydrogen concentration of <10 ppm. The symptoms were relatively mild and disappeared in 7 hours. Eight subjects with breath hydrogen concentration between 10-19 ppm had lactose intolerance, and most of them had abdominal pain. The symptoms of lactose intolerance were found frequently in children with increased breath hydrogen concentration up to ≥20 ppm, such as abdominal pain, nausea, bloating, and borborygmi. There are 2 children who had no symptoms at all until 24 hours of follow up.

Duration of lactose intolerance after lactose load

A follow-up after the lactose load was carried out and lactose intolerance symptoms disappeared in about 15 hours. Only 2 children still had the symptoms until 36 hours after lactose ingestion (**Figure 2**).

Discussion

In this study, of 1054 students of SLTPN 216 Jakarta, 157 (14.9%) had RAP based on the Apley's criteria. This was similar to a study conducted by Apley in 1958 which found that 10-15% of children aged 4-16 years had RAP. In a study of 1000 schoolage children, Apley found that RAP affects males and females equally up to 9 years of age. Between the age of 9 and 12 years, the incidence in female increases and the female-to-male ratio was 1.5:1.[40] The overall incidence appears to peak at the age of 10-12 years.

The etiology of RAP could be organic or non organic abnormalities.[30,31] The possible organic cause in this study was overlooked by the alarm symptoms which pointed to an organic cause. There was neither additional laboratory nor radiology examination in this study such as stool analysis and culture, urine culture, ultrasound of genitourinary tract, and endoscopy of GI tract. The possible organic cause in this study was found in 59 children (38.3%) i.e., epigastric pain and menstrual pain. Apley[40] in his study found only 10-15% organic causes in RAP, but Van der Meer[31] in 1993 found 42% of children had organic causes among 106 RAP children aged more than 5 years. The difference between those studies maybe due to the advance of medical science and technology that results in significant revisions in the proportion of

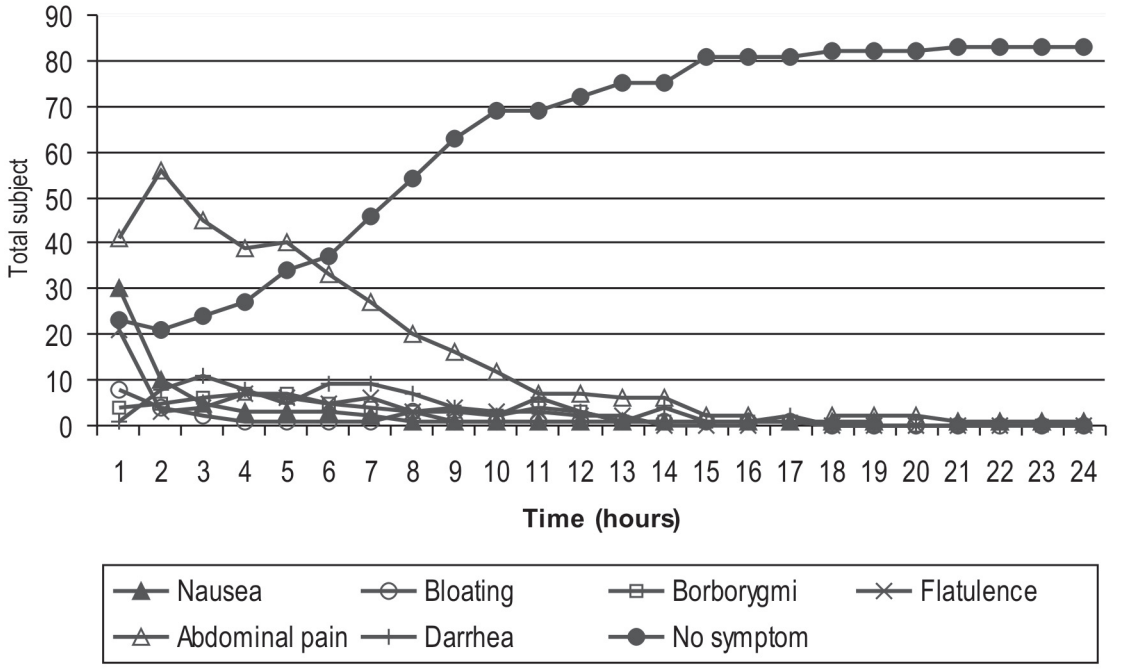


FIGURE 2. DURATION OF LACTOSE INTOLERANCE SYMPTOMS IN 85 STUDENTS

children found to have organic diseases.[22,31] It was supported by Quak *et al* that also found 52.8% organic diseases, such as gastritis, duodenitis, oesophagitis, and peptic ulcerations.[22]

The prevalence of lactose malabsorption in children with RAP aged 12-14 years in this study was 80% (**Table 2**). Webster *et al* (1995)[4] and Gremse *et al* (1999)[3] in USA found lactose malabsorption in 24% and 34%, respectively, of children with RAP aged 5-18 years. In Singapore, Quak *et al*[22] found 62.3%, while in Indonesia Sofia *et al* (2002)[27] found 73% in children aged 12-14 years.

The difference between our findings and the prevalence found in USA was probably due to racial differences (Asian and Caucasian). Our results seemed to be similar to Sofia's study which was applied to the similar age group. The higher prevalence in this study was probably related to the methods i.e., the samples of this study were children with known RAP, while Sofia's study was conducted on healthy children who had no complaint. Epidemiologically, Asian population had higher prevalence of lactose malabsorption (90-100%).[12,14]

Four children in this study experienced more-than-20-ppm breath hydrogen concentration within the first 30 minutes after lactose ingestion. This was probably due to overgrowth of bacteria; bacteria which are supposed to live in colon were overflowed to the intestine and lead to early fermentation of lactose in the intestine, which resulted in increased hydrogen gas production within 20-30 minutes (early peak).[12]

Most of the children who had history of RAP thought to be associated with certain dairy product consumption, were found to have lactose malabsorption (**Table 3**). Webster *et al* (1995)[4] suggested that the perception of symptoms related to ingestion of dairy products was similar between children with RAP who were malabsorber and non-malabsorber. It was probably because the prevalence of lactose malabsorber in this study was very high (80%) compared to that of Webster (24%). There was an interesting finding in this study concerning yogurt which is widely used as a treatment modality for lactose intolerance.[41] This study revealed that yogurt seemed to cause RAP in children instead of cure it. This was

thought to be associated with the sourness of yogurt. Appropriate storage of yogurt (recommended to be kept in 4^0C) could cause excessive sourness.[42] Several authors recommended yogurt or other fermented milk to be consumed during or after meal.[43]

The progression of lactose intolerance after lactose ingestion varied in each individual. Lactose intolerance was found in 69 children. The symptoms started to appear in 30 minutes after lactose ingestion (**Figure 1**). The most common symptoms were abdominal pain and nausea. A previous study revealed that nausea and bloating usually aroused within 30 minutes after lactose ingestion, while abdominal pain, flatulence, borborygmi, or diarrhea, aroused later in 1-2 hours after lactose ingestion.[14]

This study revealed more lactose intolerance symptoms in lactose malabsorber compared to that of non-lactose malabsorber (**Table 4**). This is in accord with a previous study that claims low lactase activity enables lactose to be hydrolyzed, aggravates various reactions leading to clinical manifestations. Barr *et al*[15] suggest that lactose intolerance symptoms were significantly found in malabsorber children. Wald *et al*[9] reported that lactose intolerance symptom significantly found more in malabsorber compared to that in non-malabsorber was only flatulence (gas). The differences between those studies with this study maybe because in this study we did not use any scoring system. Barr and Wald used the same scoring system: 0 (no symptom), 1 (mild), 2 (moderate), 3 (severe).[9,15]

Four children with increased breath hydrogen concentration of <10 ppm revealed lactose intolerance symptoms **(Table 4).** This was probably because the colonic bacteria in those children did not produce hydrogen but methane gas that could induce lactose intolerance symptoms. Previous study revealed that about 2.9% of people did not produce hydrogen gas after lactose ingestion.[38,39]

Two children with increased breath hydrogen concentration to over 20 ppm did not complain of any symptom. Symptomatology of lactose depends on many factors, such as the rate of gastric emptying, motility of the small intestine, sensitivity of colonic flora, and the amount and manner of lactose ingestion.[37] The possibility of false positive result in this study was already excluded by history taking and physical examination for the existences of pneumonia or diarrhea. We also excluded children who used several medications, such as antibiotics, metoclopropamide, laxatives, and acetylsalicylic acid.

During observation, 2 children still experienced lactose intolerance symptoms for over 24 hours, though most children had recovered from the symptoms by 15 hours after ingestion (**Figure 2**). This result fitted Davidson's [44] study who found 58% of patients with lactose malabsorption had been free from lactose intolerance symptoms by 12 hours after ingestion. The duration of lactose intolerance symptoms after lactose ingestion widely varied but mostly disappeared within 24 hours.[45]

In conclusion, the prevalence of RAP in children aged 12-14 years was 14.9%. Lactose malabsorption was detected in 80% of the subjects. Milk and yogurt were the most frequent products that cause symptoms of RAP in our subjects who mostly were malabsorber. Lactose intolerance during BHT was found in 81% of children. It had already occured in 30 minutes after lactose ingestion and lasted within 15 hours.

References

1. Hyams JS. Recurrent abdominal pain in children. Gastroenterol Nutr 1995;7:529-32.
2. Hyam JS, Treem WR, Justinich CJ, Davis P, Shoup M, Burke G. Characterization of symptoms in children with recurrent abdominal pain: resemblance to irritable bowel syndrome. J Pediatr Gastroenterol Nutr 1995;20:209-14.
3. Gremse DA, Nguyenduc GH, Sacks Al, Di Palma JA. Irritable bowel syndrome and lactose maldigestion in recurrent abdominal pain in childhood. Southern Med J 1999;92:778-81.
4. Webster RB, DiPalma JA, Gremse DA. Lactose maldisgestion and recurrent abdominal pain in children. Dig Dis Sci 1995;7:1506-10.
5. Di Palma AN, Di Palma JA. Recurrent abdominal pain and lactose malabsorption in school-age children. Gastroenterol Nutr 1997;20:180-3.
6. Mews CF, Sinatra FR. Abdominal pain. In: Wyllie R, Hyams JS, editors. Pediatric gastrointestinal disease: pathophysiology, diagnosis, management. Philadelphia: W.B. Saunders Co; 1993. p. 177-86.

7. Walker LS, Guite JW, Duke M, Barnard JA, Greene JW. Recurrent abdominal pain: a potential precursor of irritable bowel syndrome in adolescents and young adults. J Pediatr 1998;132:1010-5.
8. Firmansyah A. Aspek diagnostik sakit perut berulang. Maj Kedok Indones 1991;9:525-8.
9. Wald A, Chandra R, Fisher SE, Gartner JC, Zitelli B. Lactose malabsorption in recurrent abdominal pain of childhood. J Pediatr 1982;100:65-8.
10. Buller HA. Recurrent abdominal pain in children. Expert lecture. Presented at Pediatric Departement Medical School, University of Indonesia; 2000 Apr 14; Jakarta, Indonesia.
11. Boediarso A. Perkembangan laktase dan hubungannya dengan makanan bayi. Sari Pediatri 1993;1:17-20.
12. Lebenthal E, Kretchmer N, Alliet P. Lactase deficiency, lactose malabsorption, and lactose intolerance. In: Lebenthal E, editor. Textbook of gastroenterology and nutrition in infancy. 2nd ed. New York: Raven Press; 1989. p. 459-72.
13. Firmansyah A. Laktosa dan laktase, aspek biokimiawi dan laboratorium. Maj Kes Masy Indones 1996;5:318-21
14. Buller HA. Lactase phlorizin hydrolase: a review of the literature [dissertation]. Netherland: University of Amsterdams; 1990.
15. Barr RG, Levine MD, Watkins JB. Recurrent abdominal pain of childhood due to lactose intolerance: a prospective study. N Engl J Med 1979;300:1449-52.
16. Liebman WM. Recurrent abdominal pain in children: lactose and sucrose intolerance, a prospective study. Pediatrics 1979;64:43-5.
17. Christensen MF. Prevalence of lactose intolerance in children with recurrent abdominal pain. Pediatrics 1980;65 :681-2.
18. Lebenthal E, Rossi TM, Nord KS, Nord KS, Branski D. Recurrent abdominal pain and lactose absorption in children. Pediatrics 1981;67:828-32.
19. Blumenthal I, Kelleher J, Littlewood JM. Recurrent abdominal pain and lactose intolerance in childhood. Br Med J 1981;282:2013-4
20. Ceriani R, Zuccato E, Fontana M, Zuin G, Ferrari L, Principi N, *et al*. Lactose malabsorption and recurrent abdominal pain in Italian children. J Pediatr Gastroenterol Nutr 1988;7:852-7.
21. Hovarth K, Horn G, Hassan BG, Szamosi T, Nemes NA, Bodanszky H. Chronic recurrent abdominal pain and lactose malabsorption in childhood [abstract]. Orv Hetil 1990;131:2631-5.
22. Quak SH, Wong CK. Recurrent abdominal pain: an aetiological study among Singaporean children [cited 2004 Feb 5]. Available from URL: http://www.jicef.or.jp/wahec/ful232.htm-26k.
23. Suharjono, Sunoto, Boediarso A, Sutedjo. Lactose malabsorption in healthy Indonesian children. Paediatr Indones 1971;11:251-4.
24. Sunoto, Suharjono, Sutedjo. Two years study on sugar intolerance in Indonesian children. Paediatr Indones 1973;13:241-9.
25. Hegar B, Firmansyah A, Boediarso A, Sunoto. Aktivitas enzim laktase pada murid taman kanak-kanak. Maj Kedok Indones 1997;2:125-7.
26. Hegar B, Niken PY, Sayoeti Y, Dwipurwantoro PG, Firmansyah A. Aktivitas enzim laktase pada murid sekolah dasar. Maj Kedok Indones 2001;51:154-6
27. Sofia D. Prevalens malabsorpsi laktosa murid SLTP Negeri 7 Jakarta [thesis]. Jakarta: Department of Child Health, Medical School, Univ. of Indonesia; 2002.
28. Apley. The child with abdominal pain. London: Blackwell Scientific Publ; 1975. p. 3-54.
29. Walker WA, Hendricks KM. Pediatric Nutrition. Philadelphia: WB Saunders; 1985.
30. Boediarso A. Sakit perut berulang. Proceedings of the National Symposium of Badan Koordinasi Gastroenterologi Anak Indonesia. In: Munyi R, Abimanyu, Sofyan I, editors. Banjarmasin; 2000. p. 59-70
31. Van der Meer SB. Chronic recurrent abdominal pain in school children [abstract].Tidjschr Kindergeneeskd 1993;61:69-75.
32. Thiessen PN. Recurrent abdominal pain. Pediatrics in review 2002;23:39-46
33. Rings EHHM, Grand RJ, Buller HA. Lactose intolerance and lactase deficiency in children. Pediatrics 1994;6:562-7.
34. Buller HA, Grand RJ. Lactose intolerance. Annu Rev Med 1990;41:141-8.
35. American academy of pediatrics - committee on nutrition. The practical significance of lactose intolerance in children. Pediatrics 1978;62:240-5.
36. Buller HA, Rings EHHM, Montgomery RK, Grand RJ. Clinical aspect of lactose intolerance in children and adults. Scand J Gastroenterol 1991;26:73-80.
37. Montes RG, Perman JA. Lactose intolerance. Postgrad Med 1991;89:175-84.
38. Hegar B, Buller HA. Breath hydrogen test in lactose malabsorption. Paediatr Indones 1995;35:161-71