

Association between early feeding of banana (*Musa paradisiaca*) and vomiting or abdominal distention in neonates

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ABSTRACT

Objective To assess the relationship between banana given as early solid food feeding and symptoms of intestinal obstruction (SIO) such as vomiting and abdominal distention among neonates.

Methods A longitudinal cohort study was done in 1993 at a rural community of West Lombok District on Lombok Island, West Nusa Tenggara Province, Indonesia. There were 3420 neonates who were followed up by interviewing their mothers until 28 days after delivery. The main outcome measure was the occurrence of SIO.

Results Compared to infants who were not given solid food, the relative risk (RR) of SIO for infants given food other than banana as early solid food feeding was 1.87 (95%CI 0.48;8.24), while for infants given banana only as early solid food feeding, the RR was 9.15 (95%CI 1.96;42.58). After the adjustments of birth weight, colostrum, and breast feeding, the odds ratio of SIO for infants given banana was 2.99 (95%CI 2.65;5.14).

Conclusion Banana as early solid food for neonates feeding is an important risk factor for the occurrence of SIO [Paediatr Indones 2004;44:43-48].

Keywords: banana, early feeding, intestinal obstruction, vomiting, abdominal distention

High perinatal distress might be caused by several factors, such as maternal health condition, method of delivery, care, and early feeding to neonates.¹ The Weaning Project sponsored by the United States Agency for International Development (USAID) between 1985-1989 in West Nusa Tenggara (WNTP) and East Java provinces (EJP), Indonesia, revealed that 64% of mothers in WNTP and 76% of mothers in EJP fed their newborn neonates with crushed or chewed

bananas.² A qualitative ethnographic study conducted in Labuapi subdistrict, West Lombok District (WLD), WNTP in 1991 showed that 86% of mothers gave early solid food feeding to their neonates in the forms of banana or rice.³ A study done in Kediri subdistrict, WLD, WNTP, during 1986, revealed 42 (10.14%) out of 414 neonatal deaths with the primary symptoms of vomiting and abdominal distention. We define the later as symptoms of intestinal obstruction (SIO). Calculation of the case fatality of SIO revealed that the proportion of neonatal deaths due to SIO was higher than that of neonatal tetanus. Interestingly, all neonates dying with SIO had previously been fed solid foods shortly after birth, especially banana (green banana).⁴

The association between the provision of banana as early solid food and the appearance of SIO had not been reported previously. Some reports revealed the as-

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sociation between lack of breastfeeding and neonatal necrotizing enterocolitis (NNEC).⁵⁻⁷ In Indonesia, phyto bezoar (indigestible vegetable material) and perforation of gastrointestinal tract caused by Siamese banana which was followed by NNEC in the duodenum had been reported.⁸ Bezoar can cause symptoms like abdominal distention, vomiting, and regurgitation.⁵

The purposes of this study were to look for an association between the provision of banana as early solid food and the appearance of SIO and to understand the role of this practice in neonatal morbidity and mortality.

Methods

This was a prospective cohort study done in WLD, WNTP, Indonesia, during the year of 1993. WLD was selected due to the ease of transportation from the research center in Mataram (the capital of WNTP, lies in WLD) to the field sites (subdistricts and villages). This study was done in 20 villages of 4 purposely chosen subdistricts, namely Gerung, Kediri, Labuapi, and Gunung Sari. The villages chosen based on their total population. All neonates born in those villages were eligible to the study.

Data of delivery procedure, prenatal care, mother's condition during pregnancy, and birth weight of infant, were harvested by interviewing birth attendants, either traditional birth attendants or midwives. All neonates were monitored by daily home visit since born up to 28 days, to obtain observations and recordings related to types of food given to the infants, and any symptoms of distress or poor health. Neonates who had symptoms of vomiting and abdominal distention would be referred to neonatal intensive care unit at Mataram General Hospital. Physical, laboratory, and x-ray examination were performed. Diagnosis of NNEC was based on pneumatosis intestinalis seen in plain abdominal x-ray. Upper/lower barium examinations were done if intestinal obstruction was suspected.

The data collection instruments were pretested to ensure that appropriate responses were obtained. Data quality was assessed by editing all forms and by random cross check of approximately 10% of all household visits.

The exposure variable consisted of the provision of banana as early feeding. The outcome variable was SIO defined as vomiting and abdominal distention.

Specifically, SIO diagnosis included the following: abdominal distention and tenderness, apparent distress of the infant, clearly presence of intestinal peristaltic movements, metallic sounds heard upon auscultation, and vomiting defined as throwing out of stomach contents through the mouth with contraction of abdominal muscles. The exposure, outcome, and confounding variables were classified as dichotomous or discrete.

Sample size was calculated by unequal sample size method according to Fleiss and Schlesselman^{9,10} assuming the incidence of SIO in the exposure group of 0.012, and in the unexposed group of 0.0012, $\alpha=0.05$, and $b=0.20$. It revealed that the sample size needed was 4080 neonates, consisting of 3672 exposed neonates (who were given early feeding) and 408 of unexposed neonates.

We calculated the average amount of bananas given as early feeding to the neonates with SIO compared to that of the neonates without SIO. The amount of banana given was measured by teaspoon. The mean amount of banana given was calculated by dividing the total banana consumption measured in teaspoon (morning, noon, and afternoon) with the number of observation days. The association between the dose of banana and the appearance of SIO was then assessed by comparing low consumption (the first 50th percentile) and high consumption (the second 50th percentile). We calculated the relative risk (RR) to determine the strength of association between banana feeding and the appearance of SIO.

Data were analyzed using dSurvey software program and BMDP software package for logistic regression analysis.¹¹ We used X^2 analysis for categorical variables and student's test for comparing means of normal distribution. Statistical significance was defined by a p value of <0.05 .

Informed consent was given by the head of WLD which was appropriate for population based observational study (Guideline of Ethic in Medical Research and International Guideline for Ethical Review of Epidemiological Studies).^{12,13}

Results

A group of 3429 neonates were recruited for the study. Nine subjects migrated out of the study area and 3420 finished

the study, comprising 3061 of exposed (given other food and or banana) and 359 of unexposed (no food given) (Figure 1). One hundred and nine neonates died during the study, nine (8.7%) of them died due to SIO.

The average quantity of banana given to neonates with the SIO was 20.41 (SD 5.6) teaspoon compared to 14.21 (SD 11.61) teaspoon given to neonates without SIO ($p=0.00027$).

The cut-off point of low (lower 50th percentile) and high banana consumption (upper 50th percentile) was 20.4 teaspoon/day. The association between low consumption and high consumption of banana as early solid food feeding with the occurrence of SIO can be seen in Table 1. Table 1 shows a significant dose-response relationship for the association between banana as early solid food and the occurrence of SIO ($p=0.0001$).

The strength of association between banana as early solid food, banana and other solid food, other solid food without banana, or no early solid food and the occurrence of SIO, can be seen in Table 2. There was no significant association if we compared other solid food feeding (early solid food without banana) and no early solid food for the occurrence of SIO, RR 1.87 (95%CI 0.42;8.24), $p=0.4$, but strong association was found when we compared early banana feeding and no early solid food, RR 9.15 (95% CI 1.96;42.58); $p=0.0005$; while the RR of early banana feeding is greater than that of the combination of other solid food and banana (9.15 versus 4.23).

Logistic regression analysis was performed by adjusting all possible confounding variables i.e., banana, birth weight, colostrum feeding, breast feeding, asphyxia, and mother's fever after PROM. The odds ratio for banana as early solid food feeding to the appearance of SIO was 2.99, 95%CI 2.65;5.14, and $p=0.0012$.

SIO and NNEC

Out of 62 neonates hospitalized with SIO, 10 neonates suffered from NNEC. Nine out of 62 neonates with SIO died (15%), and from 10 neonates with NNEC, 6 died. Among neonates with SIO, 29% occurred on the first week, 23% on the 2nd week, 33% on the 3rd week, and 15% on the 4th week; while among neonates with NNEC, 6 occurred on the first week, 1 on the 2nd week, and 3 on the 3rd week, respectively. Seventy two percent of neonates with SIO had been given green banana, while 28% were given local type of banana.

The kinds of other early solid food given to the neonates in this research were honey, young coconut, and rice. Honey and young coconut were mostly given only on the first few days, while banana and rice were consistently given throughout 28 days. There was no significant association between the provision of honey, young coconut, or rice as early solid food, and the occurrence of SIO. There was also no significant association between the method of banana feeding (masticated or crushed with spoon before feeding) and occurrence of SIO.

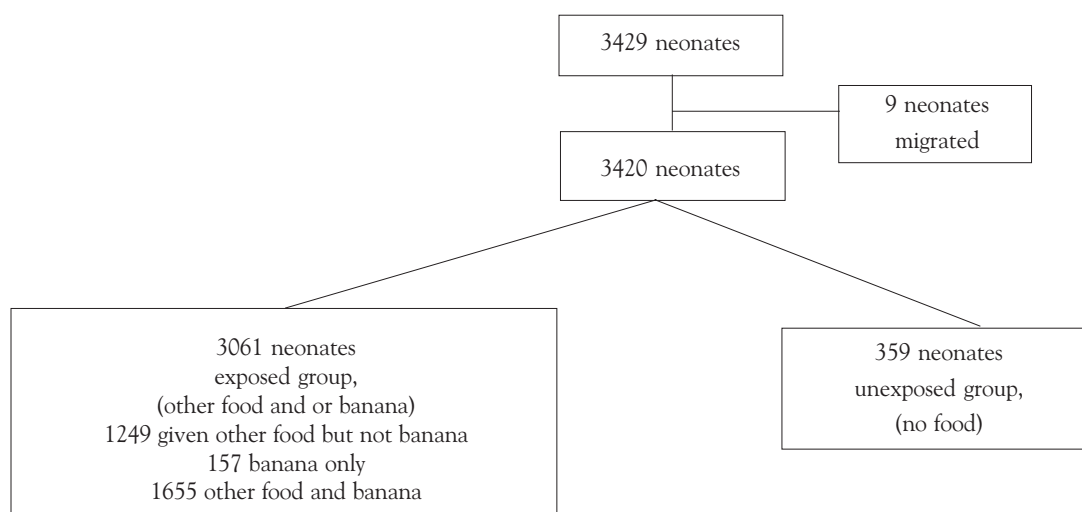


Figure 1. Distribution of participants in this study

Discussion

The method used in this research was cohort because a real experiment was impossible (not ethical). In Indonesia, there were only one report of phytobezoar, perforation of gastrointestinal tract and NNEC caused by siamese banana; although they did not report about SIO, bezoar have symptoms like abdominal distention and vomiting⁸.

The average of banana feeding in neonates with SIO was 20.40 (SD 5.60) teaspoons a day, while in neonates without SIO was 14.20 (SD 11.6) teaspoons, and this difference was significant ($p=0.00027$). There was also a significant difference ($p=0.0001$) between low and high consumption of banana as early solid food feeding for the occurrence of SIO. If banana is given together with other solid food, the amount of banana intake is less, so that it will reduce the risk (Table 2). The increase of banana feeding caused increased SIO and there was a dose response relationship. The Mantel Haenszel stratification analysis revealed that the provision of banana as early solid food had strong association with the appearance of SIO without interaction with confounding

variables. On logistic regression analysis, the odds ratio of this association after adjustment with all possible confounding variables was 2.99, 95%CI 2.65;5.14 and $p=0.0012$. All of these data revealed that there are strong association between banana as early solid food feeding and the SIO without interaction with confounding variables.

Neonates are endowed with a good ability to digest carbohydrate. The digestion of carbohydrate in neonates is mainly done by glucoamylase produced by duodenal mucosa cells because pancreatic alpha amylase is not yet produced.¹⁴ Association between the provision of banana as early solid food feeding and the appearance of SIO may be suspected by many ways i.e., banana acting as a solid mass; the substances contained in banana like serotonin, dopamine, and noradrenaline, can influence the motility of the intestinal tract.¹⁵ The dose of serotonin was 170 mg daily (the mean of the provision of banana feeding daily was 85 g and the serotonin content in banana is 2 mg/g).¹⁶ If the integrity of intestinal mucosa is damaged, serotonin will flow into the blood vessels, which may further have a significant impact. The carbohydrate crystal-

TABLE 1. ASSOCIATION BETWEEN LOW CONSUMPTION AND HIGH CONSUMPTION OF BANANA AS EARLY SOLID FOOD WITH THE OCCURRENCE OF SIO

| BANANA | SIO (+) n (%) | SIO (-) n (%) | TOTAL | p |
|------------------|------------------|------------------|-------|--------|
| Low consumption | 2 (0.2) | 881 (99.8) | 883 | 0.0001 |
| High consumption | 45 (5.1) | 837 (94.9) | 882 | |
| TOTAL | 47 | 1718 | 1765 | |

TABLE 2. ASSOCIATION BETWEEN BANANA AS EARLY SOLID FOOD, BANANA AND OTHER SOLID FOOD, OTHER SOLID FOOD WITHOUT BANANA, OR NO EARLY SOLID FOOD AND THE OCCURRENCE OF SIO

| VARIABLES | SIO | | | |
|--------------------------------|---|------|---------|-------|
| | SIO (+) | | SIO (-) | |
| | n | % | n | % |
| 1. Other solid food | 13 | 1.04 | 1236 | 98.96 |
| No food | 2 | 0.56 | 357 | 99.44 |
| | RR = 1.87 (95%CI 0.42;8.24), $X^2=0.75$, $p=0.400$ | | | |
| 2. Banana | 8 | 5.10 | 149 | 94.90 |
| No food | 2 | 0.56 | 357 | 99.44 |
| | RR=9.15 (95%CI 1.96; 42.58), $X^2=11.84$, $p=0.0005$ | | | |
| 3. Banana and other solid food | 39 | 2.36 | 1616 | 97.64 |
| No food | 2 | 0.56 | 357 | 99.44 |
| | RR=4.23 (95%CI 1.03;17.44), $X^2=4.79$, $p=0.029$ | | | |

RR=Relative Risk; 95%CI=95% confidence interval; other solid foods were honey, rice, young coconut, etc.

line pattern (b type) and the non starch polysaccharide content found in banana such as hemicellulose, algine, and pectin are material that are difficult to digest. Therefore, they are potential for fermentation and gas production. The gas could cause abdominal distention and vomiting.^{5,15}

Although the signs and symptoms are similar, NNEC and SIO are different. Firstly, 6 out of 10 NNEC cases occurring in the first week of life, while for SIO, only 33%; secondly, 6 of 10 patients with NNEC died, and only 15% in SIO; thirdly, NNEC usually occurred in LBW and premature infants, while most SIO occurred in full term infants; and fourthly, the condition of SIO is reversible before intensive destruction of the integrity of intestinal mucosa and it seemed that SIO is not the first stage of NNEC (the stage of NNEC according to Bell and Ternberg criteria).⁷

We concluded that the provision of banana as early feeding in neonates can be the cause of SIO, although future studies in other area of Indonesia are needed. In order to improve the quality of community health, it is therefore necessary to discourage the custom of giving banana as early feeding.

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