

VOMITING, ABDOMINAL DISTENTION AND EARLY FEEDING OF BANANA (*MUSA PARADISIACA*) IN NEONATES

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Abstract. The objective of this cohort study was to assess the relationship between banana given as early solid food with the symptoms of intestinal obstruction (SIO) among neonates, in a rural community in West Lombok District, West Nusa Tenggara Province, Indonesia. Mothers having newborn infants were interviewed and 3,420 neonates were followed for 28 days. Compared with infants who were not given solid food, the relative risk (RR) for infants given food other than banana as early solid food was 1.87, 95% CI 0.48-8.24, $p=0.4$, while for infants given banana only as early solid food the RR was 9.15, 95% CI 1.96-42.58, $p=0.0005$. After adjustment for birthweight, colostrum, and breastfeeding, the odds ratio for infants given banana and the appearance of SIO was 2.99, 95% CI 2.65-5.14; $p=0.0012$. These data indicate that banana given as early solid food is an important risk factor for the appearance of SIO in neonates.

INTRODUCTION

Perinatal distress can be related to maternal factors operative during pregnancy, or to factors operative during delivery or early in the postpartum period (CBS, 1995). The Weaning Project, sponsored by the United States Agency for International Development (USAID) during 1985-1989 in West Nusa Tenggara Province (WNTP) and East Java Province (EJP), Indonesia, revealed that 64% of mothers in WNTP and 76% of mothers in EJP fed their newborn with crushed or chewed bananas (USAID, 1989). A qualitative ethnographic study conducted in Labuapi Sub-district, Lombok, WNTP, in 1991, showed that 86% of mothers commenced feeding early solid food to their neonates in the forms of bananas or rice (Hananto, 1996).

A study employing verbal autopsy interviewed mothers whose neonates had just died, in Kediri sub-district, West Lombok, WNTP, dur-

ing 1986. Out of 414 deaths, 42 (10.1%) had primary symptoms of vomiting and abdominal distention. We define the latter 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. All neonates dying with SIO had previously been fed solid foods shortly after birth, especially green banana (Hananto Wiryo, 1989; 1996).

The association between the provision of banana as early solid food and the appearance of SIO has not previously been reported. Some reports revealed an association between non-breastfed infants and neonatal necrotizing enterocolitis (NNEC) (Bell and Ternberg, 1978; Giles, 1992; Dodge, 1996). In Indonesia, phytobezoar (indigestible vegetable material), and perforation of the gastrointestinal tract caused by Siamese banana, and followed by NNEC in the duodenum, has been reported (Darmawan, 1984). Bezoar can cause symptoms like abdominal distention, vomiting, and regurgitation (Dodge, 1996).

From the data above, the question arises: the provision of banana as early solid food for in neonates associate with the appearance of SIO? This study looked for an association between the pro-

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vision of banana as early solid food and the appearance of SIO, and to understand the role of this practice in neonatal morbidity/mortality.

MATERIALS AND METHODS

Study population and fields methods

A cohort study was done in West Lombok district (WLD), WNTP, Indonesia. More than 80% of mothers especially in rural Lombok Island, WNTP, give banana to their newborn as early solid food. WLD was selected due to the ease of transportation from the research center in Mataram (the capital of WNTP, which is in WLD) to the field site (sub-districts and villages). The sub-districts and villages in WLD, were chosen randomly. The sub-districts chosen were Gerung, Kediri, Labuapi and Gunung Sari. From Gerung, four villages; from Kediri five; from Labuapi six; and from Gunungsari five were chosen depending on the total populations in those areas. All infants born in the villages of the research area were eligible for inclusion in the study.

Newborn infants were reported to the field assistants in the village within 24 hours after birth by traditional birth attendants, midwives, or field assistants in the hamlet. Both the village and field assistants met with the traditional birth attendant and the infant's parents to record the delivery procedure, prenatal care, the mother's condition during the pregnancy, and the weight of the infant. The field assistant then visited the intended family daily for up to 28 days, to observe and obtain recordings related to the types of food given to the infants and any symptoms of distress or poor health. If vomiting and abdominal distention appeared, the field assistant would report it to the principal researcher, who would immediately visit the child in the field. If the principal researcher found that the symptoms matched SIO, the neonates would be referred to the Neonatal Intensive Care Unit of Mataram General Hospital. Physical, laboratory, and x-ray examinations were performed. They also received physiologic saline in 10% dextrose infusion, ampicillin (100 mg/kg body weight/day three times daily intravenous), gentamicin (5 mg/kg body weight/day, two times daily intravenous), and 2 mg intramuscular injection of vitamin K.

Diagnoses of NNEC was based on plain abdominal x-ray. If pneumatosis intestinalis were seen, the diagnosis of NNEC was performed. Upper/lower barium examinations were done if intestinal obstruction was suspected. The stools of all neonates with SIO were cultured in the Microbiology Department, Faculty of Medicine, Airlangga University, Surabaya. The patients were hospitalized until the condition improved.

The data collection instruments were developed through pre-testing to ensure that appropriate responses were obtained. Data quality was assessed editing all forms and by random cross-checking of approximately 10% of all household visits. In general, three categories of data were collected: parent attributes, pregnancy history, and delivery procedure, with a specific focus on the key indicators of neonatal health [asphyxia, low birth weight babies, and congenital cyanotic heart disease (CCHD)]. In addition, data were collected about the kinds of foods given and any symptoms appearing.

Variables

The exposure variable consisted of the provision of banana as early food. The outcome variable was SIO, defined as vomiting and abdominal distention. Specifically, SIO diagnosis included abdominal distention and pain associated with abdominal palpation, apparent distress of the infant, clear presence of intestinal peristaltic movements, metallic sounds heard upon auscultation; and vomiting defined as ejecting the stomach contents through the mouth with contraction of the abdominal muscles. The confounding variables included mother's fever after premature rupture of the membrane (PROM), asphyxia at birth, low birthweight (LBW) <2,500 g, CCHD, and the delivery procedure.

Step of analysis

First, calculate the average (mean) of giving bananas as early food to neonates with SIO, compared with neonates without SIO. The amount of banana given was measured by teaspoon. The mean of giving banana was calculated by dividing the total of banana in teaspoon (morning, noon, and afternoon) with the number of observation days. Second, find the association between the dose of banana with the appearance of SIO,

by comparing low consumption (the first 50th percentile) and high consumption (the second 50th percentile). Third, calculate the value of relative risk (RR), using the Mantel Haenszel stratification (Anderson *et al.*, 1980). Fourth, confounding variables were adjusted using logistic regression analysis (Hosmer and Lemeshow, 1989; Khan and Sempos, 1989).

Sample size

If predicted incidence of SIO in the exposure group was 0.012, while in the unexposed group it was 0.0012, $\alpha=0.05$ and $\beta=0.20$, the power of this research was 80%. The sample size needed was 4,080 neonates, consisting of 3,672 exposed neonates (group given banana as early food), and 408 of unexposed neonates. The sample size was determined by an unequal sample size method according to Fleiss (1982) and Schlesselman (1982).

Data were edited by the supervisor in the research center and then entered into the computers by trained computer operator using the dSurvey software program (Corner, 1989).

Ethics-Informed consent

A coordination meeting between the researcher, with the head of the WLD, subdistrict, villages, hamlets, formal/informal leaders was held to effect community agreement. The researcher explained the purpose of the study and the research was conducted after community agreement given by the head of the WLD. According to the Guideline of Ethics in Medical Research and the International Guideline for Ethical Review of Epidemiological Studies, this agreement was regarded sufficient to replace informed consent in observational research (Oemijati *et al.*, 1987; WHO, 1991).

RESULTS

At the end of the study, nine cases had moved out of the study area and 3,420 cases finished the study. These included 3,061 exposed (given other food and banana), and 357 unexposed (no food) (Fig 1). One hundred and nine neonates died from the following causes: nine (8.6%) SIO, six (5.7%) NNEC, 13 (12.5%) umbilical cord infection, 24 (23.1%) diarrhea, 24 (23.1%) neonatal tetanus and

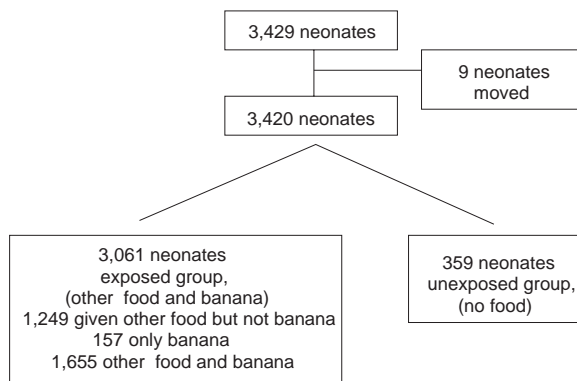


Fig 1—Three thousand, four hundred and twenty neonates finished the study; 3,061 exposed group, (other food and banana); 359 unexposed group (no food).

23 (22.1%) broncho-pneumonia.

The average quantity of banana given to neonates with SIO was 20.4 (SD 5.6) teaspoons compared with 14.2 (SD 11.6) teaspoons given to neonates without SIO, ($p=0.00027$).

The association between low consumption (lower 50th percentile) and high consumption (upper 50th percentile) of banana as early solid food and the appearance of SIO can be seen in Table 1.

Table 1 shows that there is a significant dose-response relationship for the association between banana as early solid food and the appearance of SIO ($p<0.001$).

The strength of association between banana as early solid food, banana and other solid food, and other solid food with no food (not given early solid food), to the appearance of the SIO, can be seen in Table 2. There is no significant association between other solid food (early solid food without banana) with no food (RR 1.87, 95% CI 0.42-8.24, $p=0.4$), but a strong association between banana as early solid food with no food (RR 9.15; 95% CI 1.96-42.58; $p<0.001$). The RR of banana as early solid food is greater than the combination of other solid food and banana (9.15 vs 4.23).

The determined confounding variables, which influenced the association between banana as early solid food and the appearance of

Table 1

Association between low consumption (<20.4 teaspoon/day) and high consumption (>20.4 teaspoon/day) of banana as early solid food and the appearance of SIO.

Banana	SIO (+)	R(%)	SIO (-)	R(%)	Total	p
Low consumption	2	0.23	881	99.77	883	0.0001
High consumption	45	5.10	837	94.89	882	
Total	47		1,718		1,765	

R = Row proportion (%)

Table 2

Association between banana as early solid food, banana and other solid food, and other solid food, with no food, and the appearance of SIO.

Variables	SIO			
	SIO (+)		SIO (-)	
	Freq	R (%)	Freq	R (%)
1. Other solid food	13	1.04	1,236	98.96
No food	2	0.56	357	99.44
		RR=1.87		$\chi^2=0.75$
		95% CI=0.42-8.24		p=0.400
2. Banana	8	5.10	149	94.90
No food	2	0.56	357	99.44
		RR=9.15		$\chi^2=11.84$
		95% CI=1.96-42.58		p=0.0005
3. Banana and other solid food	39	2.36	1,616	97.64
No food	2	0.56	357	99.44
		RR=4.23		$\chi^2=4.79$
		95% CI=1.03-17.44		p=0.029

R (%)=Row percentage; RR=Relative risk; 95%CI=95% Confidence interval; Other solid food=honey, rice, young coconut, etc.

SIO, after statistical calculation, are mother's fever after PROM (p=0.048) and asphyxia (p=0.029).

The Mantel Haenzel stratification analysis method revealed that the association of banana as early solid food with the appearance of SIO was not influenced (interacted) by mother's fever after PROM and asphyxia as confounding variables.

Logistic regression analysis was performed by adjusting for all possible confounding variables: banana, birthweight, colostrum feeding, breastfeeding, asphyxia and mother's fever after

PROM. The odds ratio for banana as early solid food to the appearance of SIO was 2.99, 95% CI 2.65-5.14, and p<0.01.

SIO and NNEC: from 62 neonates hospitalized with SIO, 10 neonates suffered from NNEC. Nine of 62 neonates with SIO died (14.52%), and from 10 neonates with NNEC, six (60%) died. In neonates with SIO, 28.8% occurred at the first week, 23.1% at the 2nd week, 32.7% at the 3rd week, and 15.4% at the 4th week, while for NNEC, 60% at the first week, 10% at the 2nd week, and 30% at the 3rd week, respectively.

Seventy-two percent of neonates with SIO

Table 3
Importance of individual diagnostic tests in making the causal decision.

Diagnostic test	Effect of test result on causal decision		
	Test result consistent with causation	Test result neutral or inconclusive	Test result opposes causation
Human experiment	++++	---	----
Strength of association			
From randomized trial	++++	---	----
From cohort study	+++	--	---
From case-control study	+	0	-
Consistency	+++	--	---
Temporality	++	--	----
Gradient	++		--
Epidemiologic sense	++		--
Biologic sense	+		-
Specificity	+		-
Analogy	+	0	0

Listed in decreasing order of importance: + Causation supported; - causation rejected; 0 causation not effected; the number of plus and minus signs indicates the relative contribution of the diagnostic test to the causal decision (From Sackett *et al*, 1985).

had been given green banana, while 28% had been given a local type of banana.

The other kinds of early solid food given to the neonates 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 the 28 days. There were no significant associations between the provision of honey, young coconut and rice as early solid foods with the appearance of SIO. There was also no significant association between the method of banana feeding (masticated or crushed with a spoon before feeding) and the appearance of SIO.

The stool cultures of neonates with SIO were *Escherichia coli* (57.8%), *Klebsiella pneumoniae* (12.5%), *Enterobacter* sp (10.7%), and *Proteus mirabilis* (3.6%). In neonates with NNEC they were *Escherichia coli* (50%), *enteroinvasive E. coli* (EIEC) 0136 (16.7%), *Enterobacter* sp (16.7%), and *Klebsiella pneumoniae* (16.7%).

DISCUSSION

In Indonesia, there has been only one report

of phytobezoar, perforation of the gastrointestinal tract and NNEC caused by Siamese banana. Although they did not report about SIO, bezoar has symptoms like abdominal distention and vomiting (Darmawan, 1984).

The average for feeding banana to neonates with SIO was 20.40 (SD 5.60) teaspoons a day, while in neonates without SIO it was 14.20 (SD 11.6) teaspoons, and this difference was significant ($p < 0.001$). There are also significant differences ($p < 0.001$) between low and high consumption of banana as early solid food. 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). Increased of banana feeding caused an increase in SIO, and there are dose-response relationships.

Mantel Haenszel stratification analysis revealed that the provision of banana as early solid food had a strong association with the appearance of SIO, without interaction among confounding variables. Logistic regression analysis was then performed, and the odds ratio of this association after adjustment with all possible confounding variables was 2.99, 95% CI 2.65-5.14 ($p < 0.0012$).

These data revealed that a strong association between banana as early solid food and 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 (Lebenthal, 1989).

The association between the provision of banana as early solid food and the appearance of SIO may be suspected by: (1) banana acting as a solid mass; (2) substances like serotonin, dopamine, and noradrenaline, which can influence the motility of the intestinal tract (Englyst and Cummings, 1986). The dose of serotonin was 170 mg daily (the mean of the provision of banana feeding daily was 85 g and the serotonin content of banana is 2 mg/g) (Foy and Parrat, 1960). If the integrity of the intestinal mucosa is damaged, an amount of serotonin will flow into the blood vessels, which may have a significant further impact; and (3) the carbohydrate crystalline pattern (b type) and the non-starch polysaccharide content found in banana (hemicellulose, alginate and pectin) are materials that are difficult to digest. Therefore, they are potential fermentation and gas producers. The gas could cause abdominal distention and vomiting (Dodge, 1996; Englyst and Cummings, 1986).

The causal relationship between exposure and outcome can be completely proved if the criteria of Sacket *et al* (1985) are fulfilled (Table 3) (Trout, 1981). There are nine criteria: (1) the research method must be powerful enough to prove the existence of a causal relationship, according to their degree of strength of association. These are: experimental (randomized controlled trial=RCT), cohort, and case control; (2) research on human subject; (3) and (4) temporal and dose-response relationship between exposure and outcome; (5) epidemiological sense; (6) biological sense; (7) analogy; (8) specificity; and (9) consistency. The strength of every criterion is not equal; analogy, specificity and consistency have little power.

In this research we use the cohort; the research was conducted on human subjects; there

are temporal and dose-response relationships in this research; this research also revealed epidemiological and biological sense in the community; analogy; but not specific and consistent. Specific means a single exposure caused a single outcome, while not consistent means that there is as yet no published literature about the association between the provision of bananas as early food and the appearance of SIO; but this also indicates the originality of the research. Therefore, because only two of nine criteria, which have only little power (*ie* consistency and specificity) are not fulfilled, this research can be interpreted as suggesting that the provision of banana as an early solid food for neonates, could cause SIO. Further study in other areas of Indonesia is needed.

Although the signs and symptoms are similar, NNEC and SIO are different. First, NNEC occurred 60% in the first week of life, while SIO is only 32.7%; second, 60% of NNEC died, and only 14.52% of SIO; third, NNEC usually occurred in LBW and premature infants, while most SIO occurred in full-term infants; and fourth, the SIO condition was reversible before intensive destruction of the integrity of the intestinal mucosa and it seems that SIO is not the first stage of NNEC (the stage of NNEC according to Bell and Ternberg criteria's) (Bell and Ternberg, 1978).

The higher proportion of neonates died due to diarrhea (23.1%), which suggested unhygienic preparation prior to feeding.

The NMR in the research area was 30.14/1,000 live births, lower than statistically predicted of NMR (46/1,000 live births) (CBS, 1995).

Suggestion

The provision of bananas as early food for neonates could be the cause of SIO, although future studies in other areas of Indonesia are needed. To improve community health, it is therefore necessary to discourage the custom of giving banana as early food.

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