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ORIGINAL PAPER

Association between mother's purchase intention of iron-fortified infant cereal and iron intake among children aged 6-23 months in Tangerang, Indonesia

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Abstract

Background: Iron deficiency can lead to anemia, negatively impacting children's cognitive and physical development. Mothers' knowledge of iron and the benefits of fortified complementary foods may have influenced their purchase intentions and decisions.
Objective: This study aimed to investigate the association between mothers' purchase intentions, actual purchases of iron-fortified infant cereals, and iron intake in children aged 6–23 months in Tangerang, Indonesia. Research on this topic remained limited, emphasizing the need for further studies to strengthen the existing evidence.
Methods: This study employed a cross-sectional design involving 162 mothers in pairs with their children aged 6–23 months, recruited consecutively. Data were collected using validated questionnaires. Data analysis was performed using the non-parametric Mann-Whitney test to compare groups and Spearman's correlation test to assess the strength of relationships between variables. A p-value < 0.05 was considered statistically significant.
Results: Mothers showed positive attitudes and intentions towards purchasing iron-fortified cereals, with a notable 51.9% having made recent purchases. While these purchase intentions correlate with actual purchases, they did not directly influence children's iron intake. Instead, factors such as mother's education, occupation, and household income played significant roles in determining iron intake levels.
Conclusion: Purchase intentions were associated with actual purchase intention; however, factors such as gender, mother's education, occupation, and household income did not exhibit a direct relationship with children's iron intake. This study indicates that while mother's purchase intentions are associated with actual purchases, they do not directly impact children's iron intake.

Keywords: iron intake children, iron-fortified cereal, purchase intention

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Introduction

Iron deficiency is common in children under two during the transition from milk to solid foods, as rapid growth depletes fetal iron reserves[1]. This period of rapid growth, coupled with the depletion of fetal iron reserves, significantly increases the needs for dietary iron. Ensuring adequate iron intake between 23-36 months is crucial for optimal child development before preschool[2]. Globally, iron deficiency affects millions of children, leading to impaired cognitive and motor development, weakened immune function, and increased susceptibility to infections[3]. According to the World Health Organization (WHO), around 42% of children under the age of five worldwide suffer from anemia, primarily due to iron deficiency. In Southeast Asia, the prevalence of anemia in children is particularly high, with approximately 50% of children under five affected[4]. In Indonesia, the situation is similarly alarming, where about 48.9% of children under five are reported to have anemia, reflecting the ongoing public health challenge of iron deficiency in the region[5].

The transition between 6-23 months represents a particularly vulnerable period for iron deficiency due to the increasing reliance on complementary foods that may not provide sufficient iron to meet the needs of rapid growth and development. In this period, cereals and dairy products are primary sources of iron and energy in toddler diets, accounting for 31% and 33%, respectively[6].

The quality of additional food intake and dietary diversity have a significant effect on children under two's iron intake. Iron deficiency and anaemia can be avoided with a diversified diet that includes foods high in iron, such as meat and fortified cereals. To improve iron status, supplemental foods should be introduced at six months along with ongoing nursing. In order to provide sufficient iron intake for the best possible growth and development, other important factors include socioeconomic position and the timing of the introduction of iron sources[7]. Consumption of commercially produced complementary food (CPCF) is prevalent in Germany, with 60% of infants consuming CPCF. The market survey identified 1,057 products, indicating a reliance on CPCF over homemade options, which may limit dietary variety in young children[8].

An initiative to enhance iron intake is the fortification of commercially produced complementary foods with iron. The introduction of iron-fortified foods, such as infant cereals, presents a potential strategy to address iron deficiency in this vulnerable population. The nutritional composition of commercially produced complementary foods (CPCF) has a considerable impact on consumer choice, particular iron, which is essential for children's growth and cognitive development. According to study , many CPCF are marketed as iron-fortified; nevertheless, the real iron content frequently falls below recommended levels[9,10] .

Studies in different countries showed that the prevalence of children at risk of low dietary iron intake was higher among toddlers (aged 6-23 months) as compared to other children. Market surveys in Southeast Asia indicate a high consumption of commercially produced snacks, with 55% of children in Phnom Penh and 82% in Bandung regularly consuming such products. These fortified foods have the potential to significantly boost micronutrient intake[12], provided that they are properly integrated into the child's diet. Nonetheless, over reliance toward consumption of commercially produced complementary foods (CPCF) have been shown to reduce dietary diversity[13]. CPCF provides convenience for parents, factors influencing CPCF consumption include maternal employment, wealth status, and exposure to marketing, with higher consumption linked to non-exclusive breastfeeding and promotional activities[9,10,11].

The Theory of Planned Behavior (TPB) model identifies key factors influencing the purchase intention of iron-fortified infant cereal, including attitudes, subjective norms, perceived behavioral control, and information-seeking behavior, which collectively shape consumer decisions[14,15]. Many factors influence decision making of food purchases, particularly food for children. Parental knowledge, attitudes, and behaviors are critical determinants of children's dietary intake, with mothers often serving as the primary decision-makers in household food purchases. In Jakarta, 17.1% of mothers use electronic media to learn about complementary foods, influenced by socioeconomic factors, education, and income[16].

This study, aim to investigate the association between mothers' purchase intentions, actual purchases of iron-fortified infant cereals, and iron intake in children aged 6–23 months in an Indonesian population, i.e. Tangerang City. Tangerang City is a rapidly growing urban areas, which saw a population growth of 1.16% in 2021[17]. According to the 2023 profile, the Baja Public Health Center serves 4% of Tangerang City's total population, highlighting the importance of prioritizing nutrition and health services for this population [17,18]. A study on complementary feeding practices in Tangerang found that only 17.8% met the recommended standards, indicating poor complementary feeding practices[19]. There remains a notable lack of research on complementary feeding practices and iron intake in the region as well as in Indonesia.

Methods

This cross-sectional study was conducted at a health center in an urban area of Tangerang City, a rapidly expanding municipality in Indonesia's Banten province, located approximately 26 kilometers from Jakarta. The health center was selected for its recognition as an exemplary facility, having earned third place nationally and first place in Tangerang during the 2023 National Health Day.

The study population comprised mothers and their children aged 6-23 months. The inclusion criteria for participants were mothers paired with apparently healthy children in this age range who provided informed consent for participation. Exclusion criteria included mothers with children requiring special diets due illnesses.

A convenience consecutive sampling method was employed to recruit respondents from mothers attending *posyandu* (community health services) for child growth monitoring. Data collection took place between February 20 and March 20, 2024. The sample size was determined to test the hypothesis regarding the relationship between mothers' purchase intentions of iron-fortified infant cereal and their children's iron intake, with a 95% confidence interval. Based on a previous study that found a correlation (r = 0.59) between purchase intention and sugar-related attitudes, the estimated sample size was 59. Accounting for a design effect (DEFF = 2) and an expected response rate of 80%, the total required sample size was 148 participants.

The study involved a detailed review of existing literature, online resources, and consumer surveys to gather information on different brands and types of iron-fortified infant cereals. The consumption of various brands of commercially produced complementary foods (CPCF) was measured using a Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) to estimate the children's iron intake.

Data collection tools included the SQ-FFQ and structured questionnaires on sociodemographic characteristics, nutritional knowledge, attitudes, subjective norms, and actual purchases of iron-fortified cereals. A pilot test involving 30 respondents was conducted prior to the main study to evaluate the reliability and validity of the questionnaires. Trained enumerators carried out the interviews to ensure data consistency.

Data were analyzed using IBM SPSS Statistics 26, with extensive data cleaning to ensure the accuracy of the dataset. Multiple linear regression analysis was applied to assess the influence of sociodemographic factors and maternal behaviors on purchase intentions and their subsequent impact on children's iron intake.

Setting and population

The study focused on mothers in pair of children aged 6–23 months who met the inclusion criteria: children without congenital diseases, not undergoing any specific diets, and whose mothers signed the informed consent. The exclusion criteria included respondents who did not complete the questionnaires. Sampling was conducted using a consecutive sampling method at 10 (ten) integrated health post, commonly known as *Pos Pelayanan Terpadu or Posyandu*, under the Baja Public Health Center work areas.

Sample size

Sample size was estimated to test the hypothesis of association between mothers' purchase intentions of iron-fortified infant cereal and iron intake among children aged 6-23 months in Tangerang, using sample size for correlation with 95% confidence interval. Assuming correlation between mothers' purchase intention of iron-fortified infant cereal and sugar-related attitude of 0.59[20], considering the design effect (DEFF=2) to account for the increased variation due to not using a simple random sampling technique and an 80% response rate, the minimum sample size for this study is 148 respondents. Nonetheless, the final sample of the study was 162 mothers, which can be seen in the participant selection flowchart (**Figure 1**).

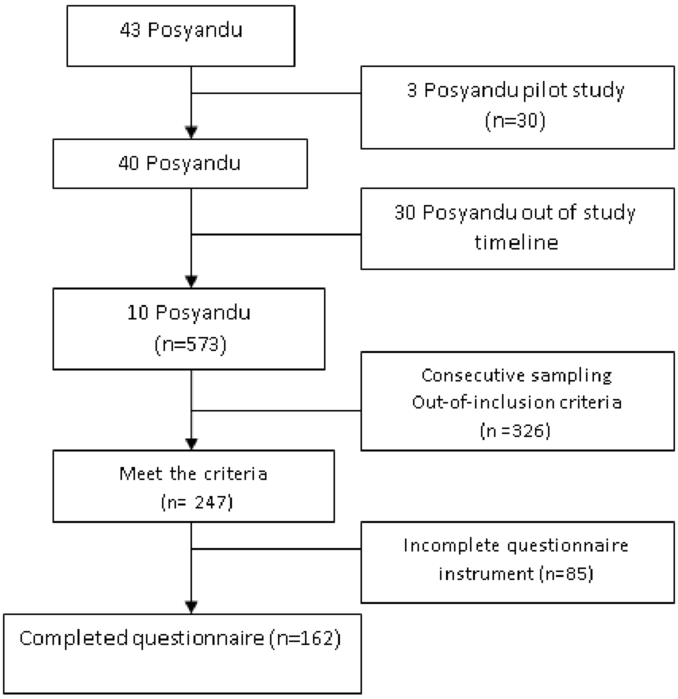

Figure 1. Participant selection

Variable measured

Data were collected using various tools. including questionnaires adapted from the Theory of Planned Behavior (TPB). The questions included mothers' purchase intention of iron-fortified infant cereals, which had been validated (Purchase Intentions: KMO = 0.509; Bartlett's test: p = 0.000) and measured using a Likert scale.

Sociodemographic characteristics were explored through structured interviews. Mothers' knowledge of nutritional claims on fortified cereals and iron-rich food sources was also assessed through structured interviews utilizing validated questionnaires. Children iron intake was assessed using Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ). Additionally, an actual purchase questionnaire, supplemented by online searches and retail store visits, was used to identify the most frequently purchased iron-rich infant cereals.

Enumerators was trained to ensure consistent data collection. All questionnaires used in the study were validated based on the previous pilot study[21].

Statistical analysis

The data were analyzed using IBM SPSS Statistics 26. A Mann-Whitney test was conducted to examine the association between mothers' purchase intentions, actual purchases of iron-fortified infant cereals, and iron intake in children aged 6–23 months in Tangerang, Indonesia. Subsequently, multivariate analysis was performed to identify potential confounding factors.

Ethical approval

The study has been approved by the Unit of Ethical Research, Medical Research Unit, Universitas Indonesia (KET-110/UN2.F1/ETIK/PPM.00.02./2024).
All participants in this study provided written informed consent before participated.

Results

Iron intake among children 6-23 months in Tangerang

Table 1 showed an overview of the sociodemographic characteristics of mothers and their children, highlighting factors that might influence iron intake among children aged 6–23 months. It underscored the role of mother's education and nutrition knowledge about iron nutrition claim, as well as household income and mother's employment status. More than half of the participants (n= 84, 51.9%) reported to actually purchasing infant cereal. The data revealed disparities in children's iron intake, with a notable proportion not meeting the recommended levels despite high rates of food purchases. These findings suggest that, beyond access to food, other factors such as mother's knowledge and socioeconomic conditions may play a critical role in ensuring adequate nutrition for children in this age group.

Table 1. Sociodemographic characteristic of mothers' and children's iron intake 6-23 month

Variable	Median (min-max)	n%	
Age mother (n%)			
< 25 years		22	13.6 %
≥ 25 years		140	86.4 %
Education of mother (n%)			
Primary/Junior /Senior high school		86	53.1%
Diploma/University/ Postgraduate		76	46.9%
Household income (n%)			
< Rp. 5.000.000 ($ 306.20)		59	36.4 %
Rp. 5.000.000 ($ 306.20)– Rp. 10.000.000 ($ 612.40)		80	49.4 %
> Rp. 10.000.000 ($ 612.40) – Rp. 15.000.00 ($918.60)		20	12.3%
> Rp. 15. 000.000 ($918.60)		3	1.9 %
Occupation (n%)			
Working mother		80	50.6%
Non-working mother		82	49.4%
Mother Iron Nutrition Claim Knowledge (n%)			
Not good knowledge (score < 70)		69	42.6%
Good Knowledge (score ≥ 70)		93	57.4%
Actual purchase			
Purchase (n%)		84	51.9%
Not Purchase (n%)		78	48.1%
Gender (n%)			
Boys		86	53.1%
Girls		76	46.9%
Age Children (n%)			
6-11 months		41	25.3%
12-17 months		62	38.3%
18-23 months		59	36.4%
Children Iron Intake			
6-11 mo (≥ 11 mg/day)	7(1-29)		
Meet		14	34.1%
Below		27	65.9%
12-23 mo (≥ 7 mg/day)	9 (1-37)		
Meet		77	63.6 %
Below		44	36.4%

Association between mother's purchase intention of iron-fortified infant cereal and iron intake

The findings of the association analysis between mother's purchase intention of iron-fortified infant cereal and iron intake in children aged 6-23 months, using the Spearman correlation test, indicate that there is no significant association between the two variables (r = 0.051, p-value=0.522).

Association between actual purchase and iron intake

The analysis of the association between actual purchase of iron-fortified infant cereal and iron intake revealed no significant association. However, it was found that the iron intake of children aged 6-23 months in the purchase category was higher than in the non-purchase category, as illustrated in the box plot in **Figure 2**.

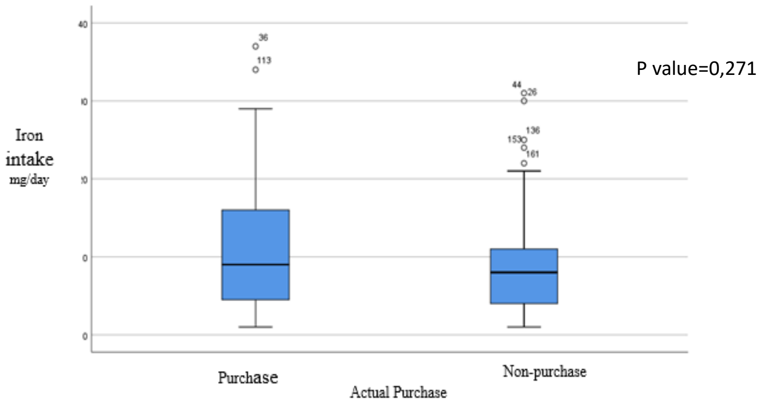

Figure 2. Association between actual purchase with iron intake

Factors associated with iron intake

Based on the analysis of respondents' characteristics and iron intake, statistically significant associations were observed in several areas. Gender appears to influence iron intake, with girls having a higher median intake than boys. Mother's education is also significant factor, as children of mothers with higher education levels tend to have better iron intake. Similarly, mother's occupation has a notable impact, with children of non-working mothers having lower iron intake compared to those of working mothers. Household income is another significant factor, with higher income levels associated with better iron intake. However, no significant associations were found between children's age, mother's age, or mothers' knowledge of iron sources and children's iron intake. These findings emphasize the importance of mother's education, employment, and socioeconomic status in improving children's dietary quality, as shown in **Table 2**.

Table 2. Children and mother's characteristics with iron intake (n=162)

Variable	Iron intake (mg/day) median(min-max)	P value
Median gender (range)		
Boy	7.50 (1-37)	0.025[mw*]
Girl	9.00 (1-34)	
Median age children (range)		
7-11 months	7(1-29)	0.654[kw]
12-17 months	8 (1-37)	
18-23 months	9 (2-31)	
Education of mothers		
Primary/Junior/Senior high school	7.5(1-37)	0.019[a]
Diploma/University/Postgraduate	9 (2-34)	

Variable	Iron intake (mg/day) median(min-max)	P value
Mother occupation		
Work	9 (2-34)	0.009mw*
Non-working mother	7 (1-37)	
Age of mother		
< 25 years	7 (2-31)	0.829mw
≥25 years	9 (1-37)	
Mother Knowledge of Iron Source Claims		
Not good knowledge (score <70)	9 (1-37)	0.565mw
Good knowledge (score ≥70)	8 (1-34)	
Household income		
<Rp. 5.000.000	6(1-37)	
Rp. 5.000.000-Rp. 10.000.000	9(1-34)	0.007kw*
Rp. 10.000.000-Rp. 15.000.000	9(1-34)	
> Rp. 15.000.000	10(5-26)	

mw = Mann Whitney kw = Kruskall Wallis

Assessment of the confounding factors

The next step is to assess confounding, which occurs when covariates affect the association between the main risk factor and the outcome. Sociodemographic factors like gender, mother's education, occupation, income, and iron nutrition claim knowledge were included in the model. Gender was significant ($p = 0.020$). A second linear regression model revealed no significant effects for knowledge of iron claims, purchase intention, or actual purchase. In the third model, gender remained significant ($p = 0.024$, **Table 3**).

Table 3. Multivariate models to assess confounding factors (n=162)

Multivariate Models	Parameter	Parameter Estimate	Standard Error	p-value
First Model	**Intercept**	2.278	3.423	0.507
	Gender	2.828	1.204	0.020*
	Education Mother	0.218	0.324	0.502
	Occupation Mother	-0.107	1.483	0.943
	Household income	1.060	1.202	0.379
Second Model	**Intercept**	9.621	5.645	0.090
	Iron nutrition claims knowledge	1.203	1.233	0.331
	Actual purchase	-1.695	1.355	0.213
	Intention	0.198	0.740	0.790
Third Model	**Intercept**	2.936	6.567	0.655
	Gender	2.747	1.209	0.024*
	Education of mother	0.238	0.328	0.468
	Household income	0.952	1.228	0.439
	Occupation mother	0.127	1.498	0.932
	Intention	0.171	0.739	0.817
	Iron nutrition claim knowledge	0.469	1.292	0.717
	Actual purchase	-1.551	1.346	0.251

*Significance level p<0.05

Discussion

Iron intake among children 6-23 months in Tangerang

Based on the results of this research, significant differences were highlighted in maternal education, with mothers who have higher education demonstrating a better understanding of children's iron intake needs compared to those with lower education[22]. Further findings show that household income also plays a key role, with most respondents earning between five and ten million rupiah, enabling them to effectively meet their children's nutritional needs[23]. Additional findings regarding maternal employment showed no significant impact, indicating that both working and non-working mothers can adequately fulfil their children's iron intake requirements[24].

The results on the maternal knowledge variable show a difference in the number of respondents with mothers who have better knowledge being more prepared to meet their children's iron intake needs. Most respondents with good knowledge understand the importance of adequate iron intake[25].

Regarding purchases, most respondents opted for iron-fortified cereal, reflecting a tendency to act on the need to meet children's nutritional requirements[26]. For gender, although boys require more iron due to higher activity levels, girls in this study had greater iron intake[27]. In terms of age, most respondents were children aged 12–17 months, a period marked by increasing iron needs requiring supplementation beyond breast milk. Children aged 6-11 months can fulfill their nutritional requirements solely through breast milk, whereas children aged 18-23 months need iron-enriched foods provided by multiple micronutrient powders (MNP). [28].

Association between actual purchase with iron intake

The study found no direct link between actual purchases and iron intake. However, children who made actual purchases had higher iron intake than non-purchasers (Figure 1). This aligns with studies from Singapore and the UK, which show that cereal purchasers tend to have better iron intake and status due to the fortification of cereals with iron[29]. A study in Canada found that ready-to-eat cereal consumption improved nutrient intake and diet quality across income levels, with cereal consumers showing higher iron intake[30]. In Tangerang City, formula and breast milk were the main contributors to iron intake in children aged 6-23 months[31].

Association between mother's purchase intention of iron-fortified infant cereal and iron intake

The study found no direct association between mothers' purchase intentions for iron-fortified infant cereal and children's iron intake. Instead, the association appears indirect, influenced by factors like actual purchases and household income. Another study in Banten province, Indonesia, found that families with children aged 6–23 months often struggle to meet iron intake needs, mainly due to low iron in formula milk and mother's health factors. This has increased the demand for iron-rich cereal, which is easy to consume and provides sufficient nutrition[32]. Another study explains that countries with a shortage of children's iron intake often purchase nutritional recipes from countries like Indonesia, which provides iron-rich food tailored to children aged 6-23 months, along with Egypt and Mexico. The study focuses on the purchase of iron-fortified infant cereal, noting that other foods, like breastmilk and formula, also contribute to iron intake. It highlights the strong intention in Indonesian society to buy complementary product commercial feeding (CPCF), linked to children's iron intake[33].

Factors associated with iron intake

The p-value for the association between gender and iron intake was 0.018, indicating an association. This aligns with a study in northern Ghana, which found that iron intake in children aged 6-23 months was influenced by gender. In Ghana, boys are more prone to stunting and diarrhea due to increased exploration during crawling or walking[34]. A lack of iron in children can lead to anemia. A study in Nepal found that children aged 6-23 months with insufficient iron intake, especially boys, were more likely to suffer from anemia. Another study showed that boys have a tenfold higher risk of anemia than girls, particularly at 9 months, with significant differences in hemoglobin levels between boys and girls from 4 to 9 months.[35]

The study shows that mother's education is linked to iron intake in children aged 6-23 months. Consistent with the study[41], higher mother's education leads to better knowledge, enabling mothers to provide appropriate iron intake for their children[36]. Based on a study in Jordan shows that higher mother's education is linked to better iron intake in preschool children, reducing the risk of iron deficiency anemia. Educated mothers are more likely to have knowledge of effective parenting, proper nutrition, and better access to health information [37].

A study on the link between occupation and iron intake in children aged 6-23 months found that a mother's employment status significantly affects iron intake. In southern Iran, recent research suggests that working mothers are more engaged in social life, enabling them to access information on addressing iron deficiencies in children[38]. A study in Egypt found that 88.4% of infants born to non-working mothers had iron deficiency anemia, compared to 15.4% of those born to working mothers. Similarly, a study in Indonesia suggests that a mother's employment status affects children's nutrition, child-rearing patterns, sanitation, and food security. This impacts iron intake in children aged 6-23 months. Additionally, family economic status influences a family's ability to meet the iron intake and healthy living needs of children in this age group[39].

The analysis shows an association between household income and children's iron intake, consistent with studies in Nepal, South Korea, and Toronto. Higher-income households have better access to nutritious food, while lower-income families face a higher risk of iron deficiency due to limited food budgets. A study in South Korea also found that iron, phosphorus, vitamin B9, and vitamin C intake increased with household income[40]. A study of 1245 children in Toronto found that low family income was linked to a higher risk of iron deficiency. Children from low-income households tend to have lower daily iron intake due to limited food budgets[41].

This study provides valuable insights for future research, offering a strong reference point. It uses a validated questionnaire and contributes new data on the intention to purchase iron-fortified infant products, a topic not previously studied. Limitations include insufficient data on iron-fortified infant cereals, mother's recall bias, and the need for expert input on the questionnaire. Strategies like food photo books were used to address biases. Additionally, the health status of children was not investigated due to time constraints.

Conclusion

This study highlights the association between mother's purchase intentions, actual purchases of iron-fortified infant cereals, and iron intake in children aged 6–23 months in Tangerang. While purchase intentions were associated with actual purchases, neither factor such as gender, mother's education, occupation, household income showed a direct link to children's iron intake. These findings suggest that addressing socio-economic disparities and improving mother's education could better support adequate nutrition and iron intake in children 6-23 months. Future studies should explore the indirect effects as well as cultural and environmental factors that promote the practice of providing iron-fortified complementary foods to enhance iron intake in children aged 6–23 months. The governments should collaborate with local /household entrepreneur (UMKM) to create policy to produce iron–fortified complementary food product.

Conflict of interest

The authors declared no conflict of interest regarding this article.

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