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ARTIKEL PENELITIAN

DIETARY FACTORS ASSOCIATED WITH HEMOGLOBIN AND ANEMIA: TEA, COFFEE, AND MEAT CONSUMPTION AMONG ADULT EMERGENCY DEPARTMENT PATIENTS IN JAKARTA, INDONESIA

FAKTOR DIET YANG BERHUBUNGAN DENGAN HEMOGLOBIN DAN ANEMIA: KONSUMSI TEH, KOPI, DAN DAGING PADA PASIEN DEWASA DI UNIT GAWAT DARURAT DI JAKARTA, INDONESIA

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ABSTRAK
Pendahuluan: *Anemia tetap menjadi masalah kesehatan masyarakat di Indonesia. Polifenol dalam teh dan kopi dapat menghambat penyerapan besi non-heme, sedangkan rendahnya konsumsi daging dapat mengurangi asupan besi dengan bioavailabilitas tinggi. Bukti mengenai hubungan faktor diet tersebut dengan status hemoglobin pada populasi klinis dewasa di Indonesia masih terbatas. Penelitian ini bertujuan menilai hubungan konsumsi teh, kopi, dan daging dengan kadar hemoglobin dan status anemia pada pasien dewasa di instalasi gawat darurat (IGD).*
Metode: *Penelitian potong lintang ini melibatkan 193 pasien dewasa di IGD RSUD Cengkareng, Jakarta. Pasien dengan kondisi yang berpotensi memengaruhi hemoglobin, termasuk sirosis, penyakit ginjal tahap akhir, keganasan, perdarahan akut, transfusi darah dalam tiga bulan terakhir, kehamilan, menstruasi, atau gangguan hematologi, dieksklusi. Konsumsi teh dan kopi dinilai sebagai variabel kontinu (cangkir/hari), sedangkan konsumsi daging dikategorikan menjadi <1, 1-2, atau ≥3 kali/minggu. Anemia didefinisikan berdasarkan kriteria WHO. Hubungan dengan kadar hemoglobin dan anemia dianalisis menggunakan uji bivariat serta regresi linear dan logistik multivariabel dengan memasukkan usia, jenis kelamin, IMT, dan variabel konsumsi diet secara simultan.*
Hasil: *Prevalensi anemia adalah 39,4%. Konsumsi teh, kopi, dan daging tidak berhubungan dengan kadar hemoglobin maupun status anemia, baik pada analisis bivariat maupun multivariabel. Jenis kelamin perempuan berhubungan dengan kadar hemoglobin yang lebih rendah pada analisis bivariat (p<0,001) dan hubungan ini tetap signifikan pada regresi linear (B=-1,024; IK95% -1,700 hingga -0,347; p=0,003), tetapi tidak berhubungan secara independen dengan anemia (OR tersesuaikan 1,099; IK95% 0,604-2,001; p=0,757). Usia yang lebih tinggi berhubungan dengan kadar hemoglobin yang lebih rendah (ρ=-0,224; p=0,002) dan dengan peningkatan odds anemia setelah penyesuaian (OR tersesuaikan 1,019 per tahun; IK95% 1,001-1,037; p=0,040).*
Simpulan: *Pada populasi pasien dewasa di IGD ini, konsumsi teh, kopi, dan daging tidak menunjukkan hubungan dengan kadar hemoglobin atau anemia. Usia yang lebih tinggi berhubungan secara independen dengan peningkatan odds anemia, sedangkan jenis kelamin perempuan berhubungan dengan kadar hemoglobin yang lebih rendah tetapi tidak dengan status anemia setelah penyesuaian. Penelitian prospektif dengan penilaian diet tervalidasi dan biomarker status besi diperlukan.*
Kata Kunci: *anemia, daging, hemoglobin, kopi, teh*

ABSTRACT
Introduction: Anemia remains an important public health problem in Indonesia. Tea and coffee polyphenols can inhibit non-heme iron absorption, while low meat intake may reduce the intake of highly bioavailable iron. Evidence on the relationship of these dietary factors with hemoglobin status in Indonesian adult clinical populations remains limited. This study assessed the association of tea, coffee, and meat consumption with hemoglobin levels and anemia among adult emergency department (ED) patients.
Methods: This cross-sectional study included 193 adult ED patients at Cengkareng General Hospital, Jakarta. Patients with conditions likely to affect hemoglobin, including cirrhosis, end-stage kidney disease, malignancy, acute bleeding, blood transfusion within the previous three months, pregnancy, menstruation, or hematologic disorders, were excluded. Tea and coffee consumption were analyzed as continuous variables (cups/day), whereas meat consumption was categorized as <1, 1-2, or ≥3 times/week. Anemia was defined using WHO criteria. Bivariate tests and multivariable linear and logistic regression models simultaneously included age,

sex, BMI, and the dietary exposure variables.
Results: Anemia prevalence was 39.4%. Tea, coffee, and meat consumption were not associated with hemoglobin or anemia in either bivariate or multivariable analyses. Female sex was associated with lower hemoglobin in bivariate analysis (p<0.001) and remained significant in linear regression (B=-1.024; 95% CI -1.700 to -0.347; p=0.003), but was not independently associated with anemia (adjusted OR 1.099; 95% CI 0.604-2.001; p=0.757). Older age was associated with lower hemoglobin (ρ=-0.224; p=0.002) and higher adjusted odds of anemia (adjusted OR 1.019 per year; 95% CI 1.001-1.037; p=0.040).
Conclusion: Tea, coffee, and meat consumption were not associated with hemoglobin levels or anemia in this ED population. Older age was independently associated with higher odds of anemia, while female sex was associated with lower hemoglobin but not with anemia after adjustment. Prospective studies using validated dietary assessments and iron-status biomarkers are needed.
Key Words: anemia, coffee, hemoglobin, meat, tea

INTRODUCTION

Anemia remains a major global public health problem and contributes to substantial morbidity and functional impairment worldwide.[1,2] In Indonesia, the 2018 National Basic Health Research (Riskesdas) reported that anemia prevalence among individuals aged ≥15 years increased from 19.7% to 27.2% in women and from 13.1% to 20.3% in men between 2007 and 2018.[3] More recent analyses using data from multiple Indonesian populations underscore marked heterogeneity in anemia prevalence and etiology.[4] This continuing burden has important implications for long-term health and healthcare systems.[5]

Anemia is multifactorial. Iron deficiency is a major cause, but inflammation and chronic disease, infections, renal disease, and inherited hemoglobin disorders also contribute.[6] Diet can influence iron availability and is potentially modifiable. In Indonesia, coffee and tea are widely consumed, while patterns of animal-source food intake vary and may provide differing amounts of bioavailable iron.[7-9]

Tea and coffee contain polyphenols that can inhibit non-heme iron absorption, whereas meat, particularly red meat, provides heme iron with higher bioavailability and can enhance absorption of non-heme iron through the "meat factor."[10] These mechanisms provide a plausible basis for examining beverage and meat consumption in relation to hemoglobin and anemia.

Several studies have examined the hematologic effects of these dietary components. In Korea, higher coffee intake has been associated with lower ferritin and, in some groups, greater odds of iron-deficiency anemia.[11,12] A large Japanese study similarly found higher green tea and coffee consumption to be associated with lower body iron stores.[13] Conversely, greater meat and fish intake was associated with a lower prevalence of anemia among older Japanese adults.[14] In Indonesia, a study among adolescent girls linked dietary patterns and heme-iron sources with iron-deficiency anemia.[15]

Despite this evidence, important gaps remain. Associations of tea or coffee with ferritin and of meat or fish with anemia vary across populations and study designs.[11-14] In Indonesia, local research has often focused on selected groups such as adolescents,leaving adult clinical populations, including patients encountered in emergency departments, less well characterized.[15] Therefore, this study aimed to examine the association of tea, coffee, and meat consumption with hemoglobin levels

and anemia status among adult patients presenting to an emergency department in Jakarta, Indonesia. The study was intended to provide preliminary, hypothesis-generating evidence for this clinical population.

METHODS

This analytic observational study used a cross-sectional design and was conducted in the Emergency Department of Cengkareng General Hospital, Jakarta, Indonesia, from August to September 2025. A convenience sample of 193 adults aged ≥18 years was recruited among patients for whom a complete blood count was obtained as part of routine care, allowing hemoglobin measurement without additional venipuncture. The sample was not population based, so the findings apply primarily to this clinical setting. Patients with liver cirrhosis, end-stage kidney disease, malignancy, acute bleeding, blood transfusion within the previous three months, pregnancy, current menstruation, or known hematologic disorders were excluded to reduce major sources of confounding.

The minimum required sample size was calculated using a formula for two independent proportions, assuming anemia prevalence of 59.7% among tea drinkers (P_1) and 37.7% among non-tea drinkers (P_2), based on a previous study among women of reproductive age in Pakistan.[16] With a 95% confidence level ($Z_1-\alpha/_2=1.96$) and 80% power ($Z_1-\beta=0.84$), the calculation yielded a minimum of 78 participants per group (156 total). Allowing for 10% non-response, the target sample size was approximately 172 participants. The final sample of 193 participants exceeded this target.

The outcomes were hemoglobin concentration (g/dL, continuous) and anemia status (anemic/non-anemic). Hemoglobin was measured in venous blood using an automated hematology analyzer (Sysmex XN-1000, Sysmex Corporation, Kobe, Japan) as part of routine clinical laboratory testing. Anemia was defined according to the 2024 WHO cutoffs (<13 g/dL for men and <12 g/dL for women).[17] Ferritin and transferrin saturation were not measured; therefore, the etiology of anemia and the relative contribution of iron deficiency could not be determined. Iron-absorption mechanisms discussed below should consequently be interpreted as biologically plausible explanations rather than confirmed etiologic findings.

The exposure variables were coffee consumption (cups/day), tea consumption (cups/day), and meat consumption (<1, 1-2, or ≥3 times/week). Each dietary exposure was assessed by the study investigator through a structured interview using a single frequency question. Coffee and tea were quantified as cups per day, consistent with exposure metrics used in previous studies of beverage intake and iron status, although those studies commonly analyzed intake using categorical thresholds.[11-13] Meat-consumption categories were adapted from Fardaus, *et al*. A one-week recall window was used to reduce the burden of longer retrospective recall; however, it may not represent habitual long-term intake and may be distorted by acute illness around the emergency department visit.[18] No formal reliability or validity testing was performed because

each exposure was captured using a single question. Future studies should use validated multi-item dietary assessment tools, such as a food-frequency questionnaire.

Covariates included age (years), sex (male/female), and body mass index (BMI). Weight and height were measured at presentation using a calibrated digital column scale (Seca 703, seca GmbH, Hamburg, Germany) and stadiometer (Seca 220), with patients in light clothing and without footwear. BMI was calculated as weight (kg)/height (m^2) and classified using Asia-Pacific criteria: underweight (<18.5), normal (18.5-22.9), overweight (23.0-24.9), obese I (25.0-29.9), and obese II (≥30).[19]

Data were analyzed using IBM SPSS Statistics version 25.0. Descriptive statistics summarized participant characteristics. Normality of continuous variables was assessed using the Kolmogorov-Smirnov test with Lilliefors correction; hemoglobin, age, BMI, coffee, and tea consumption showed non-normal distributions (all $p<0.05$), so non-parametric methods were used for bivariate analyses. Associations with hemoglobin were assessed using Spearman's rank correlation for age, BMI, coffee, and tea; the Mann-Whitney U test for sex; and the Kruskal-Wallis test for meat-consumption frequency. Associations with anemia status were assessed using the Mann-Whitney U test for continuous variables and the chi-square test for categorical variables. Multivariable linear regression included age, sex, BMI, meat-consumption frequency (dummy-coded; reference <1 time/week), coffee, and tea simultaneously; variance inflation factors (VIFs) were used to assess multicollinearity. Binary logistic regression included the same predictors and reported adjusted odds ratios (ORs) with 95% confidence intervals (CIs). Logistic model fit was assessed using the Hosmer-Lemeshow test. Statistical significance was set at $p<0.05$.

This study received ethical approval from the Health Research Ethics Committee of Cengkareng General Hospital (Approval No. 001/KEP/RSUD/VIII/2025). Informed consent was obtained from all participants before enrollment.

RESULTS

A total of 193 adults participated in the study. The mean age was 48.0 ± 17.3 years, and the mean hemoglobin concentration was 12.65 ± 2.41 g/dL. Mean daily coffee and tea consumption were 1.89 ± 1.36 and 1.39 ± 1.03 cups/day, respectively. The sample comprised 49.2% men and 50.8% women. According to the Asia-Pacific BMI classification, 5.7% were underweight, 71.0% normal weight, 11.9% overweight, 9.3% obese I, and 2.1% obese II. Based on WHO hemoglobin cutoffs, 39.4% of participants were classified as anemic (Table 1).

In bivariate analysis, hemoglobin was negatively correlated with age (Spearman's $\rho=-0.224$, $p=0.002$), indicating lower hemoglobin at older ages. Sex was significantly associated with hemoglobin (Mann-Whitney $U=3{,}143.5$, $p<0.001$); men had a higher mean rank (112.91) than women (81.58). BMI was not associated with hemoglobin ($\rho=0.020$, $p=0.783$). Meat-consumption frequency (Krus-

kal-Wallis H=0.246, df=2, p=0.884), coffee (ρ=-0.009, p=0.896), and tea (ρ=-0.024, p=0.745) were also not associated with hemoglobin (Table 2).

Table 1. Characteristics of Study Participants (n=193)

Variable	Value
Age, years	48.01 ± 17.26
Hemoglobin, g/dL	12.65 ± 2.41
Coffee consumption, cups/day	1.89 ± 1.36
Tea consumption, cups/day	1.39 ± 1.03
Sex	
Male	95 (49.2%)
Female	98 (50.8%)
BMI (WHO Asia-Pacific)	
Underweight (<18.5)	11 (5.7%)
Normal (18.5–22.9)	137 (71.0%)
Overweight (23–24.9)	23 (11.9%)
Obese I (≥25–29.9)	18 (9.3%)
Obese II (≥30)	4 (2.1%)
Anemia status (WHO)	
Anemia	76 (39.4%)
No anemia	117 (60.6%)
Meat consumption	
<1 time/week	67 (34.7%)
1–2 times/week	70 (36.3%)
≥3 times/week	56 (29.0%)

Table 2. Bivariate Associations with Hemoglobin Levels

Variable	Test	Statistic	p-value
Age (years)	Spearman's ρ	-0.224	0.002*
BMI (kg/m²)	Spearman's ρ	0.020	0.783
Coffee (cups/day)	Spearman's ρ	-0.009	0.896
Tea (cups/day)	Spearman's ρ	-0.024	0.745
Sex (mean rank: male 112.91; female 81.58)	Mann-Whitney U	3,143.5	<0.001*
Meat consumption frequency	Kruskal-Wallis H	0.246	0.884

**p<0.05. Spearman's rank correlation was used for continuous/ordinal variables (age, BMI, coffee, tea); the Mann-Whitney U test was used for sex; and the Kruskal-Wallis test was used for the three-category meat-consumption variable.*

Table 3. Bivariate Associations with Anemia Status

Variable	Anemic (n=76)	Non-anemic (n=117)	Statistic Test	p-value
Age (years), median (IQR)	55.00 (22.75)	45.00 (29.50)	MW U=3,593.5	0.025*
BMI (kg/m²), median (IQR)	21.31 (2.97)	21.54 (3.22)	MW U=4,318.5	0.737
Coffee (cups/day), median (IQR)	2.00 (2.00)	2.00 (2.00)	MW U=4,180.0	0.473
Tea (cups/day), median (IQR)	1.00 (1.00)	1.00 (1.50)	MW U=4,212.5	0.523
Sex, n (%)			χ^2=0.172	0.678
Male	36 (37.9%)	59 (62.1%)		
Female	40 (40.8%)	58 (59.2%)		
Meat consumption, n (%)			χ^2=1.075	0.584
<1×/week	27 (40.3%)	40 (59.7%)		
1–2×/week	30 (42.9%)	40 (57.1%)		
≥3×/week	19 (33.9%)	37 (66.1%)		

**p<0.05. The Mann-Whitney U test was used for continuous variables, and the chi-square test was used for categorical variables. Percentages for sex and meat-consumption categories are row percentages.*

In bivariate analysis (Table 3), age was significantly associated with anemia status: the median age was 55.00 years among anemic participants and 45.00 years among non-anemic participants (Mann-Whitney U=3,593.5, p=0.025). BMI (median 21.31 vs. 21.54 kg/m², p=0.737), coffee consumption (median 2.00 vs. 2.00 cups/day, p=0.473), and tea consumption (median 1.00 vs. 1.00 cups/day, p=0.523) were not associated with anemia status. Sex (p=0.678) and meat-consumption frequency (p=0.584) were likewise not associated with anemia.

In multivariable linear regression (Table 4), the overall model was statistically significant (F(7,185)=2.969, p=0.006), although it explained a modest proportion of hemoglobin variance (R^2=0.101; adjusted R^2=0.067). Female sex (B=-1.024; 95% CI -1.700 to -0.347; p=0.003) and older age (B=-0.027 per year; 95% CI -0.046 to -0.007; p=0.008) were independently associated with lower hemoglobin. BMI, meat-consumption frequency, coffee, and tea were not independently associated with hemoglobin. VIFs ranged from 1.02 to 1.34 (tolerance 0.746-0.981), indicating no meaningful multicollinearity among predictors.

In binary logistic regression (Table 5), older age was independently associated with higher odds of anemia (adjusted OR 1.019 per year; 95% CI 1.001-1.037; p=0.040). Sex (adjusted OR for female vs. male 1.099; 95% CI 0.604-2.001; p=0.757), BMI (adjusted OR 0.965; 95% CI 0.867-1.075; p=0.519), meat consumption (1-2 times/week: adjusted OR 1.142; p=0.709; ≥3 times/week: adjusted OR 0.748; p=0.457), coffee (adjusted OR 1.072; p=0.540), and tea (adjusted OR 1.090; p=0.556) were not independently associated with anemia. The Hosmer-Lemeshow test provided no evidence of poor model fit (χ^2=7.065, df=8, p=0.530).

Table 4. Multivariable Linear Regression for Factors Associated with Hemoglobin Levels

Variable	B	95% CI	p-value	VIF
Sex (female vs. male)	-1.024	-1.700 to -0.347	0.003*	1.038
Age (years)	-0.027	-0.046 to -0.007	0.008*	1.033
BMI (kg/m²)	0.048	-0.069 to 0.164	0.423	1.049
Meat 1–2×/week (ref: <1×/week)	-0.022	-0.816 to 0.772	0.956	1.323
Meat ≥3×/week (ref: <1×/week)	0.476	-0.371 to 1.323	0.269	1.341
Coffee (cups/day)	-0.026	-0.276 to 0.223	0.834	1.040
Tea (cups/day)	-0.020	-0.346 to 0.306	0.905	1.020

**p<0.05. Model: F(7,185)=2.969, p=0.006; R^2=0.101, adjusted R^2=0.067. Reference categories: male (sex) and <1 time/week (meat consumption). VIF=variance inflation factor.*

Table 5. Binary Logistic Regression for Factors Associated with Anemia Status

Variable	B	Adjusted OR (95% CI)	p-value
Sex (female vs. male)	0.095	1.099 (0.604 – 2.001)	0.757
Age (years)	0.018	1.019 (1.001 – 1.037)	0.040*
BMI (kg/m²)	-0.035	0.965 (0.867 – 1.075)	0.519
Meat 1–2×/week (ref: <1×/week)	0.133	1.142 (0.569 – 2.293)	0.709
Meat ≥3×/week (ref: <1×/week)	-0.290	0.748 (0.349 – 1.605)	0.457
Coffee (cups/day)	0.069	1.072 (0.859 – 1.337)	0.540
Tea (cups/day)	0.086	1.090 (0.818 – 1.452)	0.556

**p<0.05. Reference categories: male (sex) and <1 time/week (meat consumption). Hosmer-Lemeshow χ^2=7.065, df=8, p=0.530; there was no evidence of poor model fit.*

DISCUSSION

The anemia prevalence in this study (39.4%) was higher than the sex-specific estimates reported in Riskesdas 2018 (27.2% among women aged ≥15 years and 20.3% among men aged ≥15 years).[3] Direct comparison should be cautious because this study sampled adults presenting to a single emergency department rather than a community-based population. Acute illness, inflammation, and chronic comorbidity can lower hemoglobin through mechanisms such as hepcidin-mediated iron restriction and impaired erythropoiesis.[20] Selection of an acutely presenting clinical population may therefore partly explain the higher observed prevalence and limits generalizability.

Tea and coffee consumption were not associated with hemoglobin or anemia in this study. International studies have more consistently linked these beverages to lower ferritin or body iron stores than to lower hemoglobin.[11-13] Polyphenols can reduce non-heme iron absorption, and the magnitude of this effect depends on timing relative to meals and meal composition.[21-23] Because this study measured beverage frequency but did not capture timing relative to meals, beverage type or strength, portion size, or concurrent dietary enhancers and inhibitors, exposure misclassification may have attenuated associations. The null findings therefore do not establish the absence of an effect on iron status.

Meat consumption was also not associated with hemoglobin or anemia. A 2025 meta-analysis reported a small positive effect of increased red meat intake on hemoglobin, while ferritin effects were more evident in longer interventions.[24] Higher meat and fish intake has also been associated with lower anemia prevalence in older Japanese adults.[14] In the present study, meat exposure was recorded only as weekly frequency, without portion size or direct quantification of heme-iron intake. The one-week recall also poorly matches the longer time scale over which erythropoiesis and circulating hemoglobin reflect iron availability.[26] Acute illness may additionally alter recent intake.[20] Heme iron nevertheless has higher bioavailability than non-heme iron, and animal foods can enhance absorption of non-heme iron.[10,27] The present data, however, cannot support specific dietary recommendations.

Age and sex showed clearer associations with hemoglobin. Older age was associated with lower hemoglobin and was independently associated with higher odds of anemia. Age-related anemia is often multifactorial and can involve chronic inflammation, renal impairment, reduced erythropoietin responsiveness, and altered iron regulation.[28] Female sex was associated with lower hemoglobin in bivariate and linear-regression analyses but not with binary anemia after applying sex-specific WHO cutoffs.[17] Biological differences in erythropoiesis and androgen action may contribute to sex differences in hemoglobin.[29] Because menstruating and pregnant women were excluded, these findings should not be generalized to all adult women.

Short-term dietary exposure may have only a modest relationship with circulating

hemoglobin because most iron used for erythropoiesis is recycled from senescent erythrocytes, while dietary absorption contributes a smaller daily amount to systemic iron balance.[30,31] This physiological context is compatible with weak short-term dietary associations, but it could not be tested directly because ferritin, transferrin saturation, inflammatory markers, and hepcidin were not measured.

Clinically, these findings should be interpreted as evidence of no detectable association within the measurement approach used, rather than proof that tea, coffee, or meat have no influence on iron status. The study is best viewed as hypothesis-generating evidence for an emergency department population. Future studies should assess habitual intake with validated instruments, capture the timing of tea and coffee relative to meals, quantify animal-source foods and portion sizes, and include iron-status and inflammation biomarkers.

This study has several strengths, including direct laboratory measurement of hemoglobin, analysis of both continuous hemoglobin and binary anemia outcomes, and multivariable modeling with assessment of multicollinearity and logistic model fit. Several limitations are important. Participants were recruited non-randomly from a single emergency department, limiting external validity. Dietary exposure was based on brief, unvalidated single-item questions over one week; this may not represent habitual intake and may be distorted by acute illness. Iron-status and inflammatory biomarkers were unavailable, so anemia etiology could not be established. Potential confounders such as smoking, socioeconomic status, comorbidities or reason for emergency presentation, medication or supplement use, and other dietary factors were not measured. The sample-size calculation was based on a dichotomous tea-drinking comparison, whereas the primary tea analysis treated intake as a continuous variable; this may affect the precision of the original power assumptions. Finally, the cross-sectional design precludes temporal or causal inference.

Taken together, hemoglobin status in this emergency department sample was more consistently associated with age and sex than with the measured dietary exposures. The null dietary associations should be interpreted in light of exposure-measurement limitations, the absence of iron biomarkers, and the acute clinical setting. More robust prospective studies are needed before drawing conclusions about dietary determinants of anemia in Indonesian adults.

CONCLUSION

Tea, coffee, and meat consumption were not detectably associated with hemoglobin levels or anemia among adult emergency department patients in this study. Older age was independently associated with higher odds of anemia, while older age and female sex were associated with lower hemoglobin levels. These findings do not exclude longer-term dietary effects on iron status because dietary exposure was measured over a brief period and iron biomarkers were unavailable.

Prospective studies using validated dietary assessments and iron-status biomarkers are warranted.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this article.

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