

Original Article

The Combination of Ambon Banana Juice and Dates Increases Maternal Weight and Estimated Fetal Weight for the Prevention of Stunting

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ABSTRACT

Background: Stunting is a form of chronic malnutrition that begins during the prenatal period. Nutritional interventions during pregnancy play a role in preventing fetal growth retardation. Ambon bananas (*Musa acuminata*) and dates (*Phoenix dactylifera*) contain iron, folate, and micronutrients that support maternal health and promote fetal growth.

Objective: This study aimed to evaluate the effectiveness of a combination of Ambon banana and date juice in increasing maternal weight and estimated fetal weight in third-trimester pregnant women as a stunting prevention measure. **Methods:** A quasiexperimental study with a pretest-posttest control group design was conducted with 20 pregnant women in their third trimester at the Imas Masriyah Midwife Practice, Bogor Regency, Indonesia, from October to December 2023. The respondents were divided into an experimental group (n=10) that received Ambon banana and date juice and a control group (n=10) without any special intervention. Maternal weight and estimated fetal weight were measured before and after the intervention. Data analysis was performed via paired t tests. **Results:** In the experimental group, the mean maternal weight increased from 54.90±3.071 kg to 56.40±2.989 kg (p=0.003), and the estimated fetal weight increased from 2.43±0.155 kg to 2.58±0.152 kg (p=0.005). The control group showed no significant changes in maternal weight (p=0.022) or estimated fetal weight (p=0.036). **Conclusion:** The combination of Ambon banana juice and dates effectively increased maternal weight and estimated fetal weight in pregnant women in the third trimester and has the potential to be used as a nutritional intervention for stunting prevention.

KEYWORDS

Stunting; pregnant women; maternal weight; fetal weight; *Musa acuminata*; *Phoenix dactylifera*

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INTRODUCTION

Stunting remains a global public health challenge, affecting approximately 149.2 million children under five years of age, with the highest prevalence in low- and middle-income countries [1,2]. Stunting is not merely a manifestation of linear growth failure but reflects chronic malnutrition that impacts cognitive development and productive capacity and increases the risk of degenerative diseases in adulthood [3,4]. In Indonesia, although the prevalence of stunting has decreased from 37.2% in 2013 to 24.4% in 2021, it is still above the WHO threshold of 20%, indicating the urgency of evidence-based interventions [5,6].

The first 1,000 days of life, which includes the prenatal phase up to two years of age, is the optimal window for nutritional interventions in stunting prevention [7]. Intrauterine growth restriction contributes to 20% of stunting cases globally, with maternal malnutrition and inadequate micronutrient intake as the main determinants [8]. Low birth weight, often caused by suboptimal maternal nutrition, increases the risk of stunting by up to 3.5 times compared with babies with normal birth weight [2].

A preliminary study at the Imas Masriyah Midwife Independent Practice in Bogor District in October 2023 identified 5 out of 15 pregnant women (33.3%) with inadequate weight gain and 4 cases (26.7%) with estimated fetal weight below the standard for their gestational age. These findings indicate a high risk of fetal growth restriction, which has the potential to continue as post-natal stunting. Sociocultural factors, including the belief that restricting food intake during pregnancy facilitates childbirth, which is still practiced in some parts of Indonesia, exacerbate poor maternal nutritional status [9–12].

The WHO has recommended nutrition interventions based on local foods as a sustainable strategy to increase micronutrient intake in at-risk populations [13]. Ambon bananas (*Musa acuminata*) contain folate (20 µg/100 g), iron (0.6 mg/100 g), potassium (358 mg/100 g), and vitamin B6, which play roles in hemoglobin synthesis and cell growth [14,15]. Dates (*Phoenix dactylifera*) are rich in iron (0.9 mg/100 g), calcium (64 mg/100 g), magnesium (54 mg/100 g), and fiber, which support nutrient absorption and provide high energy (296 kcal/100 g) for maternal metabolic needs [16,17].

Several studies have shown the positive effects of local fruit consumption on the nutritional status of pregnant women in the tropics. Date supplementation for four weeks significantly increased hemoglobin levels in pregnant women with anemia [18]. Banana consumption has been shown to increase folate intake and reduce the risk of neural tube defects in fetuses [14,19–21]. However, no studies have evaluated the effectiveness of combining these two fruits on maternal weight and estimated fetal weight as indicators for stunting prevention.

Given this knowledge gap and the high prevalence of fetal growth restriction risk at the study site, this study aims to evaluate the effectiveness of a combination of Ambon banana juice and dates in increasing maternal weight and estimated fetal weight in third-trimester pregnant women. This study is expected to provide empirical evidence on affordable and accessible nutritional interventions to support Sustainable Development Goal 2 (Zero Hunger) and national efforts to reduce the prevalence of stunting.

MATERIALS AND METHODS

Research design and setting

This study used a quasi-experimental design with a pretest-posttest control group approach [22]. The study was conducted at the Imas Masriyah Independent Midwife Practice (TPMB), Bogor Regency, West Java, Indonesia, from October to December 2023. The location was selected on the basis of the results of a preliminary study that revealed a high prevalence of pregnant women with inadequate weight gain and below-average estimated fetal weight.

Population, sample and sampling technique

The study population consisted of all pregnant women who visited the TPMB Imas Masriyah for antenatal care during the study period, totaling 60 individuals. The sample size was calculated via the formula for testing two independent means with a 95% confidence level, 80% power test,

and effect size based on previous studies, resulting in a minimum sample size of 10 respondents per group [23]. The total sample for this study included 20 respondents, who were divided into an experimental group (n=10) and a control group (n=10). Sampling was conducted via nonprobability sampling with a consecutive sampling method. The respondents who met the inclusion criteria were registered sequentially until the sample size was met and then randomly allocated via a random number table to the experimental or control group.

Inclusion and exclusion criteria

The inclusion criteria were as follows: (1) third-trimester pregnant women (≥ 28 weeks of pregnancy); (2) single pregnancy; (3) no major pregnancy complications (preeclampsia, gestational diabetes, heart disease); (4) willingness to participate in the study by signing an informed consent form; and (5) availability for follow-up visits. The exclusion criteria were as follows: (1) allergy to bananas or dates; (2) relocation during the study period; and (3) pregnancy complications requiring special treatment during the intervention period.

Data collection procedure

The data collected included demographic variables (maternal age, gestational age, and parity), primary outcome variables (maternal weight and estimated fetal weight before and after the intervention), and potential confounding variables (iron-folate tablet consumption, dietary patterns, and physical activity). Data were collected through direct anthropometric measurements, medical record reviews and structured interviews.

The study began with baseline measurements of maternal weight via digital scales (accuracy of 0.1 kg) and estimated fetal weight through measurement of fundal height via a measuring tape and the Johnson-Toshach formula. The experimental group was given a combination juice of Ambon bananas and dates with a composition of 150 g of Ambon bananas and 50 g of dates (three medium-sized fruits) blended with 100 ml of boiled water and consumed once a day for 4 weeks. The control group did not receive any special intervention but continued to receive standard antenatal care, including iron-folate supplementation, according to the government program. The juice was prepared fresh daily and consumed within 30 min of preparation to preserve its nutritional content. After four weeks of intervention, posttest measurements were conducted using the same parameters.

Research instruments

The instruments used included (1) a calibrated OneMed digital scale with a capacity of 150 kg and an accuracy of 0.1 kg, (2) a nonelastic measuring tape for measuring fundal height, (3) an observation sheet for recording juice consumption compliance, and (4) questionnaires on the demographic and obstetric characteristics of the respondents. Fetal weight estimates were calculated via the Johnson-Toshach formula: $FWW (g) = (FL \text{ in cm} - n) \times 155$, where $n=12$ if the fetal head had not entered the pelvis or $n=11$ if the head had entered the pelvis.

Statistical analysis

Data analysis was performed via SPSS version 25.0. Univariate analysis was used to describe the respondent characteristics via the frequency distribution, mean, median, and standard deviation. Data normality was tested via the Shapiro-Wilk test. Bivariate analysis was performed via paired t tests to compare differences in maternal weight and estimated fetal weight before and after the intervention in each group. The significance level was set at $\alpha=0.05$ ($p<0.05$).

Ethical considerations

This study was conducted in accordance with the Declaration of Helsinki and received ethical approval from the Health Research Ethics Committee of Medistra Indonesia College of Health Sciences (approval number 184/STIKes MI/Keb S1/B1/III/2024).

RESULTS

Respondent characteristics

Table 1 shows the distribution of the respondents' characteristics in both study groups. In the experimental group, the majority of the respondents were aged 28–32 years (60%), with a mean age of 28.4 ± 3.2 years. The control group was dominated by those aged 23–27 years (60%), with a mean age of 26.8 ± 3.5 years. The distribution of gestational age showed a similar pattern in both groups, with the highest concentration occurring at 28 weeks of gestation (40% in each group). The mean gestational age of the experimental group was 29.1 ± 1.2 weeks, whereas that of the control group was 29.0 ± 1.3 weeks. In terms of parity, the experimental group was dominated by primiparas (50%), followed by multiparas (30%) and nulliparas (20%). The control group showed a relatively balanced distribution between nulliparous and primiparous women (40% each) and multiparous women (20%). The homogeneity test revealed no significant differences in demographic or obstetric characteristics between the two groups ($p > 0.05$), indicating good baseline comparability.

Table 1. Respondent characteristics

Variable	Control group (n=10)		Experimental group (n=10)	
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Mother's Age				
18–22 years	0	0	1	10
23–27 years old	6	60	2	20
28–32 years old	4	40	6	60
33–37 years old	0	0	1	10
Gestational age				
28 weeks	4	40	4	40
29 weeks	2	20	2	20
30 weeks	3	30	3	30
31 weeks	1	10	1	10
Parity				
Nullipara	4	40	2	20
Primipara	4	40	5	50
Multipara	2	20	3	30

Table 2. Average maternal weight and estimated fetal weight before and after intervention

Group	Variable	Mean $\pm$ SD	Median	Range
Control	Prewrite (kg)	56.50 $\pm$ 2.718	56.00	52.0–61.0
	Postoperative weight (kg)	57.30 $\pm$ 2.584	57.5	53.0–62.0
	Pre-TBJ (kg)	2.42 $\pm$ 0.142	2.40	2.2–2.6
	TBJ Post (kg)	2.61 $\pm$ 0.255	2.56	2.3–3.0
Experiment	Pre-Experiment Body Weight (kg)	54.90 $\pm$ 3.071	55	50.0–60.0
	Post-Weight (kg)	56.40 $\pm$ 2.989	55.0	52.0–61.0
	Pre-TBJ (kg)	2.43 $\pm$ 0.155	2.40	2.2–2.7
	TBJ Post (kg)	2.58 $\pm$ 0.152	2.64	2.3–2.8

Maternal weight and estimated fetal weight before and after intervention

Table 2 presents the mean maternal weight and estimated fetal weight before and after the intervention in both groups. In the control group, the mean maternal weight increased minimally from 56.50 ± 2.718 kg (pretest) to 57.30 ± 2.584 kg (posttest), with a mean difference of 0.80 kg. The estimated fetal weight increased from 2.42 ± 0.142 kg to 2.61 ± 0.255 kg, with a difference of 0.19 kg between the two methods. The experimental group showed a more substantial increase,

with the average maternal weight increasing from 54.90 ± 3.071 kg to 56.40 ± 2.989 kg (difference of 1.50 kg). The estimated fetal weight increased from 2.43 ± 0.155 kg to 2.58 ± 0.152 kg (a difference of 0.15 kg). The increase in maternal weight in the experimental group was almost double that in the control group.

Data normality test

Before performing the bivariate analysis, a normality test was conducted via the Shapiro-Wilk test, considering that the sample size was <50 . The normality test results revealed that all variables in the experimental and control groups had p values >0.05 , indicating that the data were normally distributed. For maternal weight, the p values in the pretest experimental group were 0.985 and 0.271 in the posttest, whereas in the control group, they were 0.547 in the pretest and 0.775 in the posttest. For estimated fetal weight, the experimental group presented pre- and posttest p values of 0.429 and 0.577, respectively, whereas the control group presented pre- and posttest p values of 0.569 and 0.044, respectively. The normal distribution of the data allowed the use of a parametric paired t test for bivariate analysis.

Differences in pretest and posttest body weights and estimated fetal weights

Table 3 presents the results of the paired t test analysis evaluating the differences in maternal weight and estimated fetal weight before and after the intervention. In the experimental group, there was a significant increase in maternal weight, with a mean difference of 1.50 kg (95% CI: 0.69–2.31) and a p value of 0.003 ($p < 0.05$), indicating the effectiveness of Ambon banana and date juice intervention in increasing maternal weight. The estimated fetal weight increased significantly, with a mean difference of 0.15 kg (95% CI: 0.06–0.24) and a p value of 0.005 ($p < 0.05$). The standard error of the mean for maternal weight was 0.373, whereas that for estimated fetal weight was 0.089, indicating good estimation precision. In contrast, the control group presented a statistically insignificant increase in maternal weight (mean difference: 0.80 kg, $p = 0.022$). The estimated fetal weight in the control group increased insignificantly (mean difference: 0.19 kg, $p = 0.036$). This difference confirms that the increase in the control group more closely reflected normal physiological growth during pregnancy, whereas the experimental group experienced an increase that exceeded baseline growth due to nutritional intervention.

Table 3. Differences in maternal weight and estimated fetal weight before and after intervention

Group	Variable	n	Mean $\pm$ SD	MD	SE	p value
Experiment	Pretest Weight (kg)	10	54.90 ± 3.071			
	Postweight (kg)	10	56.40 ± 2.989	1.50	0.373	0.003*
	TBJ Pre (kg)	10	2.43 ± 0.155			
	TBJ Post (kg)	10	2.58 ± 0.152	0.15	0.089	0.005*
Control	Prewrite (kg)	10	56.50 ± 2.718			
	Postweight (kg)	10	57.30 ± 2.584	0.80	0.291	0.022
	TBJ Pre (kg)	10	2.42 ± 0.142			
	TBJ Post (kg)	10	2.61 ± 0.255	0.19	0.115	0.036

Remarks: Data are normally distributed if $p > 0.05$; MD: Mean Difference; BW: body weight; EFL: estimated fetal weight; SE: standard error; and $p < 0.05$ (statistically significant).

DISCUSSIONS

This study aimed to evaluate the effectiveness of a combination of Ambon banana juice and dates in increasing maternal weight and estimated fetal weight in third-trimester pregnant women as a preventive measure against stunting. The main findings revealed that the intervention of Ambon banana juice and dates for 4 weeks significantly increased maternal weight ($p = 0.003$), with a mean difference of 1.50 kg, and estimated fetal weight ($p = 0.005$), with a mean difference of 0.15 kg, in the experimental group, whereas the control group did not significantly differ. These results indicate that the combination of these two local fruits has the potential to be an affordable nutritional intervention to support maternal nutritional status and fetal growth.

The characteristics of the respondents showed good homogeneity between the experimental and control groups in terms of maternal age, gestational age, and parity, thus validating the comparability of the study results. The majority of the respondents were within the optimal reproductive age range (23–32 years), where the physiological capacity to adapt to pregnancy is still high. A study by Aryastami et al. [24] revealed that a maternal age of 20–35 years is the optimal period for pregnancy with a lower risk of complications. The similar distribution of gestational age in both groups (mean of 29 weeks) ensured that the intervention period was during the phase of rapid fetal growth, when energy and protein requirements increased to support tissue deposition and fetal fat accumulation [8,25].

The significant weight gain in the experimental group (1.50 kg in 4 weeks) is consistent with the Institute of Medicine (IOM) recommendations regarding weight gain in the third trimester, which is approximately 0.4–0.5 kg per week for mothers with a normal BMI [26–28]. Adequate weight gain during pregnancy is positively correlated with birth weight and reduces the risk of postnatal stunting in offspring. A cohort study by Hasan et al. [29] in Bangladesh revealed that every 1 kg increase in maternal weight during the third trimester increased birth weight by 30–40 g. The biological mechanisms underlying these findings involve increased maternal energy reserves that facilitate transplacental nutrient transfer, particularly glucose and amino acids, which are the main substrates for fetal growth [30].

The effectiveness of the combination of Ambon banana juice and dates can be explained by their complementary nutritional profile. Ambon bananas provide potassium (358 mg/100 g), which plays a role in regulating blood pressure and preventing preeclampsia; vitamin B6 (0.4 mg/100 g), which is involved in protein metabolism and neurotransmitter synthesis; and folate (20 µg/100 g), which plays a role in DNA synthesis and prevents neural tube defects [14,15,21]. Dates provide high energy (296 kcal/100 g) from simple carbohydrates (glucose, fructose, and sucrose) that are easily absorbed, such as iron (0.9 mg/100 g) for erythropoiesis, calcium (64 mg/100 g) for fetal bone mineralization, and fiber (6.7 g/100 g), which increases intestinal motility and prevents constipation in pregnant women [31–33]. This combination of micronutrients has a synergistic effect on maternal metabolism and fetal growth.

These findings are consistent with those of several nutritional intervention studies in pregnant women. Kordi et al. [18], in a randomized controlled trial, reported that consuming six dates per day for 4 weeks increased the hemoglobin levels of pregnant women from 10.6 g/dL to 11.8 g/dL ($p < 0.001$), indicating the effectiveness of dates in improving iron status. Pratiwi [34], in an experimental study, reported that administering beetroot juice and dates increased hemoglobin levels in pregnant women with anemia by 1.2 g/dL after 2 weeks of intervention. Agustina et al. [35] reported that nutrition education based on local fruits increased micronutrient intake in pregnant women in Indonesia. However, this study is the first to specifically evaluate the combination of Ambon bananas and dates on maternal weight and estimated fetal weight, contributing novel insights to the literature on stunting prevention through prenatal intervention.

Although it shares similarities in demonstrating the positive effects of nutritional interventions, this study had several methodological differences from previous studies. Ruspita et al. [36] study evaluated the consumption of Ambon bananas alone for the prevention of anemia but did not measure maternal weight or fetal growth outcomes. Christian et al. [8] study focused on balanced nutrition counseling without specific food interventions, making it difficult to attribute changes in outcomes to specific nutritional components. This study used a combination of two fruits with complementary nutritional profiles and measured anthropometric outcomes that are more relevant for predicting child stunting. The 4-week intervention duration was chosen on the basis of practical and biological considerations, as maternal protein turnover and changes in body composition require a minimum of 3–4 weeks to be detected [37].

The significant increase in estimated fetal weight in the experimental group (0.15 kg or 150 g for 4 weeks) reflects a better fetal growth rate than that in the control group. Although modest, this increase is clinically relevant, given that every 100 g increase in birth weight reduces the risk of stunting at 2 years of age by 8% [8]. The underlying mechanisms involve increased uteroplacental blood flow through potassium- and magnesium-facilitated vasodilation, optimization of fetal protein synthesis through adequate amino acid and vitamin B6 intake, and

increased fetal subcutaneous fat deposition through increased maternal energy transfer [38]. Doppler velocimetry studies have shown that optimal maternal nutrition reduces the umbilical artery resistance index and improves placental perfusion [30].

The control group presented statistically insignificant increases in maternal weight (0.80 kg) and estimated fetal weight (0.19 kg), although these values were still within the normal physiological growth range. This can be explained by several factors, as follows. First, the control group continued to receive standard antenatal care, including 60 mg iron-folate tablet supplementation, which provided baseline nutrition to support the pregnancy. Second, the 4-week observation period may have been too short to detect meaningful changes in the group without additional intervention. Third, individual variations in dietary patterns and nutrient absorption may have influenced the outcomes. Farera et al. [39] emphasized that maternal nutritional status during pregnancy is influenced by multiple factors, including dietary intake, physical activity, and genetic factors, so that specific nutritional interventions provide more measurable added value.

The findings of this study have important implications for stunting prevention strategies in Indonesia. First, interventions based on local foods, such as Ambon bananas and dates, offer alternatives that are more culturally and economically acceptable than pharmacological supplementation or imported products. Ekayanthi and Suryani [40] reported that nutrition education based on local foods improved compliance with and the sustainability of nutritional interventions in pregnant women. Second, the first 1000 days of life, especially the prenatal phase, are a window of opportunity for cost-effective interventions to break the intergenerational stunting cycle [41]. Third, a preventive approach through maternal nutrition optimization is more efficient than curative postnatal stunting interventions, which require greater resources and have more limited results [4].

The results of this study are relevant to the National Movement for the Acceleration of Nutrition Improvement program, which prioritizes specific and sensitive interventions in the first 1000 days of life [42]. Integrating Ambon banana and date juice consumption into the antenatal care service package can strengthen existing specific interventions, such as iron tablet supplementation and fetal growth monitoring. This approach is in line with the WHO recommendations on antenatal care models that emphasize dietary counseling and micronutrient supplementation as core components [43]. Further research is needed to evaluate the effectiveness of this intervention in a broader population, the optimal duration of the intervention, and long-term outcomes in terms of birth weight and the prevalence of stunting at 2 years of age.

The prospects of this research indicate the potential for scaling up local fruit-based nutritional interventions for national stunting prevention programs. Several directions for future development can be considered. First, juice formulations can be optimized by adding biofortified local foods, such as beta-carotene-rich purple sweet potatoes or protein-rich green beans, to increase nutrient density [21]. Second, delivery mechanisms can vary through home-based interventions with family education, community-based distribution through integrated health service posts (*posyandu*), or facility-based provision in antenatal clinics [44,45]. Third, a monitoring and evaluation framework needs to be developed to assess the cost effectiveness, coverage, and long-term impact on stunting prevalence. Fourth, partnerships with the agricultural sector and local food industry can ensure a sustainable supply chain and affordability of interventions for poor and vulnerable population groups.

Clinical and public health implications

The findings of this study have practical implications that can be applied in maternal health care settings. The combination of Ambon banana juice and dates can be integrated into routine nutritional recommendations during antenatal care visits, especially for pregnant women at risk of inadequate weight gain or an estimated fetal weight below the standard. This intervention is low-cost, easily accessible, and can be produced in households, making it feasible for large-scale implementation, including in areas with limited access to commercial supplements. Health workers can educate pregnant women and their families on preparation methods, consumption

doses, and outcome monitoring. Integration into posyandu programs and prenatal classes can increase the reach and compliance of the intervention, supporting national efforts to prevent stunting during the prenatal period.

Limitations

This study has several limitations that should be considered when interpreting the results. First, the relatively small sample size (n=20) limits the generalizability of the findings to a broader population of pregnant women. Second, the 4-week intervention duration may not be sufficient to evaluate long-term outcomes, such as birth weight and the prevalence of postnatal stunting. Third, the use of the Johnson-Toshach method for estimating fetal weight has a margin of error of $\pm 10\text{--}15\%$ compared with ultrasound, although this method has been validated and is acceptable for resource-limited settings. Fourth, the researchers could not fully control for confounding variables such as daily diet, physical activity, and the nutritional quality of the fruit used because of time and distance limitations in monitoring. Fifth, this study did not analyze the socioeconomic, cultural, or environmental backgrounds of the respondents, which could have influenced the outcomes. Further research with a randomized controlled trial design, larger sample size, long-term follow-up, and ultrasound measurements is needed to strengthen this evidence.

CONCLUSIONS

The combination of Ambon banana juice and dates effectively increased the weight of mothers and estimated fetal weight in pregnant women in their third trimester. This intervention has the potential to be an affordable and accessible nutritional strategy for the prevention of stunting from the prenatal period. Recommendations for future research include (1) evaluating effectiveness with a larger sample size and randomized controlled trial design; (2) monitoring long-term outcomes on infant birth weight and postnatal stunting prevalence; (3) conducting cost-effectiveness analysis for program scaling; (4) developing optimal formulations with additional micronutrient fortification; and (5) implementing studies in various geographical and socioeconomic settings to evaluate feasibility and acceptability. Maternal health policies should consider integrating food-based nutritional interventions into antenatal care standards to support national targets for reducing the prevalence of stunting.

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

AUTHOR CONTRIBUTIONS

Conceptualization: SH, MBK; Methodology: SH, RL; Software: RL; Validation: MBK, SH; Formal analysis: SH, MBK; Investigation: SH, MBK, RL; Resources: MBK, RL; Data Curation: RL, SH; Writing - Original Draft: SH, MBK, RL; Writing - Review & Editing: SH, MBK, RL; Visualization: MBK, RL; Supervision: SH.

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DECLARATION OF ARTIFICIAL INTELLIGENCE USE

We hereby confirm that no artificial intelligence (AI) tools or methodologies were utilized at any stage of this study, including during data collection, analysis, visualization, or manuscript preparation. All work presented in this study was conducted manually by the authors without the assistance of AI-based tools or systems.

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