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Enhancing Infant Immunization Rates: Determinants of Complete Routine Vaccination in an Urban Indonesian Primary Health Center

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ABSTRACT

Introduction: Infant immunization is crucial in reducing mortality and morbidity, aligning with the Sustainable Development Goals (SDGs) to promote health and well-being. In Indonesia, routine immunization for infants aged 0-12 months includes essential vaccines and newer antigens like PCV and Rotavirus. Maternal beliefs significantly influence immunization completion. This study examines factors affecting mothers' decisions regarding complete immunization in the Banyu Urip Health Center area using the Health Belief Model.

Methods: A cross-sectional study was conducted on 86 mothers with infants aged 12-24 months to assess immunization completeness during their first year. The study analyzed the relationship between maternal perceptions, such as susceptibility, severity, benefits, barriers, self-efficacy, and cues to action and immunization behavior.

Results: Findings showed a moderate relationship between perceived susceptibility, severity, barriers, and cues to action with immunization behavior. A strong correlation was observed between perceived benefits, self-efficacy, and participation in complete immunization. Mothers with higher risk perception, awareness of severity, strong belief in benefits, and self-efficacy, along with strong cues to action and fewer barriers, were more likely to ensure full immunization for their infants.

Conclusion: The study highlights the importance of strengthening awareness and reducing barriers to improve immunization rates. Enhancing maternal self-efficacy and addressing perceived obstacles can increase full immunization coverage, ensuring better health outcomes for infants.

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INTRODUCTION

Infants have weak immune systems, making them susceptible to diseases (1). The role of parents is crucial in providing complete routine immunizations to protect infants from vaccine-preventable diseases (VPDs). VPDs cause 1.5 million preventable child deaths due to incomplete immunization. Each year, 2-3 million child deaths can be prevented through immunization; however, 22.6 million children worldwide are not reached by routine immunization (2). In Indonesia, the immunization program is regulated by the Ministry of Health under Minister of Health Regulation Number 12 of 2017 concerning the Implementation of Immunization.

Immunization is an effort to develop and enhance an individual's immunity to diseases so that they do not become ill or only experience mild illness. According to the Regulation of the Minister of Health of the Republic of Indonesia Number 12 of 2017, immunization is divided into program immunization and optional immunization. Program immunization consists of routine, supplementary, and special immunizations. All these vaccinations must be administered according to the type of vaccine, schedule, and timing specified in the Immunization Implementation Guidelines. Routine immunization, which is given consistently and repeatedly, includes basic and advanced immunizations, such as PCV and Rotavirus immunizations for infants aged 0-12 months (3).

Basic immunization is administered to infants before they reach one year of age and consists of five types: Hepatitis B, BCG, Polio, DPT-HB-HIB, and measles, including the first dose of IPV immunization, which began to be given nationally in 2016. The introduction of the Measles Rubella (MR) vaccine into routine immunization in Indonesia started in 2017-2018, based on ITAGI's recommendation to reduce cases of rubella and Congenital Rubella Syndrome. Rubella immunization was combined with measles immunization into MR immunization. The basic immunization schedule includes four doses of bivalent oral polio vaccine (bOPV) drops and one dose of the Inactivated Poliovirus Vaccine (IPV) injection, with the second dose given at 9 months of age together with Measles-Rubella immunization. WHO and ITAGI recommend this combination to optimize protection against polio (4).

The WHO recommends incorporating various new immunizations such as PCV and Rotavirus into routine immunization. By 2023, routine immunization for infants aged 0-12 months includes not only the basic immunizations but also PCV and Rotavirus. According to the Minister of Health's decrees HK.01.07/MENKES/6780/2021 and HK.01.07/MENKES/779/2022, PCV immunization is routinely administered to reduce morbidity and mortality from pneumonia (5). Additionally, the Rotavirus vaccine was introduced into the national immunization program in 2022 based on recommendations from WHO and ITAGI, with phased implementation in 21 districts/cities with high rates of diarrhea morbidity and mortality (6).

In summary, complete routine immunization for infants aged 0-12 months by 2023 includes basic immunizations and the latest antigens such as PCV and Rotavirus. According to the 2022 Performance Report of the Directorate of Immunization Management, the coverage of complete basic immunization for infants aged 0-11 months reached 92.65%, though it did not meet the target of 94.1% set in the Ministry of Health's 2020-2024 Strategic Plan. However, the coverage of new antigen immunizations reached 90.6%, exceeding the target of 90%. This achievement indicates challenges in the implementation of complete routine immunization, especially due to its relatively recent launch (7).

A previous study at Puskesmas Banyu Urip, Surabaya that conducted by Ari Susanti et al. (2019) found 54 stunted toddlers, with immunization history being the most influential factor ($p = 0.00001$). Among 108 respondents, 54 stunted toddlers had an incomplete immunization history (68.4%), while 54 non-stunted toddlers had a complete immunization history (92.6%). This health center runs the national routine immunization program, but the basic immunization achievement in 2023 was only 84.1% of the 100% target, and new antigen immunizations such as PCV and Rotavirus also fell short of the target. PCV 1 and 2 immunizations in 2023 increased to 85.1% and 83.4%, respectively, while Rotavirus immunization was less than 10%. Barriers to achieving targets included a lack of socialization, mothers' lack of understanding of the benefits of immunization, concerns about side effects, and poor trust in immunization.

The global immunization agenda is confronted with significant challenges, including but not limited to vaccine hesitancy, supply chain issues, unequal access, and weak healthcare systems, which collectively impede vaccine coverage (8). In order to overcome these obstacles and achieve the objectives of the agenda, there is a need to implement strategic solutions, engage the community, establish surveillance systems, ensure equitable distribution of vaccines, and advocate for policy change (9). It is imperative to recognize that overcoming these barriers is

essential to reducing infant mortality and ensuring complete immunization, a particularly pressing concern in Indonesia, where the implementation of new vaccines such as PCV and Rotavirus faces significant challenges. Addressing these issues is not only beneficial in terms of achieving national health goals but also contributes to the global health agenda.

Parental beliefs influence the level of complete routine immunization in infants. According to the Health Belief Model (HBM) theory, beliefs about susceptibility, severity, benefits, barriers, cues to action, and self-efficacy determine an individual's health behavior. This model explains the reasons behind healthy behavior. This study analyzes the determinants of complete routine immunization behavior in infants aged 0-12 months using the Health Belief Model theory.

METHOD

This study employs a clear and systematic approach to ensure the reliability and validity of the findings. Below are the components of the methodology:

Research Type

This study used a quantitative approach with a cross-sectional model, where the study was performed at a single point in time, analyzing both dependent and independent factors. The cross-sectional design is well-suited for the present study, as it furnishes a rapid overview of maternal beliefs and immunization behavior, thereby enabling efficient analysis of numerous factors. A cross-sectional model is more expeditious and less resource-intensive, rendering it suitable for the evaluation of current behaviors and the identification of salient influences.

Population and Sample/Informants

The population in this study comprises all mothers with infants aged 12-24 months. This age range was selected because it allows for the evaluation of complete routine immunization during the first 12 months of the infant's life in the working area of the Banyu Urip Health Center in Surabaya City, totaling 802 individuals. The sample size for this study was determined using the Lameshow formula, resulting in a minimum sample size of 86 from two sub-districts, namely Banyu Urip and Kupang Krajan. The sample was taken using proportional random sampling, a technique that ensures representative samples by taking a balanced number of subjects from each area.

Research Location

This study was conducted in the working area of the Banyu Urip Health Center in Surabaya City, Indonesia, from November 2023 to April 2024.

Instrumentation or Tools

This study using Health Belief Model theory. The Health Belief Model (HBM) is an ideal framework for the study of infant immunization behavior, as it emphasizes the influence of caregivers' perceptions including susceptibility, severity, benefits, and barriers on their decision to vaccinate. HBM-based instruments are characterized by their reliability, which stems from the use of standardized, validated measures to capture these perceptions and predict health behaviors with accuracy. Furthermore, the HBM facilitates the identification of key factors that are essential for the development of targeted interventions aimed at enhancing immunization rates.

Dependent Variable

The dependent variable in this study is the mother's behavior in providing complete routine immunization to infants aged 0-12 months. A questionnaire regarding immunization behavior was developed, consisting of 18 items to be filled out regarding whether immunizations were administered or not. Scoring was done using the Guttman scale with 'yes-no' answers. There are two categories: good if all types of immunizations were given as scheduled, and poor if one or more types of immunizations were not given.

Independent Variable

The independent variables in this study include perceived susceptibility, perceived severity, perceived benefit, perceived barrier, self-efficacy, and cues to action. A questionnaire on maternal beliefs was developed, consisting of 23 questions. Indicators for each belief variable were developed based on previous studies. The indicators for perceived susceptibility include the likelihood of illness, the likelihood of paralysis/death, and vulnerable age (10). The indicators for perceived severity include physiological condition, psychological condition, and social condition (11). The indicators for perceived benefit include the effectiveness and safety of immunizations (12). The indicators for perceived barriers include the healthcare system, healthcare workers, and parental factors (13). The indicators for self-efficacy include magnitude (level of difficulty), generality (breadth of belief), and strength (14). Assessment was done using a 4-point Likert scale. Positive questions used 1 for 'strongly disagree' and 4 for 'strongly agree'. Meanwhile, negative questions used 1 for 'strongly agree' and 4 for 'strongly disagree'. The variables perceived susceptibility, perceived severity, and perceived barrier each consist of 3 questions, with rating categories of low (3-6), moderate (7-9), and high (10-12). The perceived benefit variable consists of 4 questions, with rating categories of low (4-8), moderate (9-12), and high (13-16). The self-efficacy variable consists of 6 questions, with rating categories of low (6-12), moderate (13-18), and high (19-24). Cues to action consist of 4 questions, with rating categories of low (4-7), moderate (8-11), and high (12-16). To test the feasibility and quality of the questionnaire, validity and reliability tests were conducted on 40 respondents outside the sample. The questionnaire test results show a table r > calculated r of 0.313 and Cronbach's alpha > 0.6, indicating that the questionnaire is valid and reliable.

Data Analysis

Statistical analysis was performed using IBM SPSS 25. Demographic variables were presented using descriptive statistics. Significance values were calculated for each belief variable (perceived susceptibility, perceived severity, perceived benefit, perceived barrier, self-efficacy, and cues to action) in relation to routine immunization behavior. Bivariate analysis was performed using the chi-square test to determine the correlation between variables, and Spearman's rho to determine the strength of the relationships.

Ethical Approval

This study was approved by Universitas Airlngga Faculty of Dental Medicine Health Research Ethical Clearance Commission (approval no 0144/HRECC.FODM/II/2024). During the study, we removed the identities of all respondents from the dataset.

RESULTS

Table 1. Descriptive Statistics of Frequency Distribution Based on Modifying Factors

Modifying Factors	Frequencies (n=86)	Percentage (%)
Mother's Age		
Remaja (15-20 years old)	4	4,7
Young Adult (21-40 years old)	80	93,0
Middle-aged Adult (41-60 years old)	2	2,3
Mother's Education		
Not having/completing formal education	0	0,0
Elementary school	1	1,2
Middle School	12	14,0
High School	57	66,3
Undergraduate/Graduate Study	16	18,6
Mother's Occupation		
Stay-at-home Mother	61	70,9
Entrepreneur	5	5,8
Teacher/Lecturer	0	0,0
Civil Servant	0	0,0
Working at a Private Company	20	23,3
Other	0	0,0

Modifying Factors	Frequencies (n=86)	Percentage (%)
Level of Knowledge		
High	45	52,3
Moderate	27	31,4
Poor	14	16,3

Source: Primary Data

Table 1. shows that the respondents are divided into adolescence, early adulthood, and middle adulthood age groups. Most have a high school education or equivalent, followed by higher education, junior high school or equivalent, and elementary school or equivalent. The majority of the respondents' occupations are homemakers, private employees, and entrepreneurs. Most mothers' knowledge about complete routine immunization falls into the good category.

Table 2. Descriptive Statistics of Frequency Distribution Based on Individual Beliefs and Routine Immunization Behavior

Variables	Frequencies (n=86)	Percentage (%)
Perceived Susceptibility		
High	33	38,4
Moderate	35	40,7
Low	18	20,9
Perceived Severity		
High	36	41,9
Moderate	37	43,0
Low	13	15,1
Perceived Benefits		
High	47	54,7
Moderate	26	30,2
Low	13	15,1
Perceived Barrier		
High	13	15,1
Moderate	27	31,4
Low	46	53,5
Self-Efficacy		
High	44	51,2
Moderate	31	36,0
Low	11	12,8
Cues to Action		
High	43	50,0
Moderate	31	36,0
Low	12	14,0
Mother’s Behavior on Completing Routine Immunization for Infants Aged 0-12 Months		
High	57	66,3
Poor	29	33,7
Total	86	100

Source: Primary Data

Table 2. shows that most respondents have moderate perceived susceptibility and perceived severity regarding routine immunization behavior in infants aged 0-12 months. The perceived benefit is in the high category, while the perceived barrier is in the low category. Self-efficacy and cues to action are also in the high category. The majority of routine complete immunization behavior in infants aged 0-12 months in the working area of the Banyu Urip Health Center is in a good category. Out of 86 respondents, 57 have completed routine immunizations, while 29 have not.

Table 3. Inferential Analysis of the Relationship Between Individual Beliefs and Routine Immunization Behavior

Variables	P-value	CC (Coefient Contingency)	Routine Immunization Behavior	
			High	Poor
Perceived Susceptibility	0,000	0,489		
High			90,9	11,1
Moderate			23,2	11,8
Low			27,8	72,2
Perceived Severity	0,000	0,553		
High			88,9	11,1
Moderate			67,6	12,5
Low			0,0	100
Perceived Benefits	0,000	0,623		
High			89,4	10,6
Moderate			57,7	42,3
Low			0,0	100
Perceived Barriers	0,000	-0,501		
High			38,5	61,5
Moderate			40,7	59,3
Low			89,1	10,9
Self-Efficacy	0,000	0,613		
High			90,9	9,1
Moderate			54,8	45,2
Low			0,0	100
Cues to Action	0,000	0,570		
High			88,4	11,6
Moderate			61,3	38,7
Low			0,0	100

Source: Primary Data

Table 3. shows the results of the Chi-Square statistical test, with a p-value of 0.000 < 0.05 for all beliefs, indicating that H1 is accepted. This suggests a relationship between perceived susceptibility, perceived severity, perceived benefit, perceived barrier, self-efficacy, and cues to action with routine complete immunization behavior in infants aged 0-12 months in the working area of the Banyu Urip Health Center. The Spearman Rho test results show a positive correlation coefficient of r = 0.489, indicating a moderate positive relationship between perceived susceptibility (r=0.489), perceived severity (r=0.553), and cues to action (r=0.570) with routine immunization behavior. The Spearman Rho test results also show a positive correlation coefficient of r = 0.623, indicating a strong positive relationship between perceived benefit (r=0.623) and self-efficacy (r=0.613) with routine immunization behavior. A positive relationship means that the higher the perceived susceptibility, perceived severity, perceived benefit, self-efficacy, and cues to action, the better the routine immunization behavior. The Spearman Rho test results show a negative correlation coefficient of r = -0.501, indicating a moderate inverse relationship between perceived barriers and routine immunization behavior. The lower the perceived barrier, the better the routine immunization behavior in infants aged 0-12 months in the working area of the Banyu Urip Health Center.

DISCUSSION

Perceived susceptibility refers to an individual's belief about the likelihood of contracting a disease, which prompts preventive actions if they feel vulnerable (15). For mothers, this pertains to the risk of their babies falling ill or experiencing paralysis/death (10). The higher the perceived risk, the more likely individuals are to take action to reduce that risk (16). Mothers who believe their babies are vulnerable to diseases that can be prevented by immunization are more likely to vaccinate their babies (17). Research shows a significant relationship between perceived susceptibility and vaccination decisions (18). Parent's perceptions of their child's susceptibility to disease predict non-compliance with routine immunization, highlighting the need to raise awareness of risks through health education programs, mass media, and campaigns (19).

Perceived severity refers to a mother's belief about how serious the consequences of their baby's health condition could be (20). This includes beliefs about the dangers resulting from not providing routine immunizations, encompassing physiological, psychological, and social impacts (11). Research shows that a high perception of disease severity and vaccine benefits is positively associated with parents' willingness to immunize (21). Mothers with high perceived severity are more likely to be motivated to carry out routine immunizations because they recognize the serious consequences of not doing so. Conversely, if mothers do not feel threatened by the severity of the potential consequences, preventive actions are likely to decrease (20).

Perceived benefit refers to an individual's subjective opinion about the value of performing a health behavior to offset the perceived threat. If considered beneficial, a person will be inclined to follow the recommended health action (15). The effectiveness and safety of immunization are driving factors in parents' decisions to vaccinate their children, with positive beliefs linked to immunization behavior (12). Research shows that concerns about immunization safety are the main reason caregivers in Canada choose not to immunize (22). Perceived benefit is also associated with influenza immunization behavior in China (18). Cross-sectoral coordination, including the roles of CSOs, NGOs, and healthcare workers, is crucial in building inclusive and sustainable immunization programs. Healthcare workers should thoroughly explain the benefits and risks of vaccines and respectfully correct any misunderstandings (13). According to the findings of a preceding study in Africa, individuals who have not received other vaccines demonstrate a heightened propensity for vaccine hesitancy (23). However, an escalation in vaccination readiness has the potential to attenuate this hesitancy.

Perceived barrier refers to the obstacles perceived by mothers in providing routine immunizations to their children, including issues related to the healthcare system, healthcare providers, and parents themselves. These barriers encompass vaccine availability, lack of information, technical difficulties, the competency of healthcare providers, miscommunication, parental busy schedules, and negative beliefs about immunizations (13). Research in Turkey shows that lack of awareness, missing vaccination schedules, and fear of complications are barriers to Rotavirus immunization (24). Studies in Saudi Arabia and the Eastern Mediterranean region indicate that lower perceived barriers are associated with a higher intention to vaccinate (19,21). Strategies to address these barriers include educating healthcare providers, family-centered approaches, effective communication, clear language use, and promoting the concept of herd immunity (25).

Self-efficacy is the belief in one's ability to perform specific behaviors, including completing tasks and overcoming challenges (10). According to Bandura (1997), self-efficacy has three dimensions: difficulty level (magnitude), behavior scope (generality), and belief strength (strength). Self-efficacy influences individuals' feelings, thoughts, motivation, and behavior. Research in Saudi Arabia, East Asia, China, and Taiwan shows a positive relationship between self-efficacy and child immunization compliance (19,26–28). Additionally, higher self-efficacy and female gender are significantly related to higher “intention to participate” in health programs (29). Parents with high self-efficacy are more likely to immunize their children compared to those with low self-efficacy. Health education programs should include strategies to boost parents' confidence in bringing their children for immunizations (30).

Cues to action are stimuli that trigger the decision-making process to engage in health behaviors. These cues can include support or encouragement from the environment that motivates an individual to adopt healthy behaviors (31). Cues to action can be external signals such as mass media campaigns, social influences, or events, people, or factors that prompt someone to change their behavior (20). Research on influenza immunization in children in Taiwan indicates a relationship between cues to action and influenza immunization status in children. Survey results show that most child caregivers follow recommendations from healthcare professionals (32). Healthcare professionals play a central role in educating patients and parents about the safety and effectiveness of vaccines recommended by health authorities and can positively influence immunization rates simply by answering parents' questions and addressing common misunderstandings (13). This aligns with research on Rotavirus immunization in children in Turkey, which shows that objective and accurate information provided to parents by healthcare providers, especially pediatricians, appears to affect parents' decision-making (24).

A previous U.S. study shows routine vaccination coverage for children and adolescents stayed within 10 percentage points of NIS estimates (2014–2019), though varicella, MMR, and Hepatitis B coverage were consistently lower in model-based estimates (33). Real-time tracking via IIS helped identify coverage gaps and enabled targeted

interventions to prevent outbreaks. These gaps are influenced by healthcare access, accurate records, and government policies like school mandates and the VFC program, which boost coverage. However, incomplete data and migration cause underreporting. Maternal beliefs on safety and disease risk also play a role, with cultural trust in public health increasing vaccine acceptance (33).

Based on the research results, it is evident that the majority of mothers also agree that mass media can provide motivation for them to immunize, with 39 mothers (45.3%) agreeing with this statement. This is consistent with research (34) that shows sources of information, such as magazines and television, and authoritative sources, like interpersonal communication with doctors, nurses, pharmacists, and friends, have a significant positive relationship with parents' perceptions of the benefits of child vaccination and maintaining vaccination schedules. Access to health information can play a crucial role in increasing mothers' awareness to carry out immunizations. Mothers who have received health information from healthcare providers, others, or media have a higher likelihood of completing immunizations compared to those who have not received such information (35). Similarly, access to radio, television, telephone, and computers facilitates easier receipt of health-related information for mothers (36).

The findings indicate that mass media has a positive impact on family planning practices, and radio has proven to be the most effective way to inform the public (37). The family also plays a significant role in encouraging mothers to vaccinate, aligning with research in Pakistan that shows family members such as mothers-in-law, siblings, and friends play a crucial role as sources of health information (38). Parents now have access to a wide and continually growing range of information sources, with varying qualities. On the other hand, a lack of information and communication about immunization can be a major barrier in addressing vaccine hesitancy and increasing vaccination coverage.

To assist decision-makers in vaccination programs, it is important to understand how parents perceive and receive information about immunizations and whether the information or communication methods influence their decision to vaccinate (Ames et al., 2017). Healthcare providers are the primary source of information about immunizations for most parents. Health facilities should thoroughly explain the benefits and risks of vaccines, acknowledge parents' concerns, and respectfully work to correct misunderstandings. Since individuals perceive risks differently, it is crucial to inform parents about potential risks (13).

Cues to action are stimuli that trigger decisions to engage in health behaviors, such as environmental support, mass media campaigns, and social influences (20,31). Research shows that cues to action, such as advice from healthcare providers, have a significant impact on influenza immunization decisions for children in Taiwan (32). Healthcare providers play a vital role in vaccine education, answering questions, and addressing misunderstandings (13,24). Mass media also plays an important role as an information provider (34). Access to health information from various sources increases awareness and the likelihood that mothers will complete immunizations (35,36). Family and friends are also important motivators in immunization decisions (38). The lack of information and communication is a major barrier to addressing vaccine hesitancy and improving vaccination coverage (39). Healthcare providers should detail the benefits and risks of vaccines to address parents' concerns and correct misunderstandings (13).

Limitations and Cautions

This study is limited by its cross-sectional design, which captures data at a single point in time and cannot establish causality between maternal beliefs and immunization behavior. Additionally, self-reported data may introduce response bias, as mothers might overreport immunization adherence. The study's focus on a single health center in Indonesia restricts the generalizability of findings to other regions with different socio-economic and cultural contexts.

Recommendations for Future Research

Future studies should consider a longitudinal approach to assess changes in maternal beliefs and immunization behavior over time. Expanding the study to multiple regions with diverse populations could improve generalizability. Additionally, qualitative research exploring deeper insights into mothers' decision-making processes and the role of healthcare providers in influencing immunization behavior could provide valuable perspectives for intervention design.

CONCLUSION

This study finds that perceived susceptibility, severity, benefits, self-efficacy, and cues to action positively influence complete routine immunization in infants, while perceived barriers have an inverse effect. Lower maternal barriers lead to better immunization behavior. The findings highlight the need for sustained government efforts to improve immunization coverage through equitable services, skilled healthcare resources, community empowerment, a family-centered approach, and quality assurance, as outlined in the Minister of Health Regulation No. 12 of 2017.

In order to enhance the study's impact, policymakers and health practitioners should leverage these findings to design targeted interventions that reduce perceived barriers and enhance positive perceptions of immunization. Such interventions may include educational campaigns addressing vaccine safety and efficacy, community engagement programs to build trust, and healthcare provider training to improve communication with hesitant parents. Additionally, ensuring equitable access to immunization services through infrastructure development and workforce expansion would help bridge gaps in coverage. The integration of these strategies by policymakers is poised to fortify routine immunization programs, thereby leading to the enhancement of child health outcomes and the support of national immunization goals.

AUTHOR'S CONTRIBUTION STATEMENT

LAS: Conceptualization, Methodology, Writing – original draft, Writing - review. MM: Methodology, Writing – original draft. AFZ: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. DAP: Methodology, Project Administration, Writing – review & editing. IN: Data collection, data curation, Writing – draft, Writing – editing. CYL: Data collection, data curation, Writing – draft, Writing – editing. DYR: Data collection, data curation, Writing – draft, Writing – editing. ACS: Writing – draft, Writing – review & editing.

CONFLICTS OF INTEREST

All the authors declare that there are no conflicts of interest.

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Not applicable.

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