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Review Article

Risk Factors for Measles Infection During Measles Outbreaks in Southeast Asia: Literature Review

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ABSTRACT

Background: Measles remains a major health problem in Southeast Asia due to high transmission rates. In 2025, Indonesia ranked seventh with 5,035 cases, while the 2020-2025 trend shows significant fluctuations in Indonesia, the Philippines, and Laos due to outbreaks during certain periods. This study aims to identify risk factors for measles infection during outbreaks in Southeast Asia through a literature review.

Method: The literature review was conducted using databases of PubMed, ProQuest, ScienceDirect, and Google Scholar with measles related keywords. Full-text, open-access articles published within the last 10 years and originating from Southeast Asia were included. Of the 21,051 articles identified and seven articles met PRISMA criteria. Data were extracted, assessed using JBI checklist, and synthesized to identify measles risk factors.

Results: The results showed that risk factors for measles during outbreaks included individual factors (young age, malnutrition, incomplete immunization, history of contact), health services (limited access, delayed treatment), environment (housing density), and socio-demographics (negative perceptions of immunization, indigenous peoples).

Conclusion: Therefore, by identifying these risk factors, measles outbreak control in Southeast Asia can be focused on immunization, nutrition, health services, and community education.

Keywords: Outbreak; Measles; Risk Factors; Southeast Asia

INTRODUCTION

Measles is caused by the measles virus, a member of the family Myxoviridae. Its cycle includes three stages: incubation, prodromal, and eruption.[1] This disease is characterized by its high transmissibility and can easily spread through respiratory droplets and splashes from sneezing or coughing by infected individuals. The transmission risk can be as high as 90% for those who have close contact with infected persons, especially if they have not been immunized or previously infected and therefore lack immunity to the disease.[1] Measles poses a high risk to infants under 1 year old, children with poor nutrition, people living in densely populated and unhygienic areas, and children with immune disorders or vitamin deficiencies.[2] Measles can cause complications in various organs of the body, including the respiratory tract (e.g., bronchopneumonia), the digestive tract, and the eyes (e.g., keratitis).[2]

Given the complexity of this disease, vaccination is crucial for prevention. WHO recommends giving two doses of the measles vaccine to all children, either as a single dose or combined with other vaccines, such as measles-rubella (MR), measles-mumps-rubella (MMR), or measles-mumps-rubella-varicella (MMRV).[3] Along with routine immunizations, the WHO also advocates for mass immunization campaigns in countries with low vaccination rates, targeting all children and vulnerable adults who have no contraindications to measles vaccination.[3] Global efforts to control measles are also directed through the Global Vaccine Action Plan (GVAP), a worldwide immunization strategy that combines existing goals, such as eradicating polio and eliminating measles-rubella, while also establishing new objectives to strengthen immunization programs.[4]

Data show that between 2000 and 2018, stronger health systems and increased vaccination coverage successfully reduced global measles mortality by 73%. However, regional elimination of measles has not been fully achieved or maintained, and in recent years, there has even been a rise in cases and deaths. Due to the highly contagious nature of measles, a vaccination coverage of 95% with two doses administered on time is essential. Currently, global coverage for the first dose of the measles vaccine is around 85%, while coverage for the second dose is only 69%.[4] Therefore, more strategies such as scheduled vaccination campaigns and strengthening routine immunization are necessary.

Despite global efforts to eliminate measles, numerous countries still report high case numbers with various risk factors. According to the latest monthly surveillance data submitted to the WHO for February through August 2025, Yemen leads with 20,732 measles cases. Meanwhile, in Southeast Asia, Indonesia is among the countries with the highest number of cases, ranking seventh among the top 10 countries with 5,035 measles cases.[3] Based on coverage data from the WHO IVB Database for northern Southeast Asia, Cambodia has a low number of cases and is verified as having eliminated measles. In contrast, Indonesia, Laos, and the Philippines remain endemic for measles. The trend in cases from 2020 to 2025 shows that Indonesia, the Philippines, and Laos experienced significant fluctuations, mainly due to outbreaks at certain times. This differs from Cambodia, which has remained relatively stable with few cases. Regarding age distribution, children under 5 years old are the most affected group, especially those who have not received two doses of the vaccine. This situation is worsened by low coverage of MCV2 vaccination in Indonesia and the Philippines, while Cambodia has achieved high immunization rates and can maintain its elimination status.[3]

Several previous studies have identified risk factors for measles infection during outbreaks. Research in Yemen shows that low immunization coverage, poor nutritional status, and close contact with patients are the main factors driving the spread of cases.[5] Meanwhile, a systematic review study in Ethiopia found that the main factors influencing measles infection were vaccination status and contact history, with differences in attack rates and case fatality rates between regions.[6] However, both studies mainly focus on the Middle East and Africa, while comprehensive research in Southeast Asia remains limited. This indicates that the region has a relatively high burden. In 2025, Indonesia ranked seventh with 5,035 measles cases, while Cambodia has successfully maintained its elimination status through high immunization coverage.[4] Therefore, this literature review aims to fill this gap by analyzing the risk factors for measles infection during outbreaks in Southeast Asia.

METHOD

Search Course

The article search process was conducted using the PubMed, ProQuest, Science Direct, and Google Scholar databases, with the final search completed in September 2025. The keywords used are *measles, outbreak, risk factors, KLB, and Campak*. The inclusion criteria were articles published within the last 10 years, available in full text and open access, written in English or Indonesian, and conducted in Southeast Asian countries. The exclusion criteria were review-type publications, full texts that were not freely accessible, and studies that did not include risk factor parameters. The initial article search yielded 21,051 articles. Seven articles were included in the analysis after screening titles and abstracts for relevance. The article selection process followed the PRISMA Flow Diagram (Figure 1).

Data Collection

The authors conducted the entire data collection process, and disagreements will be resolved. The study analyzed data from seven articles, extracting information from each, including the author, year, title, abstract, research type, and significant findings, which were presented as risk factor parameters.

Assessment of Risk of Bias of Individual Studies and Measurements

The authors used the JBI critical appraisal checklist to evaluate the quality of the included observational studies. The checklist covered the following areas: appropriate sampling, clear case definition, valid exposure measurement, valid outcome measurement, identification and management of confounding variables, appropriate statistical analysis, data completeness, and laboratory confirmation. Each area was rated as “Criteria Fulfilled”, “Criteria Not Fulfilled”, “Criteria Not Met”, or “Not Applicable” based on JBI guidelines. The authors conducted a quality assessment of all included studies. After data extraction, the outcomes were recorded as risk factor parameters and displayed in tabular form.

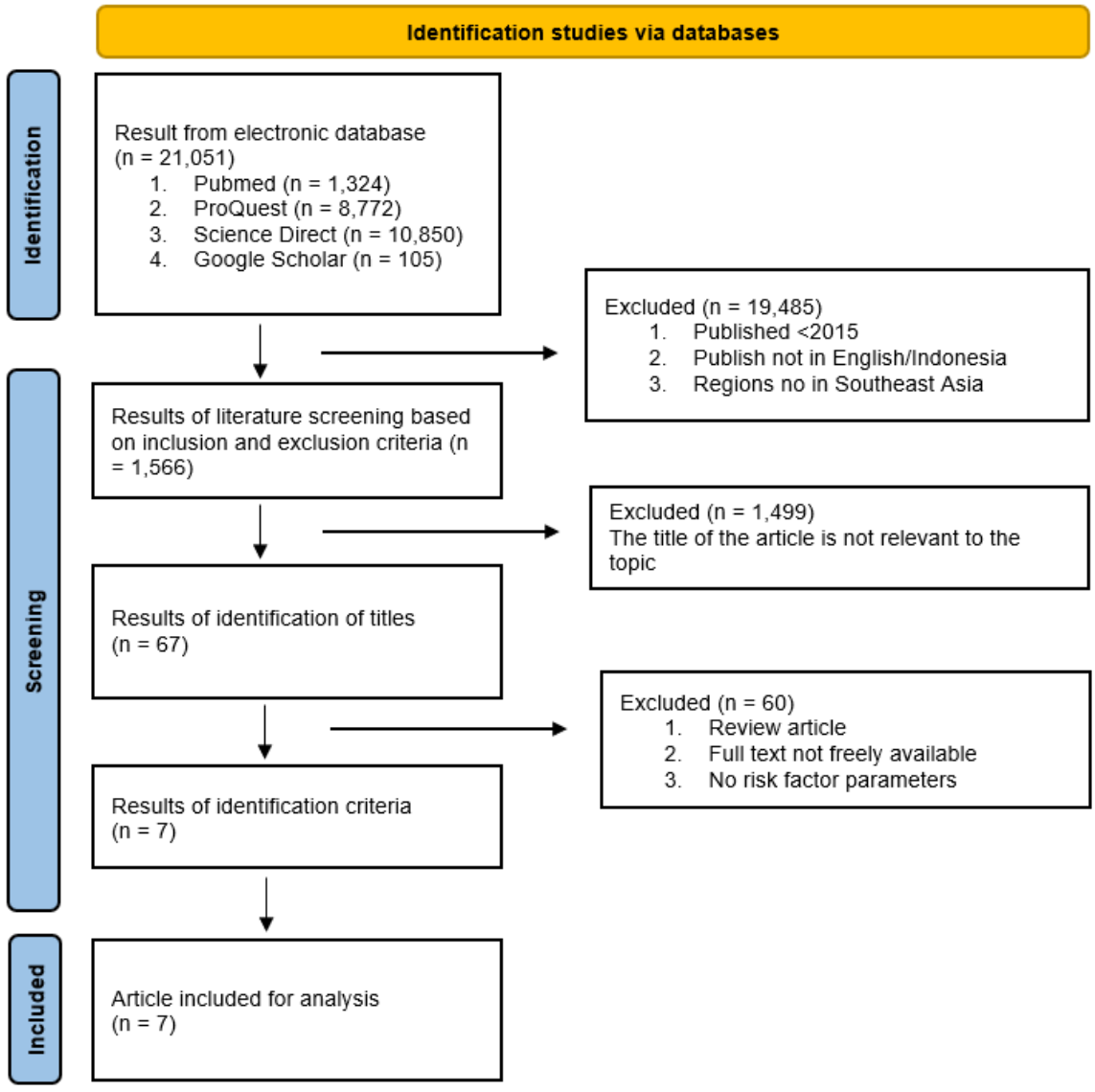

Figure 1. Diagram of Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA)

RESULTS

We yield 21,051 articles from four databases: PubMed, ProQuest, ScienceDirect, and Google Scholar. After screening the author, year, title, abstract, research type, and significant findings, seven articles met the eligibility criteria and were included in the final analysis. The article selection results correspond to the Prisma (Figure 1).

JBI Checklist

A summary of the study assessment is presented in Figure 2. The quality appraisal commenced with an evaluation of the titles and abstracts, through which seven studies were

identified as meeting the eligibility criteria. In total, seven articles were included in this review, showing moderate methodological quality.

Author	Appropriate Sampling	Clear Case Definition	Valid Exposure Measurement	Valid Outcome Measurement	Confounding Identified	Confounding Managed	Appropriate Statistics	Data Completeness	Laboratory Confirmation	Overall Quality
Sitepu et al., (2020)	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	-	High
Tran et al., (2024)	🟢	🟢	🟢	🟢	🟡	🟡	🟢	🟢	🟢	High - Moderate
M. Domai et al., (2022)	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	High
Yurnila and Evi Martha (2024)	🟡	🟢	🟢	🟢	🔴	🔴	🟢	🟢	-	Moderate
Xavier et al., (2024)	🟢	🟢	-	🟡	-	-	🟡	🟢	🟢	Moderate-High
Rosha (2024)	🟢	🟢	🟢	🟢	🟡	🟢	🟢	🟢	🟢	Moderate-High
Ardhiansyah et al., (2019)	🟡	🟢	🟢	🟢	🟡	🟢	🟢	🟢	-	Moderate

Information:

🟢 Criteria Fulfilled

🔴 Criteria Not Fulfilled

🟡 Criteria Not Met

— Not Applicable

Figure 2. JBI Checklist

After screening process using the PRISMA method and quality appraisal conducted with the JBI checklist, seven articles that met all inclusion criteria and demonstrated adequate methodological quality were included in the analysis. These studies represent various research designs and populations across Southeast Asian countries. A summary of the study characteristics and key findings related to measles risk factors is represented in the table below (Table 1).

Table 1. Literature Review Articles

No	Author	Year	Title	Methods (design, samples, variables, instrument, analysis)		Results
1.	Frans Yosep Sitepu, Elpiani Depari, Mudatsir Mudatsir, Harapan Harapan.	2020	Being Unvaccinated and Contact with Measles Cases as The Risk Factors of Measles Outbreak, North Sumatera, Indonesia	D	Case-control study	1. Not vaccinated (AOR= 2,31). 2. History of contact with patients (AOR= 3,44).
				S	All suspected and confirmed cases were recruited and included. Controls were healthy neighbors of cases, matched for age and gender.	
				V	Age group (0-14 year), gender, parents level of education (primary, secondary, tertiary), parent's occupation (businessman, employe, farmer,	

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No	Author	Year	Title	Methods (design, samples, variables, instrument, analysis)		Results
					housewife), Non vaccination, contact with a measles case, travel history to district with measles outbreak.	
				I	Questionnaire and laboratory investigation.	
				A	Univariate, independent t-test, logistic regression.	
2.	Minh Dien Tran, Nhung T. H. Pham, Hoang Nguyen Vu, Minh-Hung Tran, Hoang-Anh Ngo, Phuc H Phan.	2024	Risk Factors for Severe Complications and Mortality Among Hospitalized Child with Measles During a Major Outbreak in Northern Vietnam, 2017-2019	D	Retrospective cohort study	1. A total 87.3% children have not received the measles vaccine (MCV) 2. Children aged <9 months and 9 months to 5 years (AOR=1,74). 3. Distance from residence to hospital (AOR=1,75).
				S	All children admitted with measles admitted to VNCH between 01/01/2017 and 31/12/2019 was undertaken.	
				V	Year of admission (2017, 2018, 2019), sex, age group, vaccination status, place of exposure, distance from the hospital (km), region of residence, clinical outcome, duration between onset and admission, duration of stay within the hospital, underlying conditions, maximal form of respiratory support used, duration between onset and test (detection time) (in hours), diagnosis upon admission, complications, Co-infections, clinical classification	
				I	Questioners, paper, or electronic medical records.	
				A	Univariate, t-test, Firth's Bias-Reduced logistic regression.	
3.	Fleurette M. Domai, Kristal An Agrupis, Su Myat Han, Ana Ria Sayo, Janine S. Ramirez, Raphael Nepomuceno, Shuichi Suzuki, Annavi Marie G Villanueva, Eumelia P. Salva, Jose Benito Villarama, Koya Ariyoshi, Kim Mulholland, Luigi Palla, Kensuke Takahashi, Chris Smith, dan Edna Miranda.	2022	Measles Outbreak in the Philippines: Epidemiological and Clinical Characteristics of Hospitalized Children, 2016-2019	D	A retrospective single-center observational study.	1. Not vaccinated (AOR 1,86). 2. Pneumonia (AOR 2,40). 3. Gastroenteritis (AOR 3,61) 4. Delayed admission hospital 7 to 14 days after fever onset (AOR 2,38). 5. Living outside the NCR (AOR 1.61).
				S	All children aged under five years admitted with measles at SLH from January 2016 to December 2019.	
				V	Year of admission, admission timing, sex, age group, region of residence, distance from the hospital, place of exposure according to caregiver report, vaccination status (all age & aged over 9 month), age at time of first measles vaccination, reported barriers to vaccination, clinical information, duration between fever onset and admission (days), duration between rash onset and admission (days), vitamin A supplementation, Outcome	
				I	Philippine Integrated Disease Surveillance and Response Case Investigation Forms (CIF)	
				A	Univariate and multivariate Firth (penalised likeli hood) logistic regression	
4.	Yurnila dan Evi Martha	2024	Immunization Status and Risk of Measles/Rubella Incidence During Outbreak	D	Case-control study	Immunization history (OR= 3.25).
				S	The sampling strategy used was total sampling 78 individuals, with 44 cases testing positive for measles/rubella and 334 cases testing (control group).	
				V	Sex, age, immunization history, vaccination history.	
				I	Secondary data obtained from the annual report of the immunization surveillance section of the disease control and eradication program division (P2P) of the Pariaman city health department in 2022	
				A	Chi-Square	

No	Author	Year	Title	Methods (design, samples, variables, instrument, analysis)		Results
5.	Gregory Xavier, Nursazila Asikin Mohd Azmi, Syarifah Sakinah Syed Ismail, Gayathri Sandran, Irene K. Thinakaran, Husni Mustafa Mohamed Hir, Ngo Siok Yung.	2024	A Report on Imported Measles Outbreak in Factors at Manjung District, Malaysia in 2019	D	Reported the descriptive study	1. Male workers from Myanmar aged 24.7 years old (RR 12,04). 2. Living in crowded dormitories (RR= 3.88). 3. Immunization status not clear (RR= 0.58).
				S	All workers were considered exposed	
				V	Sex, age, nationality, symptoms, hospitalization, positive sample results	
				I	The laboratory criteria for diagnosis are by finding the presence of measles-specific IgM antibodies, or positive viral detection from the throat swab, or urine sample polymerase chain reaction (PCR)	
				A	Descriptive	
6.	Putri Tiara Rosha.	2024	Investigation of Mixed Outbreak (Measless-Rubella) in Rural Community Temanggung, Central Java	D	Case-control study	1. Did not receive measles immunization (OR=4,47). 2. Age 5-14 years (OR=3,10).
				S	All patients who experienced symptoms of fever and rash accompanied by one or more symptoms of cough, cold, conjunctivitis, diarrhea, and pneumonia were taken as samples. Meanwhile, neighbors of sufferers who were not sick were used as controls.	
				V	Age group, sex, symptoms, sub-village, contact history, vaccination status	
				I	Questionnaires and laboratory test	
				A	Descriptive, bivariate, multivariate	
7.	Ferry Ardhiansyah, Kamilah Budi R, Ari Suwondo, Mexitalia Setiawati, dan Apoina Kartini.	2019	Faktor Risiko Campak Anak Sekolah Dasar pada Kejadian Luar Biasa di Kabupaten Pesawaran, Provinsi Lampung	D	Mix methods research with case control study design supported by in-depth interviews.	1. History of immunization (OR=13,716). 2. History of contact with measles patients (OR=4,141). 3. Housing density (OR=3.971). 4. Home ventilation (OR=3,591).
				S	Purposive sampling	
				V	History of measles immunization, contact history with measles case, occupancy density, age, maternal education, family socioeconomics, and home ventilation	
				I	Questionnaires	
				A	Bivariate and multivariate	

DISCUSSION

The review of the seven articles above indicates that three main factors increase the risk of measles outbreaks during epidemics in Southeast Asia. These factors include: Individual Factors, which include characteristics inherent to a person such as vulnerable age, immunization status, nutritional status, history of close contact, and the possibility of clinical complications; Health Service Factors, which relate to the availability and capacity of services, including the distance to health facilities, the adequacy of facilities, and the coverage and quality of immunization; and Environmental Factors, which include conditions that facilitate transmission, such as population density. These three factors interact to influence the risk of infection and disease spread. The following is a comprehensive discussion of each factor.

Individual Factors

Based on a review of 11 articles in Southeast Asia, individual factors play a dominant role in increasing the risk of measles during outbreaks. Young age is the most vulnerable group, as shown by research in Vietnam, which reported a significant risk in children <9 months and 5

years, and research in the Philippines, which found more than 50% of cases in infants <1 year.[7,8] Meanwhile, in Indonesia, the 5-14 age group also shows an increased risk.[9] Incomplete immunization status has also been consistently identified as a significant risk factor in various studies.[7,10,11] This study's findings are also in line with those of Raodah et al. (2024), who reported that measles immunization plays an important role in reducing the incidence of measles outbreaks, as evidenced by lower measles cases among immunized children compared to unimmunized children.[12] In addition, a history of close contact with patients increases the chance of transmission by up to three times.[10,13] Clinical complications, such as pneumonia and gastroenteritis, also contribute to case severity and mortality.[7] Studies in Yemen and Ethiopia also support that vaccination status, contact history, and complications are dominant determinants in the spread of measles.[5,6] These factors emphasize the importance of interventions such as increasing immunization coverage, improving nutritional status, and educating families.

Healthcare Factors

Healthcare factors further exacerbate the risk and impact of measles during outbreaks. Long distances from residences to healthcare facilities represent a major barrier to timely and appropriate care, with delayed access contributing to increased case severity.[8] Delayed hospital admission, particularly when occurring 7 to 14 days after fever onset, has also been associated with a higher risk of complications due to postponed treatment. Furthermore, children residing outside the National Capital Region (NCR) are at greater risk of delayed referrals and limited transportation, conditions that can worsen clinical outcomes during measles outbreaks.[7]

Healthcare policies related to measles immunization are also important determinants, especially in Southeast Asian countries that face geographic challenges and have hard-to-reach populations. Unlike developed countries, which rely on strong healthcare systems with high immunization coverage, developing countries often depend on supplementary immunization activities (SIAs) to reach children missed by routine immunization. Portnoy *et al.* show that SIAs play a major role in increasing immunization coverage, especially among poor and remote communities, as these policies are designed to close service gaps in areas with limited access to healthcare.[14,15] These findings confirm that Southeast Asian countries need immunization strategies that are better adapted to local geographical and social conditions, so that vaccination services can continue to reach the most vulnerable populations.

Environmental Factors

Micro-level environmental factors, particularly housing density and ventilation quality, play a critical role in increasing the risk of measles transmission. Dwellings with an excessive number of occupants encourage more frequent and intense contact, thereby accelerating the secondary attack rate. Ardhiansyah (2019) reported that individuals living in densely populated environments had up to 1.379 times higher odds of measles exposure.[13] This finding aligns with reports from Malaysia showing that overcrowded worker dormitories create ideal conditions for viral spread due to close physical proximity and high interaction intensity in shared spaces.[16] As the number of occupants in a house increases, the frequency of close contact among household members also rises, which in turn heightens the likelihood that other individuals will be exposed to measles.[17, 18, 19, 20]

Transmission risk increases further when overcrowding coincides with poor ventilation. Inadequate air circulation allows infectious droplets to remain suspended indoors for longer periods. Ardhiansyah (2019) also noted that houses with insufficient ventilation had approximately 1.279 times the risk of measles.[13] The synergy between densely occupied spaces and limited ventilation creates environmental conditions highly conducive to measles transmission, reinforcing that spread is influenced not only by individual-level factors but also by the physical characteristics and environmental quality of residential settings.

CONCLUSION

The literature review demonstrates that risk factors for measles infection during outbreaks in Southeast Asia include individual factors such as young age, poor nutrition, incomplete immunization, and exposure history; health service issues like limited access and delayed treatment; environmental conditions such as overcrowding and poor ventilation; and socio-demographic aspects, including negative perceptions of immunization, indigenous communities, and non-citizen status. These findings suggest that controlling measles outbreaks in Southeast Asia should focus on increasing immunization coverage, improving nutritional status, strengthening health services, and community-based public education to promote vaccination acceptance.

Based on these findings, several practical recommendations are needed to strengthen measles outbreak control efforts in Southeast Asia. Increasing immunization coverage, especially in remote areas. Nutrition improvement and health education programs that increase public knowledge of the importance of vaccination are also important for reducing the severity of the disease. In addition, strengthening access to and capacity of health services through a more responsive surveillance system and improving the preparedness of facilities can help reduce delays in case management. In line with this, further research should focus on more in-depth, systematic literature reviews, expand the scope of reference sources, and critically examine the roles of socio-cultural factors, immunization coverage dynamics, and variations in risk across countries in the region. A methodological review of the quality of previous research is also needed to identify gaps in evidence and potential biases, so that future literature reviews can provide a more comprehensive understanding as a basis for developing more effective and targeted measles control strategies.

Declarations

Authors' contribution

PDR, SB, HAN, FS, and AAR were developing the idea, conducting data collection, and writing the rough drafts of the articles. RDJ and DSSR were reviewing the article.

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Conflict of interest

There is no conflict of interest in this research.

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