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Tel: +6625903894, Fax: +6625903845, Email: osireditor@osirjournal.net, https://he02.tci-thaijo.org/index.php/OSIR

A Design Thinking Approach to Developing an Innovative Board Game for Preventing Leptospirosis among Schoolchildren in Nan Province, Thailand

Patcharin Tantiworrawit[1]*, Panithee Thammawijaya[2]

1 Division of Epidemiology, Department of Disease Control, Ministry of Public Health, Thailand

2 Office of the Senior Expert Committee, Department of Disease Control, Ministry of Public Health, Thailand

*Corresponding author, email address: thisis_mod@hotmail.com

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Abstract

Leptospirosis is a major public health concern in Thailand. In 2024, Nan Province reported an increasing incidence of leptospirosis cases, with schoolchildren accounting for the majority, including one fatality. Entertainment-education is an effective public health communication strategy for school-aged populations, improving both understanding and engagement. This study applied a design-thinking approach to develop an innovative game-based intervention and assess its effectiveness in enhancing awareness, knowledge, and preventive practices related to leptospirosis among schoolchildren. The study employed a mixed-methods research and development design, conducted between January and September 2025. Qualitative methods were used to identify schoolchildren's needs and contexts, which informed the development of the Lepto Game, an interactive simulation board game. A quantitative one-group pre-post design was used to evaluate the intervention's effectiveness. Three main issues were identified: (1) limited communication between schoolchildren and healthcare providers about the disease and its symptoms, (2) low general awareness of leptospirosis, and (3) the need for more engaging and enjoyable health education tools. Among 132 schoolchildren who tested the intervention, satisfaction with learning was very high. In the quantitative study (n=124, 68.5% male, age 12–15 years), significant improvements were observed in mean scores for knowledge of exposure risks (0.395), symptoms (0.387), and self-care practices (0.556). Integrating design thinking with entertainment-education can create engaging interventions that effectively enhance awareness, knowledge, and preventive practices among schoolchildren.

Keywords: leptospirosis, innovative board game, design thinking, schoolchildren

Background

Leptospirosis is a significant public health concern in Thailand.[1–3] The disease is widespread in the northern and northeastern regions.[1] It is an acute zoonotic infection caused by *Leptospira* bacteria, for which rodents and domestic animals serve as common reservoirs. Transmission occurs primarily through direct or indirect contact with water, soil, or animal urine contaminated with the bacteria. In Thailand, leptospirosis is a recurring epidemic, with an annual incidence rate of approximately 4.25 cases per 100,000 population.[3] The rainy season increases rainfall and flooding, which heightens the risk of infection by creating conditions favorable for bacterial survival and transmission.[4,5] Living near rubber plantations and bathing in natural water sources have been identified as significant risk factors for severe leptospirosis in Thailand.[6] Additionally, evidence indicates that pathogenic serovars of *Leptospira* are circulating among livestock and domestic animals.[7]

In 2024, the incidence of leptospirosis in Thailand was 7.21 cases per 100,000 population. The death rate was 0.15 per 100,000 population, with a total of 94 deaths.[3] The northern and southern regions were the most affected, reporting the highest number of cases.[3] The age group over 60 years accounted for the highest number of cases. Inpatient department cases constituted 45.6% (2,135 cases) of the total reported cases (4,680).[3]

On 6 Aug 2024, Nan Provincial Health Office was notified of a severe leptospirosis case admitted to Nan Hospital. A 12-year-old girl developed high fever, headache, myalgia, and fatigue on 1 Aug 2024. She visited Mae Jarim Hospital (the district hospital) twice before being admitted and subsequently referred to Nan Hospital (the provincial hospital), where she died on 9 Aug 2024. According to Digital Disease Surveillance (DDS), Department of Disease Control data from 1 Jan to 30 Aug 2024, Mae Jarim District reported 28 leptospirosis cases, equivalent to an incidence rate of 174.9 cases per 100,000 population. The most affected age group was 10–14 years (n=11 cases), and schoolchildren predominated (n=18 cases). There was one death, resulting in a mortality rate of 6.3 deaths per 100,000 population, and the case fatality rate was 3.6%.

Gamification has emerged as a promising strategy in public health interventions across various domains, including health promotion, disease prevention, and disease management. Evidence suggests that a gamified approach can enhance participant engagement, acceptability, knowledge, and behavior change.[8,9] These interventions have demonstrated particular effectiveness among school-aged children due to their enjoyable and interactive nature.[10] Systematic reviews evaluating the use and effectiveness of board games in health education further highlight their potential to improve health knowledge and promote behavioral modification compared with traditional health education methods.[11,12] The design-thinking approach provides tools for understanding behavioral and experiential insights, integrating individual and community perspectives into public health programs, and generating creative and feasible solutions.[13]

The objectives of this study were to design an innovative game-based intervention and assess its effectiveness in enhancing awareness, knowledge, and preventive practices for leptospirosis among schoolchildren.

Methods

A mixed-methods study was conducted using a design-thinking approach to develop a public health intervention for school-aged children. The study comprised two components: (1) a qualitative study applying a design-thinking approach to explore insights, needs, perceptions, and contextual factors related to leptospirosis in order to design an innovative game-based prevention and control intervention, and (2) a quantitative study to assess the effectiveness of the developed intervention in improving awareness, knowledge, and preventive practices among schoolchildren.

Qualitative Study

The qualitative study applied the five steps of the design-thinking approach: empathize, define, ideate, prototype, and test. It was conducted between January and August 2025.

Empathize

Focus group discussion and in-depth interviews were conducted with key stakeholders, including nine schoolchildren aged 10–14 years, six parents, four teachers, and five healthcare providers in Nan Province, to explore their experiences, behaviors, and insights related to leptospirosis. A total of 24 participants were purposively selected as key informants. Four rounds of discussion were conducted, each lasting approximately three hours.

Define

Thematic analysis of interview data was used to identify core challenges, unmet needs, and contexts.

Ideate

Innovative ideas were brainstormed, and a storyboard for the prototype was developed.

Prototype

Initial prototypes were sketched and developed. These prototypes were then assessed and refined through iterative feedback from stakeholders.

Test

A focus group discussion and a survey were conducted with 132 schoolchildren from Mae Jarim School, aged 10–14 years, to evaluate the usability of the prototype and overall user experience.

Quantitative Study

Study design

A one-group pre-post quantitative design was used to evaluate changes in knowledge, attitudes, and practices (KAP) related to leptospirosis among schoolchildren following the implementation of the developed intervention. Participants completed a structured questionnaire assessing baseline scores prior to the intervention. After the intervention, the same questionnaire was administered again to measure changes in KAP.

Setting and sample size

The study was conducted from August to September 2025. A school in Mae Jarim District, Nan Province, was purposively selected due to its increased incidence and mortality from leptospirosis. The school is a public secondary school (grades 7–12) with 434 students. All schoolchildren aged 10–14 years in grades 7–9 were

invited to participate. The sample size calculation applied the paired t-test (dependent samples) model by using the formula:

$$n = \frac{(Z_{1-\alpha/2} + Z_{1-\beta})^2 \times 2(1-\rho)}{d^2}$$

where d refers to the standardized mean difference between pre- and post-intervention scores, α denotes the probability of a type I error, ower $(1-\beta)$ represents the probability of detecting a true pre-post difference, and ρ represents the assumed proportion of participants with an acceptable level of knowledge about the disease; with d=0.26, α=0.05, power=0.80, and ρ=0.50.[14–17]

$$n = \frac{(1.96 + 0.84)^2 \times 2(1-0.5)}{0.26^2} \approx 116$$

The estimated sample size based on the above calculation was 116. The sample size was increased by eight participants due to the availability of additional schoolchildren, resulting in a final sample of 124 schoolchildren.

Data Collection

A self-administered questionnaire was developed based on a comprehensive review of current literature and existing validated instruments to assess knowledge, attitudes, and practices related to leptospirosis. The development process included item generation, content validation by three field epidemiologists and two zoonotic disease experts, and pre-testing with 10 participants to ensure clarity, relevance, and comprehensibility. The questionnaire consisted of 12 multiple-choice items: four on disease knowledge and risk behaviors, four on symptoms, and four on self-care practices. Each correct item was scored as one point, for a total possible score of 12.

Statistical Analysis

Descriptive statistics, including percentages, means, and standard deviations (SDs) were used to summarize the data. Paired t-tests were used to compare pre- and post-intervention mean scores for knowledge of leptospirosis, risk behaviors, exposures, symptoms, and self-care practices, with a statistical significance level of 0.05. Data analysis was conducted using Jamovi.[18]

Results

Qualitative Study

Empathize and define

Based on four focus group discussions involving 24 participants, three main issues were identified: (1) limited communication between schoolchildren and healthcare providers about the disease and its symptoms, (2) low general awareness of leptospirosis, and (3) the need for more engaging and enjoyable health education tools. Most schoolchildren reported delays in seeking medical care due to fear of visiting doctors or hospitals: *"I'm afraid to go to the hospital, and I only have my friend to take care of me"* (Student 3). Limited knowledge about leptospirosis and its symptoms further contributed to the delayed health-seeking behavior: *"I didn't know about leptospirosis until I heard the rumor that a student had died from it"* (Student 7). Additionally, some children who did not live with their parents had to care for themselves and relied on friends or teachers to accompany them to the hospital: *"If I have a mild sickness, I won't ask for help; only if it's severe I will ask my friend to help me"* (Student 4). Schoolchildren also expressed a desire for enjoyable and engaging team-based activities that they could participate in with their peers, such as playing games together. As some children noted, *"In my free time, I enjoy playing with my friends"* (Student 1,2,6,8,9).

Ideate

A brainstorming session was conducted to explore ideas for (1) developing engaging and enjoyable health education tools, (2) enhancing awareness of the disease, its symptoms, and self-assessment of symptom severity, and (3) improving communication of personal health conditions to healthcare professionals. An interactive board game on leptospirosis was identified as the final, refined concept. The game is designed for teams of two to five players and is based on a scenario in which participants travel with friends while managing their own risks of contracting *Leptospira*. Key risk scenarios include exposure to flooding, wading through water, walking through mud, and having open wounds. During gameplay, players experience simulated symptoms such as fever, myalgia, diarrhea, nausea, vomiting, conjunctivitis, jaundice, and subcostal pain following exposure to these risk situations and behaviors. The use of protective items such as boots, sneakers, bandages, and tepid sponges reduces or eliminates these symptoms, protecting against disease progression (Figure 1).

Prototype and test

Multiple prototypes of the Lepto Game were developed and tested among the developers, with iterative refinements leading to the final version. The final prototype was tested with 132 schoolchildren aged 10–14 years from Mae Jarim School. The mean satisfaction score reported by participants was 4.73 out of 5. Schoolchildren described the game as highly engaging and fun, with 71.2% expressing interest in replaying it. Additionally, 81.8% reported feeling more encouraged and confident about seeking medical care, and 85.6% noted improved understanding of leptospirosis. Participants expressed the greatest satisfaction with the game's enjoyable, exciting, and competitive elements.

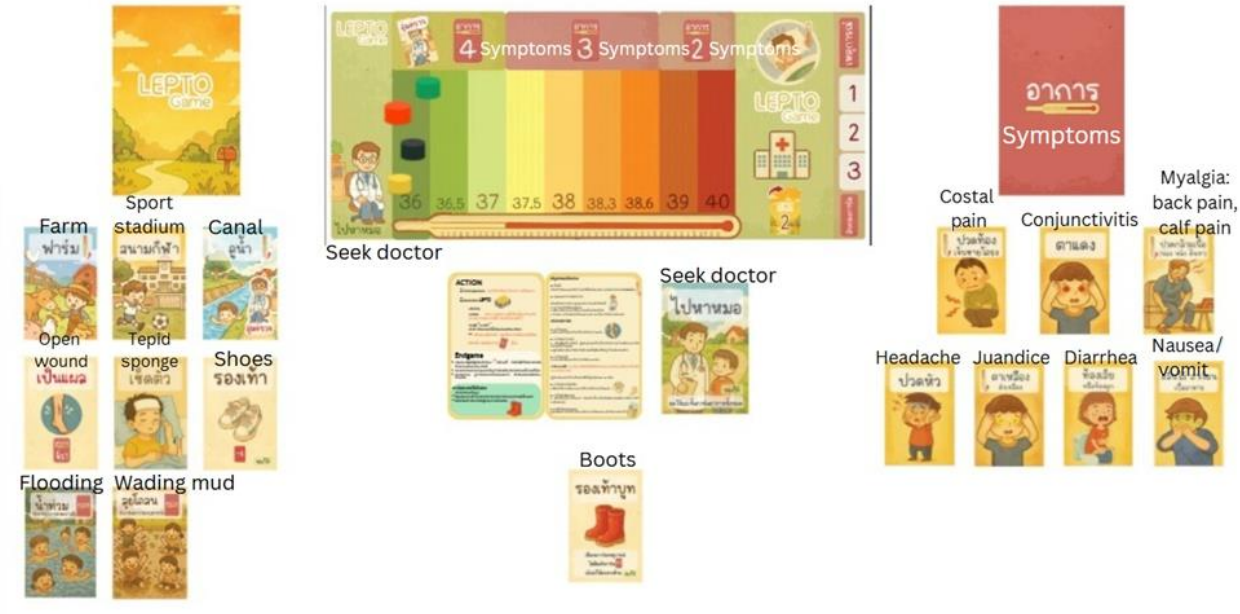

Figure 1. Final prototype of the Lepto Game, which includes a fever chart, visiting cards, risky event cards, risky behavior cards, protective wear cards, self-care card (yellow), and symptoms cards (red) with the rules and instructions in a box

Quantitative Study

A total of 124 schoolchildren from Mae Jarim school participated in the study. Most participants were male (68.5%) and aged 12–15 years, with a mean (SD) age of 13.60±0.94 years.

In the pre-test, the overall mean (SD) score for leptospirosis knowledge, symptoms, and self-care practice was 6.77±1.95 (out of 12). Among the knowledge domains, the highest mean score was observed for risk behavior related to exposure to water and mud with open wounds, whereas the lowest mean score was noted for knowledge of the pathognomonic manifestations, specifically calf pain.

In the post-test, the mean overall score increased to 8.10±1.85. The distribution of correct responses for disease knowledge, risk behaviors, exposures, symptoms, and self-care practices is presented in Table 1. The greatest improvement was observed in self-care practices, while the smallest improvement was seen in the knowledge of symptoms.

Table 1. Distribution of correct answers for disease knowledge, risk behaviors, exposures, symptoms, and self-care practices (n=124)

Variables	Pre-test n (%)	Post-test n (%)
Knowledge of exposure and mode of transmission		
• Leptospirosis is caused by exposure to contaminated water and soil through open wounds	82 (66.1)	112 (90.3)
• Most risky environment: damp, watery, and muddy areas	73 (58.9)	88 (71.0)
• Most risky behavior: exposure to water and mud with open wounds	108 (87.1)	115 (92.7)
• *Leptospira spp.* mostly found in flooding water	87 (70.2)	84 (67.7)
Knowledge of symptoms		
• Severe symptom of leptospirosis: costal pain	53 (42.7)	68 (54.8)
• Pathognomonic sign: calf pain	19 (15.3)	10 (8.1)
• Symptoms to seek medical care: fever and jaundice	62 (50.0)	84 (67.7)
• Information to inform doctors: body temperature and travel history	83 (66.9)	103 (83.1)
Self-care practices		
• Protection of leptospirosis: wearing closed-back, closed-toe shoes	61 (49.2)	84 (67.7)
• Proper home care: tepid sponge	44 (35.5)	75 (60.5)
• Avoid walking barefoot in mud	70 (56.5)	79 (63.7)
• Caution of contracting leptospirosis: seeking medical attention promptly for diagnosis and treatment	97 (78.2)	103 (83.1)

Paired t-test analysis indicated a significant increase in mean scores following the intervention. Specifically, scores for disease knowledge, risk behaviors, exposures, symptoms, and self-care practices all increased significantly after playing the Lepto Game (Table 2). The maximum total score was 12.

Table 2. Comparison of mean scores of disease knowledge, risk behaviors, exposures, symptoms, and self-care practices before and after the intervention (n=124)

Variables	Pre-test mean (SD)	Post-test mean (SD)	Mean difference	*P*-value*
Knowledge of exposure and mode of transmission				
• Leptospirosis is caused by exposure to contaminated water and soil through open wounds	0.66 (0.48)	0.90 (0.30)	0.242	<0.001
• Most risky environment: damp, watery, and muddy areas	0.59 (0.49)	0.71 (0.46)	0.121	0.007
• Most risky behavior: exposure to water and mud with open wounds	0.87 (0.34)	0.93 (0.26)	0.056	0.071
• *Leptospira spp.* mostly found in flooding water	0.70 (0.47)	0.68 (0.50)	-0.024	0.614
Knowledge of symptoms				
• Severe symptom of leptospirosis: costal pain	0.43 (0.50)	0.55 (0.50)	0.121	0.019
• Pathognomonic sign: calf pain	0.15 (0.36)	0.08 (0.27)	-0.073	0.049
• Symptoms to seek medical care: fever and jaundice	0.50 (0.50)	0.68 (0.47)	0.177	0.001
• Information to inform doctors: body temperature and travel history	0.67 (0.47)	0.83 (0.38)	0.161	<0.001
Self-care practices				
• Protection of leptospirosis: wearing closed-back, closed-toe shoes	0.49 (0.50)	0.68 (0.47)	0.185	<0.001
• Proper home care: tepid sponge	0.36 (0.48)	0.61 (0.49)	0.250	<0.001
• Avoid walking barefoot in mud	0.56 (0.50)	0.64 (0.48)	0.073	0.106
• Caution of contracting leptospirosis: seeking medical attention promptly for diagnosis and treatment	0.78 (0.42)	0.83 (0.38)	0.048	0.275

**p-values were calculated using a paired t-test. SD: standard deviation.*

Variables representing disease knowledge, risk behaviors, and exposures were also combined and analyzed by subgroup. The greatest change was observed in self-care practices, with mean scores increasing from 2.19 in the pretest to 2.75 in the post-test. Paired t-test analysis showed statistically significant increases across all grouped variables, including knowledge of exposure and mode of transmission, knowledge of symptoms, and self-care practices (Table 3).

Table 3. Grouped correct answer analysis of the disease knowledge, symptoms, and self-care practices

Variables	Pre-test mean (SD)	Post-test mean (SD)	Mean difference	*P*-value*
• Knowledge of exposure and mode of transmission	2.82 (0.98)	3.22 (0.85)	0.395	<0.001
• Knowledge of symptoms	1.75 (0.94)	2.14 (0.80)	0.387	<0.001
• Self-care practices	2.19 (0.99)	2.75 (1.03)	0.556	<0.001

**p-values were calculated using a paired t-test. SD: standard deviation.*

Discussion

The findings from this study emphasize the value of innovative approaches in health education. Insights derived from schoolchildren regarding their pains and unmet needs directly informed the development of the Lepto Game, an edutainment tool designed using design-thinking principles. This approach enabled the creation of an engaging, user-centered intervention tailored to schoolchildren's learning needs and satisfaction level. The Lepto Game effectively bridges gaps in knowledge, raises awareness, and promotes preventive practices related to leptospirosis, positively influencing children's health behaviors. Key success factors included the active involvement of end-users throughout the design process, which ensured relevance and engagement, and the incorporation of interactive, scenario-based learning that made abstract health concepts tangible and memorable. These factors contributed to high user satisfaction, improved knowledge retention, and greater motivation to adopt preventive behaviors. Evidence from meta-analyses

further supports the effectiveness of entertainment-education in improving persuasive health outcomes.[20–22] Its age-appropriate and interactive design facilitates learning about leptospirosis risks, prevention, and health-seeking behaviors, while enhancing children's confidence in communicating health information.[23] Overall, applying design thinking in public health facilitates a deeper understanding of target populations, allowing interventions to be tailored to their real-world needs, preferences, and behaviors. In the context of health education, this approach provides a practical pathway for developing engaging, relevant, and impactful interventions that effectively promote health awareness, knowledge, and preventive practices.[24–26]

Low levels of awareness, knowledge, and preventive practices related to leptospirosis have been reported in many disease-endemic countries within Southeast Asia.[27–30] Public health interventions aimed at improving knowledge, attitudes, and practices should therefore be emphasized within health education programs.[13] Findings from this study demonstrated significant improvements in self-care practices, particularly in wearing proper footwear and using tepid sponging for fever management. These elements were key components of the Lepto Game. Significant improvements were also observed in children's understanding of risks associated with exposure to contaminated water and soil through open wounds, as these scenarios were actively experienced within the gameplay. Additionally, knowledge related to exposure to floodwater while walking barefoot outdoors did not show improvement, likely because this information was already familiar to participants prior to the intervention.[30,31]

The Lepto Game, as a novel health education tool, provides practical implications for school-based interventions by tailoring content to users' insights and needs, thereby reinforcing contextual knowledge. Meta-analyses have also indicated that the board games can effectively enhance knowledge, influence behavior and even impact biological outcomes.[32–34] However, careful attention to game design, player interaction, and implementation strategies is essential to maximize the effectiveness of entertainment-education approaches.[35] The Lepto Game also has the potential to be integrated into existing school systems cost-effectively, making it suitable for low-resource settings in leptospirosis-endemic countries.

Limitations

Interpretation of the mean difference for the variable of the pathognomonic signs of leptospirosis should be made with caution, as misemphasis in the symptom information presented on the Lepto Game symptoms card may have affected participants' responses. The use of tailored messages in board games may not fully address all knowledge gaps or accommodate the diverse experiences, cultural backgrounds, and learning styles of participants. Participants in the study were purposively selected by the school from the cluster where leptospirosis had occurred. As a result, the students who participated may have been more motivated, engaged, or interested in health education than the general student population. This selection process could have led to an overestimation of the intervention's effectiveness in terms of knowledge acquisition and retention. Additionally, the study employed a one-group pre-post design without a control group, which limits the ability to attribute observed improvement solely to the intervention. The study was conducted in a single school, which may limit the generalizability of the findings to other regions or populations with different sociodemographic characteristics. This study did not measure actual health outcomes or real-life preventive practices among schoolchildren, limiting the ability to assess the long-term behavioral impact of the intervention. Finally, the study did not compare the Lepto Game with conventional health education methods; therefore, future research should consider conducting a comparative study to evaluate the relative effectiveness of the intervention.

Recommendations

A design-thinking approach proves valuable for developing health education tools, as it helps address the specific needs of target users and maximizes their satisfaction. The Department of Disease Control (DDC), Ministry of Public Health, should apply design-thinking principles to empathize with and define the target population, enabling the development of tailored and impactful prevention and control interventions. The Lepto Game illustrates how a contextual, user-centered approach can enhance engagement, awareness, knowledge, and preventive practices among schoolchildren.

For a broader impact, the DDC could cooperate with the Office of the Basic Education Commission, Ministry of Education, to implement the Lepto Game in school classrooms, extracurricular activities, and community programs, with adaptations for diverse settings. Translating the game into English and other local languages could further expand its reach and effectiveness in leptospirosis-endemic countries. Future studies should evaluate the long-term impact of the Lepto Game on real-life health outcomes and preventive practices to confirm its effectiveness beyond the educational setting, and compare it with conventional health education methods to assess relative effectiveness.

Conclusion

This study suggests that integrating design thinking with entertainment-education can produce engaging, user-centered interventions that enhance awareness, target health knowledge, and promote preventive practices among schoolchildren to optimize learning outcomes. The Lepto Game demonstrates that tailored education tools to the needs and experiences of children can increase engagement and knowledge to adopt health behaviors. Incorporating interactive, scenario-based learning can effectively translate abstract health concepts into practical, actionable strategies leading to improved knowledge, attitudes, and preventive practices related to leptospirosis. To support broader implementation, adaptation of the Lepto Game should consider the socioeconomic context and characteristics of the target population.

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Author Contributions

Patcharin Tantiworrawit: Conceptualization, methodology, writing—original draft, writing—review & editing. **Panithee Thammawijaya:** Writing—review & editing.

Ethical Approval

This study did not require ethical approval, as it involved the development and evaluation of an educational tool without the collection of identifiable personal or sensitive health data. All participants were informed about the purpose of the study and provided voluntary consent to participate in the game and related assessments.

Informed Consent

Informed consent was obtained from all participants involved in the study.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

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Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this work, the author used ChatGPT to correct grammatical errors and manage references. The content produced by this tool was reviewed and edited by the authors, who accept full responsibility for the final text.

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