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ORIGINAL RESEARCH

Effectiveness of Asthma Home Management Manual and Low-Cost Air Filter on Quality of Life Among Asthma Adults: A 3-Arm Randomized Controlled Trial

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Background: Asthma affects the quality of life (QoL) of millions of people worldwide. Effective control is paramount to a decline in prevalence and severity. To address this, we aimed to investigate the effectiveness of an asthma home management manual and low-cost air filter in improving resource-limited settings.

Patients and Methods: This randomized controlled trial was conducted between March to July 2022. The participants were 18–55 years old outpatient with asthmatic patients. A total of 114 participants were recruited and randomly assigned to three groups: home management only, home management and air filtering, and control. Validated measurement tools were applied, and the Wilcoxon test was used to evaluate changes in QoL.

Results: Asthma burden was found in at least one-third of participants in each group. At baseline, there was no difference in mAQLQ scores among participants in all group allocations (p-value > 0.05), and the air filter group had an increase in the total mAQLQ score (p-value = 0.044) and post-intervention activity quality of life (p-value = 0.002). The environmental quality of life increased post-intervention (p-value = 0.004) and remained higher after four weeks of follow-up compared to baseline (p-value = 0.041) in the home management group participants.

Conclusion: The findings indicate that the enforcement of a home management manual and the application of low-cost filters in air circulation systems offer advantages in improving the quality of life of patients with moderate and mild asthma.

Keywords: Asthma, home management manual, low-cost air filter, quality of life

Introduction

Asthma is the most prevalent chronic disease and has become a significant global issue. According to the World Health Organization (WHO), over 339 million people suffer from breathing difficulties caused by asthma, with more than 80% of the deaths occurring in low- to middle-income countries.[1,2] The prevalence of asthma in Asia is lower than that in European and American countries; however, the trend shows that convergence is on the horizon.[3] Additionally, the economic burden is substantial, with a global annual cost exceeding $81.9 billion (about $250 per person in.[4] In Thailand, the population reported suffering from asthma in previous years, highlighting the urgency of addressing this escalating health concern.[5,6]

Environmental triggers in combination with genetic variables play a critical role in exacerbating asthma symptoms.[7] Housing conditions, laden with dust mites, cockroaches, rodents, molds, and pet dander, are significant contributors to asthma morbidity.[8–10] More than 92% of the homes contain at least one allergen in dust, emphasizing widespread exposure to indoor allergens.[11] Tenant behavior, including smoking and combustion of nitrogen oxides, further aggravates indoor asthma triggers.[12] Home environmental management has emerged as a crucial strategy with studies demonstrating its efficacy in

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reducing asthma triggers and improving outcomes. Studies have found the effectiveness of strategies on allergen avoidance including asthma control education, home management, and air filter installation.[9,10] For example, interventions involving home visits, pest control, and air circulation management have resulted in statistically significant improvements in asthma control, quality of life, and environmental conditions.[13] Similarly, targeted home environmental programs have reduced the number of asthma triggers. Home-based education and environmental interventions led to a 30% decrease in emergency visits for asthmatic patients.[14,15] Air quality monitors, gas-particle counters, and allergen-specific assays can be employed to investigate the effectiveness of allergen avoidance strategies, as well as the outcome measurement using questionnaire scores or health impact assessments for asthma control and life quality.[16,17]

Identifying the sources of asthma triggers within households revealed associations with cleaning, cooking, washing, smoking, and human activities.[18,19] Outdoor particulate matter (PM) also contributed to household triggers.[20] Although it is challenging to eliminate all trigger sources, managing exposure through proper ventilation, such as using stove-top fans and air purifiers, has proven to be effective. Studies indicate that air filtration devices, especially High-Efficiency Particulate Air (HEPA) purifiers, reduce indoor allergen levels and particulate matter, thereby enhancing the quality of life of asthma patients.[21,22] The adoption of other standardized air filters with high MERV also had a significant impact on eliminating allergens and particles in home setting and improving air quality.[23–25]

Considering the substantial improvements in recognizing and controlling asthma triggers, there is still a lack of viable alternatives, particularly straightforward to apply, low energy consumption, and affordable for asthmatic adults. This study aimed to fill this gap by assessing the effectiveness of an asthma home management manual and low-cost air filter installation in enhancing the quality of life of adults in Chanthaburi, Thailand.

Materials and Methods

Study Design and Participants

This study was an unblinded three-arm randomized control trial conducted between March and July 2022 in the Chanthaburi Province, Thailand. The inclusion criteria were as follows: diagnosis of asthma by a physician under the National Health Security Office (NSHO), mild and moderate persistent asthma according to the Global Initiative for Asthma (GINA) classification,[26] aged 18–55 years old, living in private housing within the study area, and willing to participate. Participant selection regarding to asthma severity was emphasized on having day and night symptoms ranged from once a week to daily, exacerbation which limited to affect activity and sleep, and corresponding FEV1 and PEF variability. However, those who were allergic to food, had a history of another respiratory disorder, or were pregnant and were excluded from this study. This study was registered in the Thai Clinical Trials Registry (TCTR20210322001). The study protocol was approved by Chulalongkorn University Ethics Review Committee (COA No. 048/2564) and Chanthaburi Research Ethics Committee/Region 6 in compliance with the Declaration of Helsinki. Written informed consent was obtained from all participants.

Sample Sizes, Randomization, and Data Collection

The sample size was calculated using the G*Power program with a power set at 0.8 and a significancy level set at 0.05. A total of 114 participants were included based on a previous study parameter, including a 10% anticipation for dropped out case.[27]

The participants were randomly assigned to one of three arms in a 1:1:1 ratio (Figure 1). Group allocations included participants receiving a home management manual only (home management group), a low-cost air filter and home management manual (air filter group), and usual outpatient asthma care as a control group. At baseline, all participants were asked to complete the validated questionnaires. The same measurements were conducted after four weeks of intervention and at four weeks of follow-up.

Intervention

Participants in both intervention groups were provided an explanation of the home management manual at the first visit (Table 1). This activity highlights the manner in which participants prevent asthma triggers at home, including how to

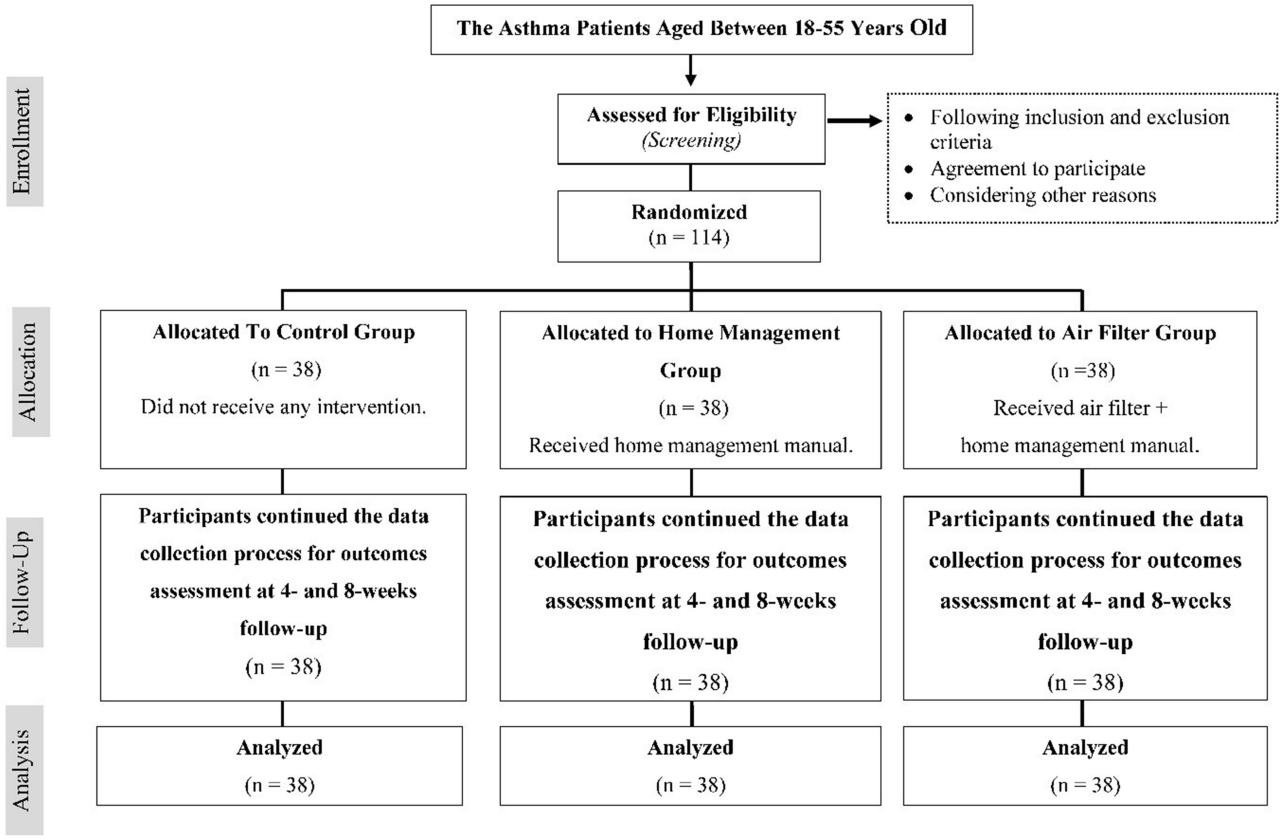

Figure 1 Flowchart of Enrollment, Randomization, and Retention of Participant According to Multi-arm Consort Diagram.

handle dust mites, fungi, pests, pollen, and pollutants, and practice weekly home cleaning routines. Participants were empowered with information to obtain stronger knowledge and awareness of asthma triggers.

The air filter group was also given a residential and easy-to-get 3M Filtrete™ in conjunction with a home management manual.[35,36] The filter is made of polypropylene fiber, moisture-resistant, and can capture airborne particles. 3M Filtrete™ is designed to be more effective in filtering than ordinary filters, and it is easy to install at home. The researcher presented a graphic of how to set the air filter on the backside of an electric fan (Figure 2).[37] All intervention activities ran over 4-weeks and during which the researcher managed a good rapport with the participants, assuring that they remained in the study.

Table 1 Home Management Manual Applied in the Study

Elimination of dust mites[28,29]	Cleaning home • Use damp towel to clean up all surface of furniture and use damp mop to clean floor. • Changing and washing bed and pillow cover in hot water and keep dry completely
Mold[30]	Eliminated source of moisture • Clean up the mold with soap and water. Always keep all surfaces dry. • Make the air ventilation flow by using an exhaust fan or open window when cooking and showing. • If there is water leak in your home, fix it.
Cockroaches and Pests[31]	• Keep counters, sinks, tables, and floors clean and free of clutter. • Clean dishes, crumbs, and spills right away. • Store food in airtight containers. • Seal cracks or openings around or inside cabinets.

(*Continued*)

Table 1 (Continued).

Pets[32]	• Find another home for your cat or dog. • Keep pets outside if possible. • If you must have a pet inside, keep it out of the bedroom with an asthma patient. • Keep pets off your furniture.
Secondhand smoke[33]	• Do not let anyone smoke near your child. • If you smoke, until you can quit, do not smoke in your home or car.
Chemical irritants[34]	• Make sure your child is not around. • Open windows or doors or use an exhaust fan. • Always follow the instructions on the product label.
Outdoor air pollution[34]	• Monitor the Air Quality Index on your local weather report. • Know when and where air pollution may be bad. • Regular exercising is healthy. Check your local air quality, knowing when to play and when to take it a little easier. • Schedule outdoor activities at times when the air quality is better. In the summer, this may be in the morning. • Stay inside with the windows closed on high pollen days and when pollutants are high. • Use your air conditioner to help filter the air coming into the home. Central air systems are the best. • Remove indoor plants if they irritate or cause symptoms for you and your family.

Measurement

Thai Mini Asthma Quality of Life (mAQLQ)

The Thai mAQLQ questionnaire is a self-administered questionnaire adapted from the AQLQ to assess asthmatic quality of life in the last two weeks.[38] The questionnaire contained 15 items separated into four domains: symptom (five items), emotional (three items), environmental (three items), and activity (four items). Responses were recorded on a 7-Likert scale, with a higher score indicating a better quality of life.

Asthma Control Test (ACT)

ACT is a self-administered questionnaire that comprises five variables explaining asthma symptom management during the previous month: activity limitation, shortness of breath, asthma symptoms at night and throughout the day, frequency of rescue drug usage, and asthma symptom control. Participants' responses were recorded on a 5-Likert scale indicating a lower score indicating a worse condition.[39]

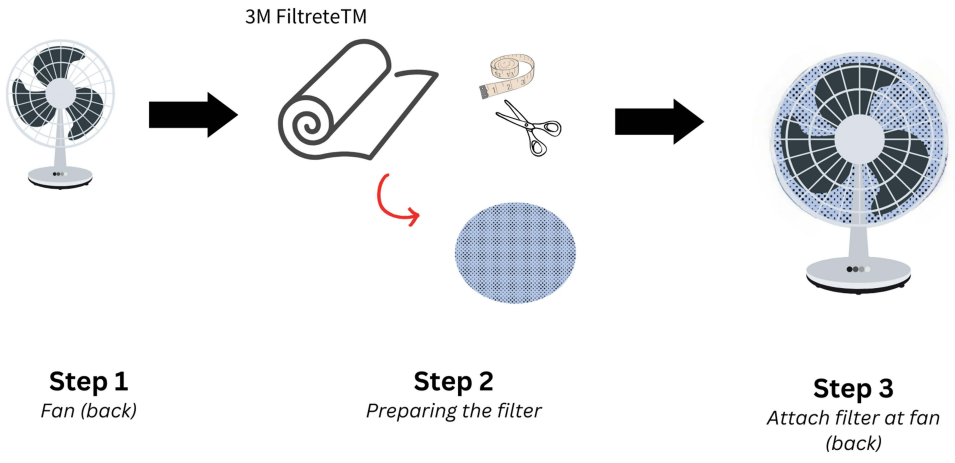

Figure 2 Air filter set-up.

Sociodemographic Questionnaire

This part of the questionnaire recorded information about the participants and their health-related conditions. Sociodemographic information included age (years), sex (male/female), and educational level. Health-related information recorded included a binary response (yes/no) to alcohol consumption, smoking status, any chronic disease, any medical use, family history of asthma, and any kinds of allergy (food, dust mites, pets, pests, etc.)

Data Analysis

Data analysis was performed using SPSS version 29 (Chulalongkorn University License). The analysis was based on the intention-to-treat principle. Descriptive statistics of sociodemographic information were presented as frequency (percentage) and median (interquartile range/IQR). The normality of the data was assessed using the Kolmogorov–Smirnov test. The Kruskal–Wallis test and chi-square test were used to test the comparability of baseline data, as the data were skewed. The Wilcoxon test was used to analyze the outcomes.

Result

Participants in all group allocations remained in the study after four weeks of intervention, as well as another four weeks of follow-up (Figure 1). The majority of the participants were 47 years old (IQR: 13). Female participants were predominant in the control (76.3%) and home-management (57.9%) groups (Table 2). Participants from all the group

Table 2 General Characteristics of Participants

Characteristics	Frequency (%)			*P*-value
	Home Management (n = 38)	Air Filter (n = 38)	Control (n = 38)	
Sex				0.005
Male	9 (23.7)	23 (60.5)	16 (42.1)	
Female	29 (76.3)	15 (39.5)	22 (57.9)	
Education level				0.38
Up to secondary school	18 (47.4)	21 (55.3)	24 (63.2)	
Higher	20 (52.6)	17 (44.7)	14 (36.8)	
Alcohol consumption				0.70
No	26 (68.4)	23 (60.5)	26 (68.4)	
Yes	12 (31.6)	15 (39.5)	12 (31.6)	
Smoking status				<0.001
No	38 (100.0)	30 (78.9)	25 (65.8)	
Yes	0 (0.0)	8 (21.1)	13 (34.2)	
Chronic disease				0.47
No	8 (21.1)	8 (21.1)	12 (31.6)	
Yes	30 (78.9)	30 (78.9)	26 (68.4)	
Medication use				0.013
No	18 (47.4)	28 (73.7)	29 (76.3)	
Yes	20 (52.6)	10 (26.3)	9 (23.7)	
Family history of asthma				0.038
No	32 (84.2)	22 (57.9)	25 (65.8)	
Yes	6 (15.8)	16 (42.1)	13 (34.2)	
Allergy				0.48
No	11 (28.9)	16 (42.1)	14 (36.8)	
Yes	27 (71.1)	22 (57.9)	24 (63.2)	
Characteristics (median, IQR)				
Age, years	48.0 (5)	43.0 (15)	46.5 (14)	0.09
Asthma Control Test, score	23.0 (6)	22.5 (6)	21.0 (4)	0.56

Table 3 Change of Asthma Quality of Life at Baseline, Post-Intervention, and Follow-Up

mAQLQ	Median (25–75 Percentile)					
	Home Management	*P*-value†	Air Filter	*P*-value†	Control	*P*-value†
Total score						
Baseline	89.0 (80.8–96.3)		95.5 (82.3–100.3)		93.0 (84.5–99.0)	
Post-intervention	93.0 (80.3–103.0)	0.33	97.0 (90.0–101.3)	0.044	90.5 (77.0–99.0)	0.12
Follow up	95.5 (83.3–104.0)	0.63	94.0 (82.3–101.0)	0.95	93.0 (80.8–99.0)	0.62
Emotion						
Baseline	31.5 (26.7; 34.0)		32.0 (31.0; 34.2)		31.0 (26.7; 33.0)	
Post-intervention	32.0 (26.5; 34.0)	0.49	31.0 (29.0; 34.0)	0.15	31.0 (26.0; 33.2)	0.50
Follow up	32.0 (28.3; 35.0)	0.68	32.0 (29.0; 34.0)	0.98	31.0 (27.7; 34.2)	0.16
Activity						
Baseline	18.0 (16.7; 21.0)		20.0 (16.7; 21.0)		19.0 (17.0; 21.0)	
Post-intervention	20.0 (17.0; 21.0)	0.65	21.0 (19.0; 21.0)	0.09	19.0 (17.0; 21.0)	0.38
Follow up	20.5 (17.2; 21.0)	0.95	20.0 (16.7; 21.0)	0.80	19.0 (17.0; 21.0)	0.93
Environmental						
Baseline	15.0 (10.7; 16.0)		16.5 (14.0; 19.0)		17.0 (13.0; 19.0)	
Post-intervention	17.0 (13.7; 21.0)	0.004	17.0 (16.0; 19.0)	0.20	17.0 (13.0; 19.0)	0.83
Follow up	17.0 (11.7; 21.0)	0.041	17.0 (14.0; 19.0)	0.82	17.0 (12.7; 19.0)	0.78
Symptoms						
Baseline	26.0 (23.0; 28.0)		27.0 (20.7; 28.0)		27.5 (23.0; 28.0)	
Post-intervention	26.0 (20.0; 27.0)	0.28	28.0 (25.5; 28.0)	0.002	26.0 (21.7; 28.0)	0.12
Follow up	27.0 (23.7; 28.0)	0.79	27.0 (20.7; 28.0)	0.34	27.5 (22.0; 28.0)	0.44

allocations had the same educational level. Based on Category,[39] participants in both intervention groups included controlled asthmatics, and those in the control group included partially controlled asthmatics, but the difference was not statistically significant. Comorbidity was significant in at least one-third of participants in each group. There was no difference in mAQLQ scores among participants in all group allocations at the baseline.

Table 3 shows that the air filter group had an increase in the total score of mAQLQ (p-value = 0.044) after four weeks intervention (Table 3). Domain-wise, their symptom quality of life was increased post-intervention compared to baseline (p-value = 0.002). Among home management group participants, their environmental quality of life was increased at post-intervention (p-value = 0.004) and remained higher after four weeks of follow-up period compared to baseline (p-value = 0.041). There was no significant difference in the total score of mAQLQ after follow-up period in any group allocation.

Discussion

Overall, the use of a home management manual and low-cost air filter for asthmatics showed a positive association with changes in the quality of life among adult participants. The impact of home management with adjusted air filtration can improve the quality of life among the intervention groups. The current study detected evidence that providing a home management manual only elevated asthma patients' quality of life. Our findings are consistent with those of previous studies that have investigated the application of air filters to control asthma severity and improve the quality of life of patients with asthma sufferers.[40–42]

Of the two intervention groups, those who received the home management manual and air filter simultaneously had a higher total mAQLQ score in the fourth week of intervention. The combination of education and practice stimulates the perception and behavior of patients with asthma. Previous studies have shown that multiple interventions administered to patients with asthma can reduce symptoms and emergency department (ED) visits related to asthma.[43–45] Addressing asthma causes and initiating real-life actions can help minimize asthma flare-ups and improve quality of life.[46,47]

However, the mAQLQ scores were not significant after the follow-up period. We linked these findings with the type of filtration used in the study and time observations. The 3M Filtrete™ Filter is made from polypropylene fibers, which

are popularly applied for filtration in safety masks.[48] This fiber can be used as an air filtration medium as well as a HEPA filter because it has a higher melting point.[49] We utilized a 3M Filtrete™ filter with microparticle filtration efficiency rating (MPR) was 1000 and thickness 0.72 mm (in metric) while it can work properly and effectively.[49,50] It is also commonly applied in air-conditioner (AC) filtration systems. We propose the application of this filter to the backside of an electric fan as a low-cost air-filtration system. The absence of advanced technology and unwrapped air filters may render the fibers inefficient for long-term applications. Dust, particulate matter, pollen, mold, and allergens can be trapped and easily accumulate in fans and filters. This condition could enable the spread of these pollutants during fan operation and produce poor air quality in the rooms of the participants. Contaminated air can lead to asthma symptoms in sufferers.[51] In addition, the study area experienced a highly polluted period during data collection. Thailand has been reported to suffer from severe air pollution during winter and fire burning annually.[52,53] Ambient air pollutants have been related to increasing PM, dust mites, pollen, and allergens in indoor conditions.[54–56] Therefore, regular maintenance is encouraged when adapting to the current practice.[37]

Emphasizing the AQLQ category, participants in the air filter group showed significantly improved asthma quality by alleviating symptoms after the intervention. The application of an air filter leads to a decline in symptoms in patients with asthma. Then, the adjusted filter encourages a slight improvement in participants' activity. The association between rising asthma symptoms and human productivity loss was investigated years ago.[57–59] When symptoms were controlled, the participants had the opportunity to work actively. In addition, the implementation of health promotion- and technology-supported approaches among asthmatic children clarified that education and intervention yielded more positive outcomes.[60]

The study could not identify a change in the general quality of life of the participants who received the manual only. Most participants in all three groups were smokers and alcohol drinkers, which was attributed to asthma symptoms.[61,62] These characteristics should be considered in order to impact the findings.

Even so, participants' quality of life with regard to the environmental aspect was significantly increased post-intervention and remained higher at the follow-up point relative to baseline. As our intervention followed the suggested program (Table 1), the manual provided an understanding of how to control living conditions and minimize asthma triggers. Notably, educational programs that focus on home control have the potential to control asthma and improve the quality of life of asthmatic patients. Our findings are consistent with previous investigations.[27,60,63,64] This study also added to the record that home management is promising for optimizing asthmatic quality of life in a short observation period.

Despite these findings, this study had several limitations. First, the outcome measurements in this study were based on a questionnaire assessment where environmental contributors triggering asthma, such as PM, dust mites, mold, and pollen cannot be explained. Further research should incorporate objective outcome measures. Second, the study did not consider for irritant-induced asthma and concomitant diagnosis of allergic rhinitis (AR) on asthma. The connection between AR and asthma extends across epidemiology, pathophysiology, and treatments, suggesting they represent diverse expressions of an inflammatory airway. Epidemiological evidence consistently demonstrates a high prevalence of co-occurrence between asthma and AR, with AR often prior to the onset of asthma and showing as a significant risk factor for its development. However, the study employed Randomized Controlled Trials (RCTs) to mitigate potential confounding factors. In addition, even though our study was able to manage 100% participant retention of an RCT, the findings are limited to generalization in areas that experience a highly polluted season, similar to the study area.

Conclusion

Our study has shown promising cost-effective options to promote better quality of life among adults with asthma. These findings indicate that the adoption of a home management manual and economical air filtration can potentially relieve patients of asthma in their daily lives, especially those who live in countryside regions. Further research is required to strengthen the filter design. Furthermore, we suggest investigating more specific environmental allergens and housing conditions related to asthma symptoms and quality of life for an in-depth understanding.

Trial Registration

This study is registered under Thai Clinical Trials Registry with the number: TCTR20210322001.

Data Sharing Statement

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

Ethics

This study was approved by the Chulalongkorn University Ethics Review Committee (COA No. 048/2564) and the Chanthaburi Research Ethics Committee/Region 6 (COA No.024/64).

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Author Contributions

All authors in this study made an important contribution to the work reported, including the concept of the study, study design, execution, acquisition of data, analysis, and interpretation, as well as took part in drafting, revising, and critically reviewing the article. The authors have agreed to publish this study in the journal to which this article has been submitted.

Disclosure

The authors declare no conflicts of interest in this work.

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