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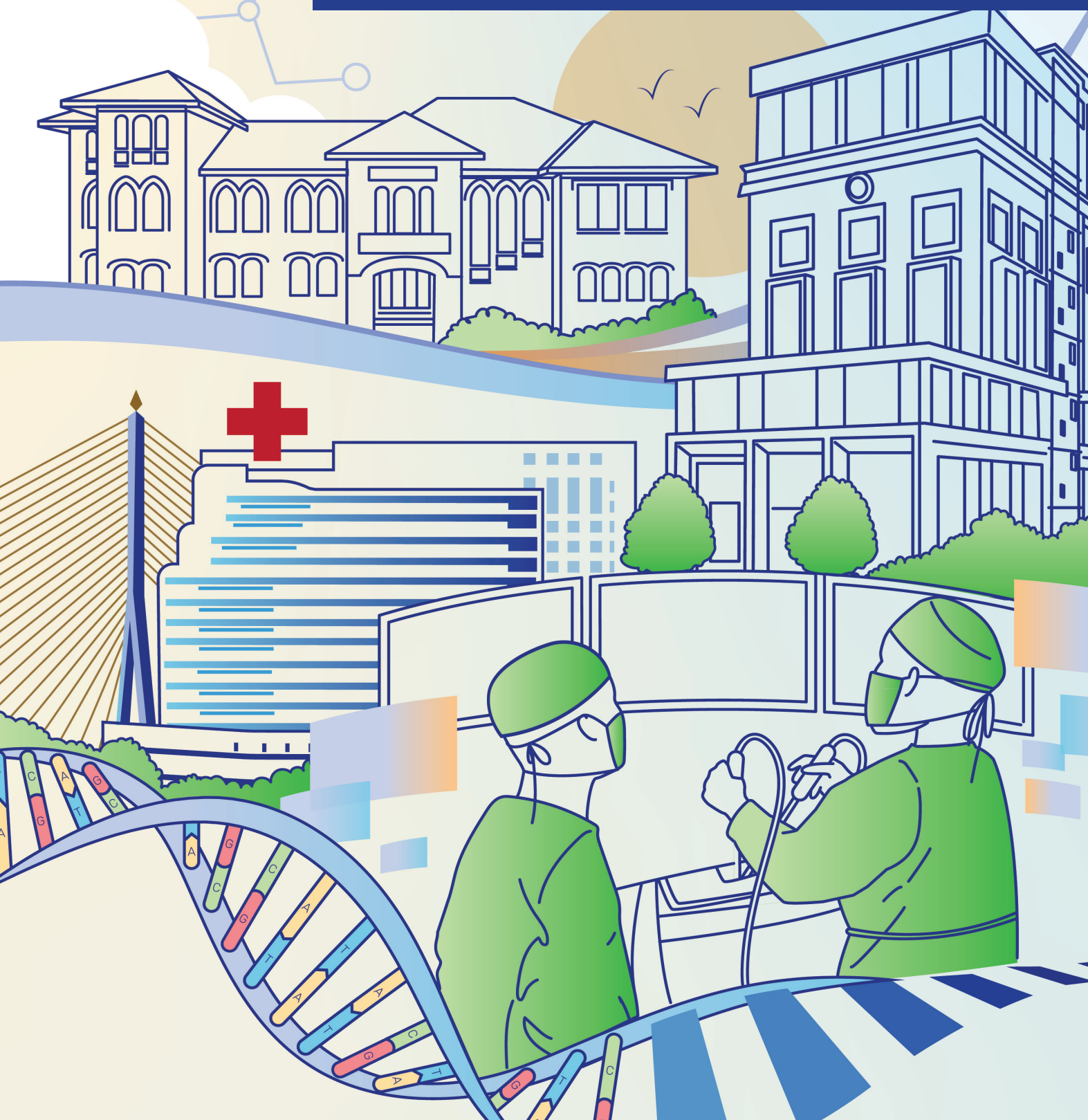

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ORIGINAL ARTICLES

Original Article

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User Satisfaction and Its Impact on the Intention to Utilize Telemedicine Services in the Dusit Model Prototype Area

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ABSTRACT

OBJECTIVE: Gaining insight into user satisfaction and its impact on the intention to use telemedicine is essential for the continued success of such services.

METHODS: A cross-sectional study was carried out through an online survey targeting users of the Vajira@Home telemedicine platform. Data were collected via online survey questions, which was collected and analyzed through descriptive statistics, chi-squared tests, and multivariate binary logistic regression to explore the correlation between satisfaction and the intention to use telemedicine.

RESULTS: A total of 389 respondents completed the questionnaire. Most respondents (81.2%) reported being satisfied with telemedicine services, and 72.5% indicated a strong intention to continue using them. Satisfaction emerged as the most influential factor in predicting the intention to use telemedicine (adjusted odds ratios (OR) = 13.28; 95% CI, 6.47–27.26; $p < 0.001$). Participants with a monthly income between 15,000 and 30,000 Thai Baht also showed a significantly higher intention to use the service (adjusted OR = 3.40; $p = 0.048$). Other demographic variables were not significant after adjustment.

CONCLUSION: Satisfaction is the primary factor influencing the intention to use telemedicine under the Dusit Model. These results highlight the need to prioritize patient-centered care and improve user experiences to support the long-term integration of telemedicine into urban healthcare systems.

KEYWORDS: Dusit model, patient satisfaction, telemedicine, urban health services, utilization intention

INTRODUCTION

In recent years, healthcare has undergone significant changes due to advancements in digital technology[1-3]. Telemedicine has become a key tool for improving access to healthcare services[4,5], especially in urban settings where traffic congestion and long wait times often delay medical consultations[4,6]. Telemedicine is one of the notable innovations resulting from these technological developments[2,3,5]. In Thailand, the government has actively promoted the integration of telemedicine into the public health system[7].

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A prominent example of this effort is the Dusit Model in Bangkok, which aims to modernize healthcare delivery through the use of technology[8,9].

In response to these challenges, the Bangkok Metropolitan Administration and Faculty of Medicine Vajira Hospital, Navamindradhiraj University, developed the Dusit Model[9], a prototype healthcare system that incorporates telemedicine to enhance access to care and make better use of healthcare resources. This model included four districts as follow Dusit, Bang Sue, Bang Plat, Phra Nakorn from fifty districts in Bangkok Metropolitan Administration.

This approach is especially applicable in urban environments like Bangkok, where traffic congestion and time limitations often discourage individuals from seeking prompt medical attention[10,11]. The Dusit Model is a collaborative effort in the city's central district, designed to deliver comprehensive, integrated, and accessible healthcare services. It uses a hybrid model that combines in-person care with remote consultations via telemedicine platforms, particularly through tools such as Vajira@Home[9]. The long-term viability of such programs depends largely on user satisfaction and their intention to adopt and continue using these services, even as technological infrastructure and available features continue to evolve[12].

Although telemedicine shows considerable promise, its effectiveness largely relies on user satisfaction[13]. A thorough understanding of the relationship between user satisfaction and the intention to utilize telemedicine services is essential for informed policy development and service improvement[2-4,13,14]. Satisfaction may be influenced by various factors, such as perceived effectiveness, responsiveness, service quality, trust in healthcare providers, and ease of use. Each of these elements can significantly affect an individual's decision to incorporate telemedicine into their routine healthcare practices[14-16].

Within the framework of the Dusit Model, it is important to evaluate whether patient satisfaction is linked to their intention to adopt and continue using telemedicine services. Identifying the main factors contributing to satisfaction and their influence on behavioral intentions will offer important guidance for healthcare policymakers, service providers, and technology developers[6,17,18]. Recognizing these factors will support the improvement of telemedicine services to better meet patient needs and promote sustainable healthcare delivery in the long term[2,6,19-21]. In this study, intention to utilize telemedicine services refers to the users' intention to continue using telemedicine in the future after their initial experience, rather than initial adoption among non-users.

This study aimed to investigate the association between user satisfaction and the intention to utilize telemedicine services within the Dusit Model prototype area. The findings are expected to provide meaningful input for healthcare administrators, policymakers, and system developers in supporting patient-centered care and encouraging continued adoption of telemedicine.

METHODS

This study used primary data collected from individuals with experience using telemedicine within the Dusit Model area. The research was conducted following approval from the Institutional Review Board of the Faculty of Medicine Vajira Hospital, Navamindradhiraj University (COA 076/2568). An online questionnaire was used to collect information on user attitudes, which could not be effectively assessed through other means, thus requiring human participant involvement.

To ensure the validity of the measurements, all questionnaire items related to the study variables were developed based on established literature[19,22-25]. The items were adapted to

assess user attitudes and perceptions specifically related to the telemedicine services provided through the Vajira@Home application (version updated; 1 Dec 2024). To ensure the reliability of the questionnaire, originally developed in Thai (Cronbach's alpha > 0.7)[26,27], a panel of three experts conducted multiple evaluations and revisions.

The participants for the questionnaire were selected using simple random sampling. In this method, each individual in the target population had an equal and independent chance of being chosen. A complete list of eligible participants was compiled, and individuals were randomly selected using a random number generator to ensure unbiased representation. This approach was chosen to minimize selection bias and to enhance the generalizability of this study's results. Participant privacy and anonymity throughout the data collection process was performed.

The data collection tool consisted of two parts. A self-administered survey, created using Google Forms, was used to gather data between December 2024 and January 2025. The survey was distributed to patients through the Vajira@Home platform and the central telephone line of the Faculty of Medicine, Vajira Hospital. To ensure ethical compliance, the study followed standard protocols and maintained participant privacy and anonymity throughout the data collection process.

The questionnaire was structured into two main sections. The first section collected general participant information, including sociodemographic details such as gender, generation, education level, monthly income, and prior use of other telemedicine platforms. This section included a combination of closed-ended questions for selection and open-ended questions for written responses. The second section focused on assessing user satisfaction and intention to use telemedicine services within the Dusit Model area, using a 5-point Likert scale ranging from "least" to "most."

The variables were assessed using a 5-point Likert scale, except for certain individual data such as selections and blank fields, to ensure accurate participant evaluations. Satisfaction and intention levels were evaluated using five and four corresponding questions, respectively, both employing a 5-point Likert scale. The dependent variable was the intention to utilize telemedicine services[22-25] within the Dusit Model prototype area. This section consisted of four close-ended questions, with responses evaluated on a 5-point Likert scale (1-5), representing a range from "lowest" to "highest". Prior research[5,28-29] established that an 80% cutoff point effectively represents a high intention level for telemedicine adoption among participants. This threshold helped guide the definition of a "high" intention score in this study. To facilitate meaningful comparison across different levels of intention and to allow for the calculation of crude odds ratios, the total intention scores were categorized into three distinct groups. Low intention (< 12 points): Reflects participants scoring below 60% of the maximum possible score (20 points), indicating limited intention. Moderate intention (12-15 points): Represents participants with moderate levels of intention, approximately 60-75% of the maximum score. High intention (16-20 points): Corresponds to participants achieving 80% or more of the maximum score, aligning with prior research benchmarks for high intention. For the multivariate binary logistic regression analysis, scores were categorized as non-intention (< 16) and intention (16-20). In this study, responses for the dependent variable were coded as 0, no intention, and 1, intention.

The independent variables, which relate to satisfaction levels with telemedicine services within the Dusit Model area, consist of five close-ended questions. Responses were evaluated using a 5-point Likert scale (1-5), ranging from "lowest" to "highest." The total scores for this variable were then categorized

into dissatisfied (< 20) and satisfied (20-25), with responses for satisfaction coded as 0, dissatisfaction, and 1, satisfaction.

The covariates included demographic characteristics, which were informed by previous disability studies[5,22]. These covariates consisted of gender [female, male, lesbian, gay, bisexual, transgender, queer, intersex (LGBTQ+)], generation (age) [zoomers (Generation Z) (20-28), millennials (Generation Y) (29-43), Thirteeners (Generation X) (44-59), Baby Boomers (≥ 60)], educational level [below bachelor's degree, bachelor's degree or equivalent, above bachelor's degree], occupation [government employee, private sector employee, self-employed, and other], monthly income Thai Baht (THB) [below 15,000, 15,000-30,000, 30,001-50,000, above 50,000], and experience with other telemedicine platforms [no experience, with experience].

Descriptive statistics were used to summarize the sample characteristics. Chi-squared analysis was conducted to examine the relationships between each variable, while Fisher-Freeman-Halton test was applied to analyze the generation variable. Variables found to be significant in the chi-squared analysis, Fisher-Freeman-Halton test and Fisher's Exact test were included in the multivariate binary logistic regression analysis to assess their association with the dependent variable of telemedicine acceptance. Data analysis was performed using IBM SPSS Statistics for Windows (version 29.0.2.0 Armonk, NY: IBM Corp), with support from Mahidol University.

RESULTS

Out of 426 invitations sent to patients, 389 completed the questionnaire, with no reminders issued to participants. The survey response rate was 91.3%. A total of 389 participants took part in the study. Regarding gender, 46.3% identified as male, 48.1% as female, and 5.6% as having alternative gender identities, including LGBTQ+. In terms of age, the largest group of participants (62.5%) were from Generation Y (ages 29-43), followed by 19.3% from Generation X (ages 44-59), 14.9% from Generation Z (ages 20-28), and 3.3% from Baby Boomers (age 60 and above). The majority of respondents (64.8%) had a bachelor's degree or equivalent, 18.7% had education below a bachelor's degree, and 16.5% had education beyond a bachelor's degree. Regarding occupation, 37.3% were employed in the private sector, 28.5% were government employees, and 34.2% were self-employed or in other professions. As for monthly income, 41.4% earned between 15,000 and 30,000 THB, 31.9% earned between 30,001 and 50,000 THB, 17.7% earned over 50,000 THB, and 9.0% earned less than 15,000 THB. Regarding prior experience with other telemedicine platforms, 60.9% of participants had no prior experience, while 39.1% had used such platforms before. Finally, 81.2% of respondents rated the service as satisfactory, while 18.8% expressed dissatisfaction.

The crude ORs related to the intention to utilize telemedicine services were analyzed, considering multiple demographic, socioeconomic factors, and satisfaction levels. The results revealed significant associations between the likelihood of intending to use telemedicine services and various demographic factors, as shown in Table 1.

Factors significantly associated with the intention to utilize telemedicine included generation ($p < 0.001$), educational level ($p < 0.001$), occupation ($p = 0.003$), monthly income ($p < 0.001$), experience with other telemedicine platforms ($p = 0.022$), and satisfaction level ($p < 0.001$). Participants from Generation Y had the highest proportion of high intention to utilize telemedicine (76.5%), while only 7.7% of Baby boomer had high intention to utilize telemedicine service. Higher educational attainment was associated with a greater intention to use telemedicine. Private sector and government employees had higher intention rates compared to the self-employed. Those with prior telemedicine experience and higher satisfaction levels were more likely to intend to use the service.

Table 1 Crude odds ratios (ORs) of the intention to utilize telemedicine service

Variables	Intention to Utilize Telemedicine Service						P-value
	Low		Moderate		High		
	n	%	n	%	n	%	
Gender							0.750
Male	26	14.5	31	17.2	123	68.3	
Female	24	12.8	41	21.9	122	65.3	
LGBTQ+	4	18.2	5	22.7	13	59.1	
Generation (Years)#							
Generation Z (20-28)	6	10.4	14	24.1	38	65.5	< 0.001*
Generation Y (29-43)	14	5.8	43	17.7	186	76.5	
Generation X (44-59)	24	32.0	18	24.0	33	44.0	
Baby Boomers (≥ 60)	10	76.9	2	15.4	1	7.7	
Educational Levels							< 0.001*
Below Bachelor's Degree	20	27.4	21	28.8	32	43.8	
Bachelor's Degree or Equivalent	25	9.9	46	18.3	181	71.8	
Above Bachelor's Degree	9	14.1	10	15.6	45	70.3	
Occupation							0.003*
Government Employees	15	13.5	16	14.4	80	72.1	
Private Sector Employees	10	6.9	33	22.8	102	70.3	
Self-Employed and Others	29	21.8	28	21.1	76	57.1	
Monthly Income							< 0.001*
Below THB 15,000	15	42.9	13	37.1	7	20.0	
15,000-30,000 THB	11	6.8	33	20.5	117	72.7	
30,001-50,000 THB	13	10.5	21	16.9	90	72.6	
Above 50,000 THB	15	21.7	10	14.5	44	63.8	
Experience with Other Telemedicine Platforms							0.022*
No Experience	36	15.2	56	23.6	145	61.2	
With Experience	18	11.8	21	13.8	113	74.4	
Satisfaction Levels							< 0.001*
Dissatisfied	31	42.5	30	41.1	12	16.4	
Satisfied	23	7.3	47	14.9	246	77.8	

Abbreviations: LGBTQ+, lesbian, gay, bisexual, transgender, queer; n, number; THB, Thai Baht
*P-value < 0.05
#Fisher-Freeman-Halton test

Multivariate binary logistic regression analysis (Table 2) identified satisfaction level as the strongest predictor of the intention to utilize telemedicine (adjusted OR = 13.28; 95% CI, 6.47-27.26; p < 0.001). Monthly income between 15,000 and 30,000 THB also showed a significant association (adjusted OR = 3.40; 95% CI, 1.01-11.42; p = 0.048). Other factors, including generation, education, occupation, and prior telemedicine experience, did not show statistically significant associations after adjustment.

Table 2 Multivariate binary logistic analysis for the intention to utilize telemedicine (n = 389)

Variables	Unadjusted		Adjusted		P-value
	OR	95%CI	OR	95%CI	
Generation (Years)‡					
Generation Z (20-28)	1		1		
Generation Y (29-43)	1.72	0.93-3.18	1.37	0.60-3.11	0.456
Generation X (44-59)	0.41	0.20-0.84	0.49	0.16-1.13	0.087
Baby Boomers (≥ 60)	0.44	0.01-0.36	0.10	0.95-1.11	0.061
Educational Levels					
Below Bachelor's Degree	1		1		
Bachelor's Degree or Equivalent	3.27	1.91-5.59	1.65	0.68-3.98	0.270
Above Bachelor's Degree	3.04	1.50-6.16	1.27	0.41-3.98	0.676
Occupations					
Government Employees	1		1		
Private Sector Employees	0.92	0.53-1.59	0.86	0.44-1.68	0.651
Self-Employed and Others	0.52	0.30-0.89	1.11	0.53-2.34	0.779
Monthly Income					
Below 15,000 THB	1		1		
15,000-30,000 THB	10.64	4.33-26.11	3.40	1.01-11.42	0.048*
30,001-50,000 THB	10.59	4.23-26.50	3.19	0.84-12.10	0.088
Above 50,000 THB	7.04	2.69-18.44	2.59	0.63-10.71	0.189
Experience with Other Telemedicine Platforms					
No Experience	1		1		
With Experience	0.54	0.35-0.85	0.67	0.37-1.21	0.186
Satisfaction Level					
Dissatisfied	1		1		
Satisfied	17.86	9.11-35.03	13.28	6.47-27.26	< 0.001*

Abbreviations: CI: confidence interval; n, number; OR: Odds ratio, THB, Thai Baht
*P-value < 0.05
‡Fisher's Exact test

DISCUSSION

This study examined the factors influencing the intention to utilize telemedicine services in the Dusit Model prototype area, with a particular emphasis on user satisfaction. The results confirm that user satisfaction is a key factor in determining the intention to use telemedicine services, aligning with prior research that highlights the importance of service quality, ease of use, perceived benefits, and user support—factors that contribute to satisfaction with telemedicine services[22-25,29].

Among all the predictors, satisfaction was the strongest factor influencing the intention to use telemedicine, with satisfied users being more than 13 times more likely to report a high intention to use the service (adjusted OR = 13.28; p < 0.001). This emphasizes the significance of service quality, user-centered design, responsiveness, and the overall patient experience in shaping behavioral intentions. These findings are consistent with previous studies that underscores the role of user experience in driving the intention to utilize and accept health information technologies[12-14,20,21].

Interestingly, while several demographic and socioeconomic factors, such as generation, education, and occupation, were significantly associated with intention in the univariate analysis, these associations weakened in the multivariate analysis. This suggests that although demographic factors may initially seem influential,

satisfaction serves as a more direct and stronger predictor of behavioral intention. However, monthly income between 15,000 and 30,000 THB remained significantly associated in the adjusted model (adjusted OR = 3.40; p = 0.048), indicating that middle-income users may find telemedicine more beneficial or convenient.

Importantly, generational differences were observed. Generation Y users demonstrated the highest intention to utilize telemedicine, reflecting their greater digital literacy and adaptability to online health services. In contrast, Baby Boomers were the least likely to report a positive intention, possibly due to age-related barriers such as lower digital skills, technological anxiety, or different healthcare expectations. These results underscore the need for targeted education and support to improve engagement among older adults, as suggested by previous studies using the Extended Technology Acceptance Model[20,21,30-32] and the Unified Theory of Acceptance and Use of Technology model[20,33].

Additionally, while prior experience with telemedicine was not statistically significant in the adjusted model, its positive trend suggests that familiarity may still help reduce barriers to future use[15,18,23,24,33]. This implies that pilot programs and guided onboarding could be effective strategies to encourage adoption, particularly for first-time users.

Furthermore, the cost-effectiveness of telemedicine is a critical consideration for future research and policy development. Telemedicine offers substantial potential to reduce healthcare system burdens, decrease patient transportation costs, and minimize lost work time due to hospital visits. From a policy standpoint, the implications of this study are clear. To ensure the sustainability and broad adoption of telemedicine services, healthcare systems must focus on user satisfaction by continually enhancing interface usability, reliability, and the human aspects of care, such as empathy and trust[32,34-35]. Special attention should be given to underrepresented or digitally marginalized groups, including individuals with lower educational levels or those who are self-employed, by providing customized outreach and support.

This study has several limitations that should be considered when interpreting the results. First, the cross-sectional design limits the ability to establish a causal relationship between satisfaction and the intention to use telemedicine services. Second, data were collected through self-reported questionnaires, which may be influenced by recall bias or social desirability bias. Third, the study was conducted in a single urban prototype area (Dusit Model), which may limit the generalizability of the findings to other regions or rural populations. Finally, although the survey included a broad range of demographic factors, it did not address deeper psychosocial or cultural influences that may affect the intention to utilize telemedicine services.

Despite these limitations, this study contributes to the growing evidence that the intention to utilize telemedicine services is not solely determined by technological availability but is heavily influenced by the user's experience and satisfaction. These findings should inform developers and decision-makers in designing more inclusive, efficient, and patient-centered telehealth systems.

Future research should use longitudinal designs to evaluate the long-term use and health outcomes of telemedicine, while qualitative studies can provide deeper insights into user experiences and barriers, especially among older adults and first-time users. Including clinical outcomes will help assess the effectiveness of telemedicine compared to traditional care. Further research into platform usability, digital accessibility, and region-specific factors can inform improvements in service design and policy. Studies focused on interventions, such as digital literacy programs or onboarding support, are also recommended to increase adoption among underserved groups. Lastly, exploring psychosocial and cultural influences will offer a more comprehensive understanding of user behavior, supporting the development of inclusive and sustainable telehealth systems.

CONCLUSION

This study underscores the strong relationship between user satisfaction and the intention to utilize telemedicine services within the Dusit Model prototype area. Satisfaction was found to be the most significant predictor, highlighting the importance of patient-centered service delivery. To ensure continued adoption, healthcare systems must focus on improving the user experience, especially among digitally underserved groups. These findings provide valuable insights for enhancing telemedicine implementation in urban healthcare settings.

CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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DATA AVAILABILITY STATEMENT

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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Original Article

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Incidence and Risk Factors of Long COVID in Children and Adolescents: A Single-Center Cohort Study in Thailand

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ABSTRACT

OBJECTIVE: The study aimed to find the incidence of Long COVID in children less than 18 years of age and associated risk factors.

METHODS: This is an observational retrospective and prospective cohort study of children under 18 years of age with evidence of COVID-19 infection from October 2021 to February 2023. Participants were assessed 3, 6, and 9 months after acute infection, with direct evaluation by pediatricians at the first and third visits and by phone call at 6 months. Long COVID was defined as persistent symptoms for at least three months after initial infection. Factors associated with Long COVID were analyzed using univariate and multivariate logistic regression presented using odds ratio (OR) and a 95% confidence interval (CI).

RESULTS: A total of 233 children (mean age 9.95 years; 50.20% female) were included. At 3 months, 83 (35.62%) had persistent symptoms, decreasing to 24 (10.30%) at 6 months; none reported ongoing symptoms at 9 months. Common complaints at 3 months included dyspnea (34.94%), hair loss (33.73%) and sleep disturbances (25.30%). At 6 months, hair loss (37.50%) and sleep problems (25%) remained prominent. Univariate analysis showed that older age (> 10 years), comorbidity, and moderate severity symptom during acute infection were significantly or borderline significantly associated with Long COVID. In the final multivariate model, only the moderate severity symptom remained independently predictive of persistent symptoms at 6 months (adjusted OR 10.56, 95% CI: 1.01–110.33, p = 0.049).

CONCLUSION: More than a third of the children experienced symptoms at 3 months, while persistent cases decreased substantially at 6 months. A moderate-severity symptom during acute illness was a key independent risk factor for Long COVID. These findings underscore the importance of close monitoring, particularly in patients with moderate-severity symptoms, to ensure timely interventions and support for recovery.

KEYWORDS: long COVID, pediatrics, risk factors, Thailand

INTRODUCTION

Coronavirus disease 2019 (COVID-19), caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has profoundly affected global health systems and daily life. As of early 2025, over 700 million people around the world had been confirmed to have COVID-19[1]. In Thailand, the cumulative number of cases has exceeded four million[2], with the first case reported in January 2020. Although children

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generally experience milder acute symptoms of COVID-19 compared to adults, they can still develop serious complications, including the multisystem inflammatory syndrome in children[3].

Beyond acute illness, the focus has turned toward 'Long COVID', a condition characterized by persistent health problems following SARS-CoV-2 infection[4-6]. These problems can persist for months and encompass a wide range of physical and psychological symptoms[7]. Although standard clinical guidelines for Long COVID were established relatively early for adults[8,9], consensus on pediatric-specific definitions emerged more recently. In 2022, a modified Delphi process proposed criteria specifically for children and adolescents[10], and in February 2023, the World Health Organization released an official definition of the post-COVID condition in these age groups[11]. The pathophysiology of long COVID is multifaceted and not yet fully elucidated. However, emerging evidence points towards a constellation of interconnected factors, such as immune dysregulation with possible viral persistence, disruption of the microbiota, the development of autoimmunity, endothelitis, metabolic dysfunction, and sequelae of intensive care[12-14].

Studies in adults indicate that risk factors for Long COVID include female sex, middle age, and certain comorbidities such as asthma[15-17]. However, data on pediatric Long COVID remain limited, partly due to variations in study design, follow-up intervals, and case definitions[18-20]. Emerging evidence suggests that children and adolescents can experience a variety of persistent symptoms, including respiratory, neurological, and psychological complaints, that can affect daily functioning[19]. Beyond the prevalence differences observed between adults and children, the global prevalence also showed significant continental variation, with lower rates in the USA and Europe compared to Asia [21]. This considerable inter-continental heterogeneity underscores the continued importance of region-specific research. In Thailand, only a few studies have addressed Long COVID in children[22,23], leaving substantial gaps in understanding its incidence, clinical features, and potential risk factors within this population.

In this context, we aimed to investigate the incidence and persistence of Long COVID in Thai children and adolescents. We also sought to identify demographic and clinical risk factors associated with prolonged symptoms, thereby contributing to a more comprehensive understanding of pediatric Long COVID and informing follow-up and management strategies in this age group.

METHODS

This single-center, retrospective, and prospective single-arm longitudinal cohort study was conducted at King Taksin Memorial Hospital, a tertiary care center in the Thonburi district of Bangkok, Thailand. The study period spanned October 2021 to February 2023, during which COVID-19 cases in Thailand were managed according to national guidelines. We included Thai children under 18 years of age who had confirmed SARS-CoV-2 infection by reverse transcription-polymerase chain reaction or a Food and Drug Administration -approved antigen test. The children were enrolled if they could be followed at 3, 6, and 9 months after acute infection. The exclusion criteria included inability to attend scheduled follow-up visits or complete telephone assessments, and the presence of any pre-existing medical condition that, in the investigator's clinical judgment, would directly interfere with the accurate assessment of persistent symptoms or developmental outcomes (e.g., significant developmental disorders, severe neurological impairment). Chronic stable conditions such as allergic diseases or congenital heart disease were not considered exclusionary. Written informed consent was obtained from parents or legal guardians and assent was obtained from children aged 7 years and older.

Baseline demographic and clinical data, including age, sex, weight, height, comorbidities, and acute infection severity, were extracted from

medical records. The severity of the acute phase was classified per the criteria of the National Institutes of Health[24]: asymptomatic (no symptoms despite a positive test), mild (upper respiratory symptoms without dyspnea or desaturation), moderate (lower respiratory involvement without hypoxia), and severe (lower respiratory involvement with oxygen saturation < 94% in room air). Information on antiviral therapy (Favipiravir) was recorded according to the Thai COVID-19 treatment guidelines at the time[25]. Children with comorbidities or moderate/severe symptoms were more likely to receive antiviral therapy and/or hospitalized.

Long COVID was defined as the presence of one or more symptoms persisting at least three months after SARS-CoV-2 infection[11]. Participants were evaluated at three points post-infection: 3, 6, and 9 months. The 3- and 9-month evaluations were conducted in person by a pediatrician, while the 6-month assessment was performed by telephone to reduce hospital visits. A symptom checklist was used to evaluate respiratory (rhinorrhea, dyspnea, cough), cardiovascular (chest pain, palpitations), gastrointestinal (abdominal pain, diarrhea, nausea/vomiting, appetite loss), neurological (headache, dizziness, tremors, sensory disturbances), musculoskeletal (joint or muscle pain), dermatological (rash, hair loss), and psychological symptoms (mood changes, anxiety, sleep disturbance). Parents or legal guardians reported symptoms in children under 6 years of age. Children 6 years and older were encouraged to self-report. Children under 6 years of age underwent developmental screening using the Developmental Surveillance and Promotion Manual (DSPM)[26]. DSPM assesses five domains: gross motor, fine motor, receptive language, expressive language, and social/self-help skills. A developmental quotient < 70 indicates delay. Participants aged 10 years and older underwent psychological assessment utilizing standardized instruments. Depressive symptomatology was evaluated using the Children's Depression Inventory (CDI-Thai version)[27], with a score of 15 or higher indicating clinically significant depression. Anxiety symptoms were assessed via the Screen for Child Anxiety Related Disorders (SCARED-Thai version)[28]; a total score of 25 or higher was considered suggestive of a potential anxiety disorder. Psychological screening was conducted at 3-month and 9-month follow-up visits. At each time point, participants aged 10 years and older were assessed using the CDI-Thai version and the SCARED-Thai version during their in-person evaluations.

For children aged 6 years and older, symptom self-reporting was encouraged during structured interviews conducted by pediatricians. Parents or guardians were present during the assessment to assist or clarify if needed. Responses were cross-checked with parental reports to enhance data reliability, and any discrepancies were resolved during the interview.

All analyzes were performed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were summarized as mean ± standard deviation or median with interquartile range, depending on the data distribution. Categorical variables were presented as frequencies and percentages.

To identify factors associated with Long COVID, a univariate logistic regression was first conducted for variables of interest (age, sex, comorbidity, severity of acute infection and Favipiravir use). Variables with a p-value < 0.2 in the univariate analysis were included in the multivariate logistic regression. Adjusted odds ratio (OR) and corresponding 95% confidence interval (CI) were calculated to determine independent predictors. A two-sided p-value < 0.05 was considered statistically significant.

This study was approved by the Bangkok Metropolitan Administration Ethics Committee for Human Research (S008h/65). Written informed consent was obtained from the parents or legal guardians of all participants, and assent was obtained from children aged 7 years and older. The data was managed in compliance with institutional data-protection policies and the principles outlined in the Declaration of Helsinki.

RESULTS

A total of 233 children and adolescents (mean age 9.95 years, range 0.39-17.98 years) were enrolled (Table 1). Of these, 117 (50.22%) were female, and 49 (21.03%) had an allergic condition (e.g., asthma, allergic rhinitis, atopic dermatitis) or other comorbidity such as congenital heart disease, transfusion dependent beta thalassemia, HIV infection (CD4 > 350 cells/mm^3 with viral load suppression), hypertension, obstructive sleep apnea and psoriasis. During the acute phase, 30 children (12.88%) were asymptomatic, 184 (78.97%) had mild severity and 19 (8.15%) had moderate severity without the need for mechanical ventilation. Fifteen participants (6.44%) required hospital admission. According to the Thai COVID-19 treatment guidelines[20], 142 (60.94%) of the children received Favipiravir, primarily due to underlying comorbidities or moderate to severe presentations.

Follow-up data were available for all 233 participants at both 3- and 6-month assessments. At 3 months, 83 participants (35.62%) reported persistent symptoms, which decreased to 24 participants (10.30%) at 6 months. At 9 months, 125 of the original 233 participants (53.60%) returned for in-person evaluation, and no participants reported ongoing symptoms at that time (Figure 1).

Table 1 Descriptive characteristics

Descriptive Characteristics	Results (233) N (%)
Sex	
Male	116 (49.78%)
Female	117 (50.22%)
Age (years), median (IQR)	9.95 years (0.39-17.98)
Age range	
Infant (0-1 years)	10 (4.29%)
Toddlers (> 1-3 years)	12 (5.15%)
Preschool-aged children (> 3-5 years)	29 (12.45%)
School-aged children (> 5-10 years)	62 (26.61%)
Adolescents (> 10-18 years)	120 (51.50%)
Pre-existing comorbidity	
No	184 (79%)
Yes	49 (21%)
Family infection	
No	2 (0.86%)
Yes	231 (99.14%)
Treatment Place	
Covid ward	15 (6.44%)
Home isolation	108 (46.35%)
Hospital	97 (41.63%)
Community isolation	13 (5.58%)
Symptomatic COVID	
Asymptomatic	30 (12.88%)
Mild symptom	184 (78.97%)
Moderate symptom	19 (8.15%)
Favipiravir	
No	91 (39.06%)
Yes	142 (60.94%)

Abbreviations: IQR, interquartile range; N, number

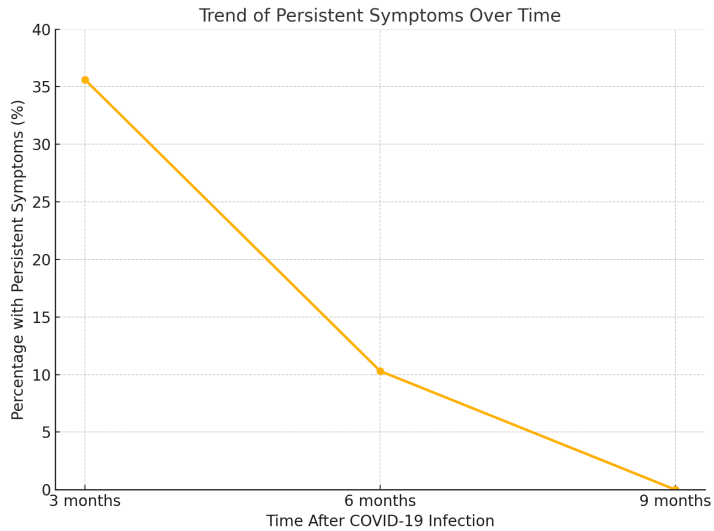

Figure 1 Trend of persistent symptoms among children and adolescents following SARS-CoV-2 infection at 3, 6, and 9 months

At three months, 65.06% of the participants reported 1-2 symptoms, the most frequently reported symptoms were dyspnea (34.94%), hair loss (33.73%), sleep disturbances (25.30%), rhinorrhea (22.89%) and fatigue (13.25%). At six months, 24 patients reported 3 or fewer symptoms, hair loss (37.50%), and sleep problems (25%) remained prominent, while overall respiratory complaints decreased (Table 2). Psychological symptoms, including anxiety and depressed mood, were also observed. Among those aged ≥ 10 years, self-report questionnaires revealed a higher prevalence of subclinical anxiety or depressive symptoms (Table 3).

Table 2 Persistent symptoms at 3 and 6 months after acute infection

Reported symptoms	3 months N = 83 (%)	6 months N = 24 (%)
Cardiorespiratory		
Cough	2 (2.41%)	1 (4.17%)
Sore throat	1 (1.20%)	0
Rhinorrhea	19 (22.89%)	2 (8.33%)
Dyspnea	29 (34.94%)	1 (4.17%)
Pleuritic chest pain	3 (3.61%)	1 (4.17%)
Chest pain	7 (8.43%)	0
Gastrointestinal		
Diarrhea	6 (7.23%)	0
Constipation	2 (2.41%)	0
Abdominal pain	6 (7.23%)	0
Neuropsychiatric		
Decrease attention	3 (3.61%)	1 (4.17%)
Depressed mood	3 (3.61%)	1 (4.17%)
Worry	2 (2.41%)	4 (16.67%)
Headache	10 (12.05%)	0
Balance problem	2 (2.41%)	0
Tremor	3 (3.61%)	0

Table 2 Persistent symptoms at 3 and 6 months after acute infection (continued)

Reported symptoms	3 months N = 83 (%)	6 months N = 24 (%)
Numbness	5 (6.02%)	2 (8.33%)
Dysosmia	4 (4.82%)	0
Fatigue	11 (13.25%)	1 (4.17%)
Sleep problem	21 (25.30%)	6 (25%)
Dizziness	6 (7.23%)	2 (8.33%)
Dermatological		
Rash	3 (3.61%)	0
Hair loss	28 (33.73%)	9 (37.50%)
Others		
Muscle weakness	8 (9.64%)	2 (8.33%)
Joint pain	1 (1.20%)	0
Fever	1 (1.20%)	0

Abbreviations: N, number

Table 3 Psychological screening in children > 10 years of age at 3 and 9 months

Screening tool	3 months (N = 120)	9 months (N = 55)
Positive screening for depression*	37 (30.83%)	14 (25.45%)
Positive screening for anxiety**	58 (48.33%)	25 (45.45%)

Abbreviations: N, number

*Children's Depression Inventory score ≥ 15

**Screen for Child Anxiety Related Disorders score ≥ 25

Table 4 shows that in the univariate analysis, older age (> 10 years), comorbidity, and moderate severity symptom were significantly associated with persistent symptoms at six months (OR 6.333 [95% CI: 1.426–28.128], p = 0.015; OR 3.808 [1.585–9.148], p = 0.003; OR 16.917 [1.873–152.771], p = 0.012), while female sex showed borderline significance (p = 0.094) and treatment with Favipiravir was not significantly associated (p = 0.869).

In the multivariate model, only children with symptoms of moderate severity remained significantly more likely to develop Long COVID at six months (adjusted OR 10.558, 95% CI: 1.010–110.326, p = 0.049). Age > 10 years retained borderline significance (adjusted OR 4.435, 95% CI: 0.958–20.527, p = 0.057), while comorbidity and female sex were no longer statistically significant in the fully adjusted model.

Table 4 Factors associated with Long COVID

Variables	Univariate logistic regression		Multivariate logistic regression	
	Odds Ratio (95% CI)	P-value	Adjusted Odds Ratio (95% CI)	P-value
Age 6-10 yr	0.663 (0.058,7.550)	0.740	0.558 (0.047, 6.557)	0.642
Age > 10 yr	6.333 (1.426,28.128)	0.015*	4.436 (0.958, 20.527)	0.059
Female	2.139 (0.877, 5.213)	0.094	2.403 (0.850, 6.794)	0.098
Any comorbidity	3.808 (1.585, 9.148)	0.003*	2.331 (0.829, 6.559)	0.109
Mild severity of acute infection	2.762 (0.353, 21.634)	0.333	2.564 (0.309, 21.244)	0.383
Moderate severity of acute infection	16.917 (1.873, 152.771)	0.012*	11.079 (1.042, 117.786)	0.046*
Favipiravir treatment	1.076 (0.450, 2.573)	0.869	0.633 (0.224, 1.792)	0.389

Abbreviations: CI, confidence interval; N, number; yr, year

*P- value < 0.05 indicated statistically significant.

Additional logistic regression analyses at the 3-month follow-up demonstrated consistent results regarding significant predictors (age > 10 years, female sex, and moderate severity of symptoms). Full details are available in the Table 5.

At nine months, 125 participants returned for in-person evaluations, and none reported persistent physical symptoms. Developmental screening among children < 6 years did not detect new delays. However, standardized screening for anxiety and depression continued to yield elevated scores in a subset of children aged ≥ 10 years (Table 3), underscoring the need for ongoing mental health monitoring, although these psychological findings did not necessarily meet clinical diagnostic criteria.

DISCUSSION

This study investigated the incidence and clinical presentation of Long COVID in Thai children and adolescents, identifying potential risk factors and examining the trajectory of symptoms over nine months. We found that 35.62% of the participants reported persistent symptoms at three months. This decreased to 10.30% at six months and no participant reported ongoing symptoms at nine months. These findings are consistent with previous reports demonstrating a wide variability in the prevalence of pediatric Long COVID, 1.60-70% depending on the study[18-20]. The other Thai studies, such as Wongwathanavikrom et al.'s report prevalence of 39.70% at 3 months in children after COVID pneumonia and Lokanuwatsatien et al.'s overall prevalence of 30.20% in a pediatric cohort with most asymptomatic to mild symptom in acute infection like our study[22-23]. This finding may support hypothesis that greater initial disease severity, potentially manifesting as increased lung involvement and inflammation, may contribute to a higher risk of developing long COVID. The decline in symptom prevalence at six months reflects a similar trend observed in other studies, where pediatric Long COVID symptoms tend to improve over time[19,22]. Our study found long COVID decreased to 10.30% at six months, with no symptoms at nine months. This is lower than the 20.64% prevalence at 6-12 months in those under 18 reported by Lopez et al.'s meta-analysis[19], and also lower than the 9.60% (3-6 months) and 6.90% (6-12 months) persistence seen in another Thai pediatric study[29]. The more rapid resolution in our cohort suggests a potentially different long COVID trajectory, though methodological differences should be considered.

Our results also highlight that moderate severity of symptoms during the acute phase of the illness, older age (> 10 years), and underlying comorbidities showed significant or borderline associations with persistent symptoms at six months. After adjusting for covariates, moderate symptom severity remained a significant independent risk factor for Long COVID,

Table 5 Factors associated with Long COVID symptoms at 3 months after COVID infection

Variables	Univariate logistic regression		Multivariate logistic regression	
	Odds Ratio (95% CI)	P-value	Adjusted Odds Ratio (95% CI)	P-value
Age 6-10 yr	2.026 (0.833,4.929)	0.120	2.057 (0.789, 5.361)	0.140
Age > 10 yr	3.146 (1.506,6.575)	0.002*	2.684 (1.202, 5.996)	0.016*
Female	2.730 (1.553, 4.797)	< 0.001*	3.460 (1.787, 6.700)	< 0.001*
Any comorbidity	1.425 (0.746, 2.724)	0.284	-	-
Mild severity of acute infection	4.800 (1.402, 16.435)	0.012*	7.929 (1.740, 36.145)	0.007*
Moderate severity of acute infection	19.500 (4.198, 90.573)	< 0.001*	54.353 (7.658, 385.766)	< 0.001*
Favipiravir treatment	1.412 (0.803, 2.481)	0.231	-	-

Abbreviations: CI, confidence interval; N, number; yr, year
*P- value < 0.05 indicated statistically significant.

consistent with prior research indicating that children with more severe acute illness may be at higher risk of prolonged recovery[30,31]. While older age retained borderline significance in the multivariate model, the lack of statistical significance for underlying disease contrasts with some studies reporting that comorbidities, especially asthma or allergic conditions, predispose children to persistent symptoms[22,31]. Discrepancies between our findings and those in the literature may be due to differences in patient populations, sample sizes, and specific comorbidities included.

A notably high proportion of participants reported hair loss (33.73% at three months and 37.50% at six months), surpassing the rates reported in other studies[19,23]. A possible explanation is stress-related telogen effluvium triggered by the illness itself or by psychosocial factors during the pandemic. Sleep disturbances also remained prominent at six months (25%), underscoring the potential impact of COVID-19 on children's mental health and daily functioning.

Psychological symptoms were another important finding, particularly among adolescents (≥ 10 years). Although few participants explicitly reported anxiety or depressive moods, self-report screening tools[27,28,32] revealed a higher prevalence of subclinical symptoms. This discrepancy suggests that routine mental health evaluation may be necessary, as children may not report emotional or behavioral changes. Pandemic-related disruptions, such as school closures and social isolation, may have amplified stress in this population[4-6].

Using the DSPM, we did not detect developmental delays in children under six years of age[26], supporting earlier research indicating that mild or asymptomatic COVID-19 might not substantially affect early developmental milestones[33]. Nonetheless, children with more severe illness could need longer-term monitoring to detect subtle cognitive or motor impacts.

This study has several limitations. Its single-center retrospective-prospective cohort design without a control group limits generalizability and introduces potential selection bias. The modest sample size and lack of predefined subgroup analysis calculations may compromise statistical power and stability of results. Attrition at nine-month follow-up (~46%) could lead to selection bias, impacting symptom prevalence accuracy. Data collection via phone interviews at six months, rather than in-person assessments, may introduce reporting bias. Additionally, the absence of viral genotyping and detailed vaccination status limits the evaluation of variant-specific effects and vaccine impact on outcomes. Psychological assessments were screening measures, potentially underestimating mental health burdens, and unmeasured socio-environmental factors might represent residual confounding. Nonetheless, the findings contribute valuable insights into pediatric Long COVID, emphasizing the need for close monitoring and routine psychological screening in post-COVID care.

CONCLUSION

In this single-center cohort of Thai children and adolescents, more than one-third experienced persistent symptoms at three months following SARS-CoV-2 infection, and around 10% continued to have complaints at six months. Moderate severity symptoms during the acute illness were a significant independent risk factor for Long COVID at six months. Clinicians should therefore prioritize follow-up and supportive care for children with moderate acute COVID-19, especially regarding physical and mental health monitoring.

CONFLICT OF INTEREST

The authors declare that they do not have any conflicts of interest.

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DATA AVAILABILITY STATEMENT

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

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Original Article

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Recognition, Knowledge, and Attitudes Toward Labor Companionship: A Hospital-Based Prospective Study

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ABSTRACT

OBJECTIVE: To evaluate the recognition, knowledge, and attitudes toward labor companionship among pregnant women, their labor companions (LCs), and hospital personnel (HP).

METHODS: This cross-sectional survey included women who gave birth our hospital between October 2022 and April 2023. Their LCs and selected HP were also invited to participate. Data on personal demographics, recognition, knowledge (considered good if participants correctly answered ≥ 8 out of 10 questions), and attitudes (considered positive with scores ≥ 48 out of 60 on 12 questions) were collected through a self-answered questionnaire. Attitudes were assessed once for HP and twice (before and after delivery) for women and their LCs.

RESULTS: A total of 191 individuals participated, including 67 pregnant women, 106 LCs, and 18 HPs. The overall recognition rate was 20.4%, with rates of 50.0% among HP, 14.9% among women, and 18.9% among LCs. Good knowledge was found in 9.5% of pregnant women, 8.1% of spouses, and 33.3% of HP (p = 0.066). Positive attitudes were observed in 72.7% of HP. Among pregnant women, 84.4% had positive attitudes before delivery, and 81.3% maintained them afterward (p = 0.060). For LCs, positive attitudes were recorded in 69.8% before delivery and 81.4% after (p = 0.308).

CONCLUSION: The study found that recognition of labor companionship was low, and most participants lacked sufficient knowledge. However, nearly three-fourths exhibited positive attitudes. Notably, pregnant women's attitudes did not improve after having an LC, whereas LCs demonstrated more positive attitudes following their experience.

KEYWORDS: attitudes, hospital personnel, labor companion, labor companionship, pregnant women

INTRODUCTION

Labor is the process of childbirth, during which pregnant women experience both physical and psychological stress, including fear and anxiety[1]. A comprehensive approach from hospital personnel (HP), including obstetricians, nurses, and midwives, is crucial to addressing not only the physical well-being of the mother and but also her psychological and emotional needs, ensuring the health of both the mother and the unborn child[2]. Delivery room practices differ based on factors such as cultural backgrounds,

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local healthcare protocols, patient load, and resource availability. In settings with limited medical staff, nonmedical personnel may play a vital role in supporting pregnant women.

The World Health Organization (WHO) recommends the presence of a companion during labor to enhance childbirth outcomes and increase women's satisfaction, emphasizing respectful care that protects their autonomy, decision-making ability, and right to choose[3]. National policies allowing a chosen labor companion (LC) exist in regions such as the Americas, Southeast Asia, and Europe but are not widely implemented in the Eastern Mediterranean, Africa, and the Western Pacific[4]. In 2018, the WHO highlighted global disparities in labor companionship policies and called for future research on effective implementation strategies[4].

Several studies, including systematic reviews, have demonstrated that continuous labor companionship can improve childbirth outcomes for both mothers and infants without adverse effects[2,5-6]. The presence of an LC has been associated with greater satisfaction with the birth experience, reduced anxiety through emotional support, decreased reliance on pain relief and medical interventions, and enhanced psychological comfort[6-7].

Labor companionship remains uncommon in Thailand, with limited research available on the subject. An international qualitative study under the Quali-Dec project investigated factors influencing the implementation of labor companionship in Thailand as a strategy to reduce cesarean section rates[8]. This study revealed that LC, typically provided by a woman's husband or mother, is perceived as highly beneficial and acceptable within the Thai cultural context. The implementation of structured training programs for companions, focusing on appropriate support methods and collaboration with healthcare professionals during pregnancy, could enhance the overall benefits for expectant mothers[8]. Two quasi-experimental studies studied the effect of LC on Thai pregnant women. Another study found that primiparous women who had trained female family members as LCs reported higher satisfaction compared to those who received standard care[9]. Other studies have reported that the presence of a LC may contribute to a reduced need for labor induction among women in the delivery room[10]. However, public hospitals currently lack formal policies to support the integration of companions during labor[8].

Our hospital, a tertiary care facility in Thailand, has allowed LCs in the labor room since 2019. However, no assessment has been conducted on the fundamental aspects of labor companionship among those involved. This study aimed to evaluate the recognition, knowledge, and attitudes toward labor companionship among pregnant women who gave birth at the hospital, their companions, and HPs.

METHODS

This cross-sectional survey study was approved by the Institutional Review Board (COA 006/2022). The sample size was determined using Cochran's Formula[11] ($N = Z^2P(1-p)/e^2$) for an unknown population size of LC in our hospital in 2023. However, the population proportion was known, as approximately 95% of pregnant women were accompanied by their husbands, other family members, or friends during the delivery period. The population proportion was 0.95 ($p = 0.95$), the reliability level of this study was 95% ($Z = 1.96$), and acceptable sampling error was 0.05 ($e = 0.05$); therefore, a minimum of 73 LC participants were required. After adding an attrition rate of 10%, at least 80 LC participants were required.

This study focuses on LC; people who came to the hospital with pregnant women were included. For pregnant women and HP, the convenience sampling method was used to recruit. The inclusion criteria comprised Thai pregnant women over 18 years old who gave birth at the hospital between October 2022 and April 2023, one of their accompanying persons who acted as an LC, and HP. HP included nurses

from the delivery or operating room, obstetrics ward, administrative nurses, and hospital policymakers. Exclusion criteria included women who gave birth before arrival or outside the delivery or operating rooms, those whose infants or themselves required special medical care, and individuals who declined participation.

Eligible participants received an information sheet and a verbal explanation from a research assistant. Participation was voluntary, with assurance that their decision would not impact their medical care. They had the option to skip any question or withdraw from the study at any time. The questionnaire, divided into four sections, was completed at their convenience.

Part 1: Collected personal data, including age, gender, marital status, education level, monthly family income, and the LC's relationship to the pregnant woman.

Part 2: Assessed recognition of LC (yes or no), prior experience as an LC (yes or no), and the preferred individual to serve as an LC.

Part 3: Evaluated knowledge of labor companionship through 10 questions with response options of "correct," "incorrect," or "not sure" (with "not sure" classified as incorrect). Scores ranged from 0 (all incorrect) to 10 (all correct).

Part 4: Measured attitudes toward labor companionship using 12 statements rated on a scale from 1 (strongly disagree) to 5 (strongly agree), with total scores ranging from 12 (all strongly disagree) to 60 (all strongly agree). Pregnant women and their LCs responded to the same attitude questions before (predelivery attitudes) and after (postdelivery attitudes) the experience of having or being an LC.

Before the study, the Thai version of the Part 3 (knowledge) and Part 4 (attitudes) questionnaires was reviewed, discussed, and revised until the researchers reached a consensus. Three independent experts—an obstetrician, an anesthesiologist, and a nurse—validated the final version. Reliability testing was conducted on 30 individuals with similar characteristics to the study participants, yielding Cronbach's alpha coefficients of 0.819 for the knowledge questionnaire and 0.907 for the attitude questionnaire.

All questionnaire data were de-identified and analyzed anonymously. Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 28.0 (IBM Corporation, Armonk, NY, USA). Continuous variables are reported as mean ± standard deviation for normally distributed data or as median with interquartile range (IQR) for non-normally distributed data. Categorical variables are presented as frequency and percentage.

Knowledge was classified as "good" if participants answered at least 8 out of 10 questions correctly (≥ 80%). Attitudes were considered "good" with scores exceeding 48 out of 60 (≥ 80%). The pre- and postdelivery attitudes of pregnant women and their LCs were compared. Univariate analysis was performed to identify factors associated with good knowledge or good predelivery attitudes, using the Chi-square or Fisher's exact test as appropriate. Data were stratified by education level (bachelor's degree or lower vs. higher than a bachelor's degree) and monthly family income (more than 2,700 USD or less). A p-value < 0.05 was considered statistically significant.

RESULTS

Among the 717 pregnant women who gave birth at our hospital during the study period, 611 women or their LCs declined participation. A total of 191 participants were included: 67 pregnant women, 106 LCs (all spouses), and 18 HPs.

The mean age of all participants was 36.4 ± 6.4 years. Among pregnant women, 85.1% were experiencing childbirth for the first time, while 77.4% of their spouses were first-time fathers. In contrast, half of the HPs had at least one child. Additional participant characteristics are presented in Table 1.

Table 1 Characteristics of participants

Characteristics	N = 191	Mother N = 67	Spouses N = 106	Hospital personnel N = 18
Age, mean SD (year),	36.4 ± 6.4	34.3 ± 4.2	37.2 ± 4.8	31 (IQR 26, 45.5)
Gender				
Male	108	-	106 (100)	4 (22.2)
Female	83	67 (100.0)	-	14 (77.8)
Marital status, N = 177				
Married	182	67 (100.0)	106 (100.0)	9 (50.0)
Single	9	-	-	9 (50.0)
Number of children				
0	9	-	-	9 (50.0)
1	141	57 (85.1)	82 (77.4)	2 (11.1)
> 1	41	10 (14.9)	24 (22.6)	7 (38.9)
Education				
Higher than bachelor	102	38 (56.7)	57 (53.8)	7 (38.9)
Bachelor or lower	89	29 (43.3)	49 (46.2)	11 (61.1)
Family income				
≤ 2,700 USD	64	25 (37.3)	28 (26.4)	11 (61.1)
> 2,700 USD	127	42 (62.7)	78 (73.6)	7 (38.9)

Abbreviations: IQR, interquartile range; N, number; SD, standard deviation; USD, The United States dollar

Regarding recognition, 20.4% were aware of LC, with the highest rate among HPs (50.0%). Recognition was similar between pregnant women (14.9%) and their spouses (18.9%). A total of 90.1% had no prior experience of having or being an LC, including 98.5% of pregnant women, 83.0% of spouses, and all HPs. Recognition and experience data are detailed in Table 2.

Among the 52 pregnant women who answered the question about their preferred LC, the majority (94.2%) chose their spouses, while the remaining respondents preferred a nurse as their LC.

Fewer participants completed the section on knowledge and the role of LCs (Table 3). The overall mean knowledge score was 5.6 ± 1.8 out of 10, with pregnant women scoring 5.5 ± 1.8, spouses 5.4 ± 1.7, and HPs 5.9 ± 2.1. Good knowledge, defined as answering more than 8 out of 10 questions correctly, was observed in 9.5% of pregnant women, 8.1% of spouses, and 33.3% of HPs (p = 0.066).

Table 2 Recognition and experience about labor companionship

	Overall N = 191	Mother N = 67	Spouse N = 106	Hospital personnel N = 18
Ever heard about labor companion				
Yes	39 (20.4)	10 (14.9)	20 (18.9)	9 (50.0)
No	152 (79.6)	57 (85.1)	86 (81.1)	9 (50.0)
Experience as a labor companion				
Yes	19 (9.9)	1 (1.5)	18 (17.0)	-
No	172 (90.1)	66 (98.5)	88 (83.0)	18 (100.0)

Abbreviation: N, number

Table 3 Knowledge about labor companionship

Labor companion	Correct answer		
	Mother N = 21	Spouse N = 37	Hospital personnel N =12
1. Is generally accepted in Western countries	6 (28.6)	8 (21.6)	5 (41.7)
2. One benefit is a prompt call for help if needed	17 (81.0)	22 (59.5)	8 (66.7)
3. Maybe her spouse, pregnant woman's relative or friend	18 (85.7)	32 (86.5)	12 (100.0)
4. A female who has had delivered her own child will serve well	9 (42.9)	10 (27.0)	5 (41.7)
5. Maybe present during the whole process of labor	2 (9.5)	4 (10.8)	1 (8.3)
6. May also take care of other women in labor at the same time	6 (28.6)	17 (45.9)	6 (50.0)
7. Will comfort a pregnant woman leading to less stress	19 (90.5)	35 (94.6)	9 (75.0)
8. Having husband as a labor companion will strengthen their relationship and bonding with their newborn	17 (81.0)	36 (97.3)	11 (91.7)
9. Will decrease postpartum blue/ depression	12 (57.1)	25 (67.6)	9 (75.0)
10. Can reduce maternal and perinatal (baby) mortality	9 (42.9)	12 (32.4)	5 (41.7)

Abbreviation: N, number

When analyzing each question, the percentage of correct responses ranged from 9.5% to 90.5% among pregnant women, 10.8% to 97.3% among spouses, and 8.3% to 100.0% among HPs. Five statements consistently received low scores across all groups: "LCs can stay throughout the entire labor process," "Labor companionship is widely accepted in Western countries," "Female LCs perform better," "LCs can assist other women in labor," and "Labor companionship can reduce maternal and perinatal mortality."

Regarding attitudes toward LC, nearly all of the 12 attitude statements received scores above 4 on a scale of 60. The analysis included predelivery attitude scores and the percentage of participants with good attitudes (scores ≥ 48). The mean attitude score was 52.2 ± 5.5 for HPs, with 72.7% classified as having good attitudes. Among pregnant women, the mean score was 51.4 ± 6.2, with 75.8% demonstrating good attitudes, while spouses had a mean score of 50.4 ± 7.4, with 62.7% showing good attitudes.

We further analyzed the attitudes of pregnant women and spouses who completed both pre- and postdelivery assessments. Among 32 pregnant women, the mean attitude score was 52.5 ± 5.4 predelivery (84.4% with good attitudes) compared to 51.4 ± 5.6 postdelivery (81.3% with good attitudes) (p = 0.060). For 43 spouses, the pre- and postdelivery scores were 51.4 ± 6.0 (69.8% with good attitudes) and 52.5 ± 8.7 (81.4% with good attitudes), respectively (p = 0.308).

The pre- and postdelivery attitudes of pregnant women and their spouses were analyzed, revealing that most attitude items improved after firsthand experience. The greatest improvements were seen in "strengthening the bond between pregnant women and their LC" (+0.31) for pregnant women and "strengthening the bond between the LC and newborn" (+0.52) for spouses. However, pregnant women showed a slight decline in agreement with the statement "having an LC will comfort the pregnant women during labor both physically and emotionally" (−0.06). Table 4 presents the attitudes of HPs toward labor companionship, as well as the pre- and postdelivery attitudes of pregnant women and their spouses.

We also examined factors that might influence the knowledge and postdelivery attitudes of pregnant women and their spouses. Younger HPs demonstrated better knowledge compared to older HPs (100% vs. 28.6%, p = 0.028). Additionally, pregnant women from lower-income families had better attitudes than those from higher-income families (75.0% vs. 47.2%, p = 0.033). Other factors, including gender, parity, education level, recognition, or prior experience with LC, were not significantly associated with knowledge or attitudes (data not shown).

Table 4 Attitudes about labor companionship

Issue about the practice of labor companion	Positive attitude responses (agree to strongly agree), mean ± SD						
	Hospital personnel (N = 18)	Women			Spouses		
		Pre-labor (N = 62)	Post-labor (N = 32)	Difference	Pre-labor (N = 102)	Post-labor (N = 43)	Difference
1. The hospital should support this as a part of maternal healthcare.	4.39 (0.61)	4.37 ± 0.71	4.44 ± 0.61	0.07	4.37 ± 0.69	4.55 ± 0.55	0.18
2. The mother may select anybody as her labor companion.	4.28 (0.67)	4.39 ± 0.75	4.65 ± 0.54	0.26	4.34 ± 0.79	4.41 ± 0.82	0.07
3. Labor companion should be a one-to-one manner to support the mother during labor.	4.28 (0.75)	4.32 ± 0.83	4.41 ± 0.74	0.09	4.20 ± 0.78	4.45 ± 0.66	0.25
4. It will comfort the mother during labor both physically & emotionally.	4.56 (0.51)	4.58 ± 0.62	4.52 ± 0.57	- 0.06	4.51 ± 0.63	4.72 ± 0.50	0.21
5. The mother's wishes can be relayed to medical personnel.	4.33 (0.77)	4.31 ± 0.78	4.36 ± 0.65	0.05	4.07 ± 0.88	4.28 ± 0.91	0.21
6. It may comfort the mother by gentle touch or massages.	3.94 (0.87)	4.10 ± 0.82	4.27 ± 0.76	0.17	4.14 ± 0.90	4.53 ± 0.63	0.39
7. Mother will be less stressed.	4.44 (0.62)	4.44 ± 0.64	4.58 ± 0.56	0.14	4.38 ± 0.72	4.65 ± 0.48	0.27
8. The mother can receive empathy & admiration of her patience & strength.	4.33 (0.59)	4.39 ± 0.71	4.45 ± 0.62	0.06	4.31 ± 0.72	4.53 ± 0.55	0.22
9. It will strengthen bonding between mother and her labor companion.	4.28 (0.90)	4.27 ± 0.77	4.58 ± 0.50	0.31	4.13 ± 0.82	4.33 ± 0.78	0.20
10. It will build a bonding between a labor companion with the newborn.	4.22 (0.88)	4.13 ± 0.84	4.39 ± 0.79	0.26	3.95 ± 0.97	4.47 ± 0.67	0.52
11. The personnel can provide their usual medical service without difficulty.	4.06 (0.80)	4.32 ± 0.79	4.39 ± 0.61	0.07	4.21 ± 0.77	4.35 ± 0.69	0.14
12. This serves as a holistic obstetrical care.	4.41 (0.62)	4.25 ± 0.72	4.42 ± 0.71	0.17	4.08 ± 0.73	4.42 ± 0.66	0.34

Abbreviation: N, number

DISCUSSION

Only 20.4% of participants in this study were aware of labor companionship, despite most having higher education. Recognition was highest among HPs (50.0%), but remained lower than the 93% reported in a previous study from India[12]. In contrast, recognition rates were lower among pregnant women (14.9%) and spouses (18.9%). These differences may be attributed to the varying prevalence of labor companionship across countries, with the practice being more common in regions where medical services are limited.

All LCs in this study were the women's spouses, aligning with prior research findings. Additionally, 94.2% of participants preferred their spouses as their LC[13-15], as they sought both physical and emotional support during labor, aimed to strengthen parental bonding, and wished to share the emotional experience of childbirth[8,16-17]. However, studies from Asia[12,18] and Africa[13] have reported different preferences, including mothers[12], other family members[13,18], nurses, doctors[12,19], or female companions[14,19]. Women may prefer non-spousal LCs due to expectations of better support from individuals with labor experience[12,14,18-19] or cultural norms that discourage male presence during childbirth[16]. Some women prioritize choosing a compassionate individual who can remain with them throughout labor[6].

The low response rate to the knowledge questions—only one-third of women and spouses and two-thirds of HPs—may be due to a lack of recognition or knowledge, leading participants to skip this section. This was reflected in the modest mean scores and the overall low percentage of participants demonstrating good knowledge. Our findings, which showed slightly higher mean scores and better knowledge among HPs compared to other participants, were consistent with a previous study in India, where nurses had good knowledge while pregnant women had only fair knowledge[20]. However, the 33% rate of good knowledge among our HPs was lower than the 44%–53% reported in previous studies[20-21]. This difference may be due to labor companionship being more commonly practiced in those countries compared to ours.

The low level of knowledge among pregnant women and spouses in our study was unexpected, especially given their high education levels, which have been linked to better knowledge in previous studies[13,21]. This may be due to labor companionship being uncommon in our country. Additionally, many couples in our study viewed labor companionship primarily as psychological support rather than a source of medical or nursing care, possibly causing them to overlook its other benefits. Previous studies have also identified factors contributing to inadequate knowledge, such as unawareness of global or WHO guidelines[15], lack of information from healthcare providers about the right to have an LC[15], hospital policies or restrictions related to infection control, overcrowding, privacy concerns, and costs[12].

The positive predelivery attitudes observed in 75.8% of pregnant women in our study were similar to the 82% reported in previous studies[20,22]. Research from Thailand has also highlighted positive attitudes and higher satisfaction among those with LCs[8-9]. These favorable perspectives may be due to the increased confidence provided by emotional and physical support, strengthened family relationships, and improved adherence to midwives' instructions[20-21]. However, some studies, including ours, found that certain pregnant women were less optimistic, believing that no one could truly relieve their pain or address their physical needs[19-20]. This was reflected in our study by the low score on the belief that LCs could provide comfort through gentle touch or massages. The reason may be data in our study were from pregnant women in the delivery room or during childbirth, a period of physical and emotional stress[23], which can contribute to negative feelings toward the birth process, including fear, and adverse emotional responses[24] of our pregnant women. Different findings between our study which could not positive attitude towards LC of women and previous reports showing positive might be due to cultural difference or approach of the healthcare providers to women in each hospital.

Among spouses, 62.8% had positive predelivery attitudes. However, some negative views were associated with concerns about LC's role in relaying maternal messages to medical personnel. A study from Thailand also reported negative attitudes among spouses, including beliefs that their wives should be solely cared by medical professionals, fears of witnessing their wives' pain, and feelings that their presence was not beneficial[8].

The experience of having or being an LC can positively impact attitudes. In our study, both pregnant women and their spouses showed slightly more positive attitudes postdelivery. The most notable improvement was in the perception of "strengthening the bond between pregnant women and LC," likely due to the comfort and pain relief provided by the LC, which facilitated closer connections[25-27]. Another area of improvement was "strengthening the bond between the LC and newborn." Previous studies have suggested that when fathers serve as LCs, their first contact with the newborn fosters positive emotions and strengthens their bond with baby, reinforcing family relationships[6,28]. Unexpectedly, the attitude score decreased for the belief that "having an LC will comfort the pregnant women during labor both physically and emotionally." This may be due to LC's performance or the availability of abundant resources and skilled healthcare personnel in our hospital, where physical and emotional support from an LC may be perceived as less essential.

Our study found that 72.7% of HPs had a positive attitude toward labor companionship, a relatively high rate compared to the 51%–73% reported in previous studies[20,29-30]. These favorable attitudes may stem from the perceived benefits of labor companionship, such as reducing women's dependence on medical staff, easing workload, providing emotional support, and enhancing pain management, which can contribute to shorter labor durations and fewer cesarean deliveries. However, some HPs held negative attitudes due to concerns about privacy, distrust,

uncertainty regarding the role of LCs, and potential disruptions in communication between women and staff[7,31]. These negative perceptions were more common among older, more experienced HPs, who may be more familiar with practices that conflict with hospital policies, potentially creating obstacles to implementing labor companionship[15,29].

Regarding factors associated with good knowledge and positive attitudes, our study found that younger healthcare professionals had significantly better knowledge (100% vs. 28.6%) than their older counterparts. This may be due to greater awareness of labor companionship, a concept emphasized by the WHO in 2018[4]. However, this finding contrasts with a previous study that reported higher knowledge levels among older professionals[30].

Additionally, we observed significantly more positive attitudes toward labor companionship among women with lower family incomes (75.0% vs. 47.4%). This contrasts with a previous study that found better attitudes among those with higher incomes[19]. Economic status, personal experiences, or social backgrounds may influence these differences. Women with higher incomes, as seen in our study, may have greater self-confidence or control in difficult situations, potentially affecting their perceptions of labor companionship.

Our study has several limitations. First, it was conducted in a tertiary hospital with a well-developed medical care system, where emotional support may have been emphasized over physical support. Second, the study took place around the delivery time, which may have affected participants' focus due to medical preparations and excitement, leading to fewer responses, especially postdelivery. Third, the random selection of a limited number of HPs may have influenced the findings due to differences in service roles and responsibilities.

Despite these limitations, our study has notable strengths. It is one of the few studies on labor companionship in our country. Aside from a qualitative study exploring perspectives on LC[9] and a Quali-Dec policy suggesting it as a strategy to reduce cesarean section rates[32], research on this topic remains scarce. Additionally, our survey included pregnant women and their spouses who had firsthand experience with labor companionship, ensuring the reliability of the data. Lastly, we compared overall and specific pre- and post-labor attitudes to highlight key areas for consideration.

CONCLUSION

Our study revealed low recognition and knowledge of labor companionship among participants, underscoring the need for national advocacy, particularly in areas with limited medical personnel. The intangible benefits of labor companionship—such as strengthening the bond between women and their spouses, as well as between spouses and newborns—can encourage pregnant women, their spouses, and hospital policymakers to adopt this practice. The low scores on knowledge-related items, including labor processes and benefits like reduced perinatal mortality, highlight the need for educational initiatives before women and their LCs take part in childbirth. Future studies should investigate this issue in different settings, such as public hospitals or various regions, and assess the long-term impact on family well-being.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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DATA AVAILABILITY STATEMENT

Please contact the corresponding author for data availability.

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Original Article

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Efficacy of Lower Uterine Segment Compression in Women with 3rd Stage of Labor Blood Loss More Than 300 ml for the Prevention of Early Postpartum Hemorrhage: A Multi-Center Open-Labeled Randomized Controlled Trial

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ABSTRACT

OBJECTIVE: To compare the efficacy of 20-minute lower uterine segment compression (LUSC) and conventional treatment for postpartum hemorrhage (PPH) prevention in women with blood loss > 300 ml in the 3rd stage of labor.

METHODS: Patients were recruited from four hospitals under the Bangkok Metropolitan Administration. In total, 1082 postpartum patients who experienced the 3rd stage of labor bleeding exceeding 300 ml were enrolled in this study, and were randomly equally split into a control group, in which patients received conventional treatment for PPH prevention, and the LUSC group, in which patients received 20-minute LUSC and conventional PPH prevention measures. LUSC was administered by compressing the suprapubic area covering the lower uterine segment using four digits (index to little finger) of one hand until bleeding had ceased. The primary and secondary outcome of this study were to assess amount of blood loss in the 4th stage of labor and the rate of PPH of LUSC group compare to control group.

RESULTS: A total of 1,128 patients with the 3rd stage bleeding exceeding 300 ml were identified, 34 patients declined participation, and 12 patients were excluded due to twin pregnancies (6 cases), hydramnios (2 cases), and hysterectomy (4 cases). 541 patients in control group had mean age 28.70 ± 6.48 year while 541 patients in LUSC group had mean age 27.41 ± 6.22 year (p = 0.001). There were statistically significant differences in parity, the duration of rupture of the membrane, duration of the 2nd and 3rd stages of labor, birth attendant, and the degree of perineal tear between the two groups. The mean volumes of blood loss in the 4th stage of labor of the control group were 90 (50,150) ml versus 50 (40,70) ml in the LUSC group (p < 0.001). PPH occurred in 45.5% of the control group compared to only 26.1% in the LUSC group (p < 0.001).

CONCLUSION: 20-minute LUSC is effective for reducing blood loss and preventing PPH in patients who experience more than 300 ml blood loss in the 3rd stage of labor.

KEYWORDS: lower uterine segment compression, postpartum hemorrhage, PPH prevention

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INTRODUCTION

A systematic analysis of the global causes of maternal deaths reported that the worldwide maternal mortality rate during 2003-2009 was approximately 27.1% (uncertainty interval (UI): 19.9-36.2%), with more than two-thirds of maternal deaths attributed to postpartum hemorrhage (PPH)[1]. It was also reported that roughly 62-92% of intensive care unit (ICU) admissions related to pregnancy occur in the postpartum period, with hemorrhage being a leading cause within this group[2]. The overall incidence of PPH varies from 1-10% of all deliveries[3].

By definition, PPH is characterized by bleeding exceeding 500 ml following vaginal delivery and more than 1,000 ml following cesarean delivery, occurring within 24 hours postpartum[3]. Although a hemorrhage of 500 ml would not yet induce hemodynamic changes, reducing the incidence of PPH is considered crucial for improving maternal health, and would also contribute to the achievement United Nations Millennium Development Goal 5[4,5].

Various guidelines exist to help prevent PPH, such as the 2022 guidelines from the International Federation of Gynecology and Obstetrics that recommend the use of oxytocin for both vaginal delivery and cesarean section. Other choices include ergotamine, misoprostol, carbetocin, and controlled cord traction for placental removal, with the selection dependent on the specific conditions in each geographical area[6]. There are also several mechanical modalities to treat PPH, including arterial embolization, balloon tamponade[7-9], uterine compression sutures[10,11], and iliac artery ligation[12]; all of which are invasive methods.

As an alternative to the above invasive methods, lower uterine segment compression (LUSC) was proposed by Chantrapitak in 2009 as a non-invasive method. This involves applying pressure with one hand to the lower uterine segment on the anterior abdominal wall until bleeding ceases. It was reported that patients experienced no pain for 10 minutes after LUSC, and also that LUSC reduced blood loss by 47% in PPH patients[13]. Another study in 2011 by the same authors reported that a 10-minute application of LUSC could prevent early PPH in a low-risk group of patients for vaginal deliveries[14]. Similarly, Anansakunwat et al. reported in 2018 that a 20-minute application of LUSC could prevent early PPH in low-risk normal deliveries[15].

While LUSC has been proven to be effective in preventing PPH in low-risk vaginal deliveries, it still requires the attention of one personnel to perform the compression, and therefore it may not be suitable in places where staff availability is limited. The Royal Thai College of Obstetricians and Gynaecologists (RTCOG) recommends the use of a measuring bag to evaluate the amount of bleeding that make an assessment of the amount of blood loss more accurate and can aid assessing PPH risk. This study focused on patients with blood loss ≥ 300 ml in the 3rd stage of labor to investigate whether LUSC can prevent progression to PPH. A 20-minute duration for LUSC was chosen as it aligns with the normal clotting time range of 8.5 to 15 minutes, or up to 20 minutes in some cases[16,17].

The aim of the current research was to investigate the effectiveness of 20-minute LUSC in preventing PPH in women delivering vaginally who experience blood loss of at least 300 ml. The primary outcome of the current research was to assess amount of blood loss in the 4th stage of labor of LUSC group compare to control group. The secondary outcome of this study was the rate of PPH in both groups.

METHODS

The present study was approved by the Ethics Committee of the Bangkok Metropolitan Administration (S001h/60) and registered in the Thai Clinical Trials Registry (TCTR20180320006), with written informed consent forms signed by all subjects. This study was conducted across four hospitals under the Bangkok Metropolitan Administration, namely Charoenkrung Pracharak Hospital, Ratchapiphat Hospital, Sirindhorn Hospital,

and Taksin Hospital. The study recruited women who delivered between April 1, 2018, and December 10, 2021, and who experienced blood loss of at least 300 ml in the 3rd stage of labor. The inclusion criteria were: age 18-50 years old, vaginal delivery at gestational age 28-42 weeks, and a blood loss of at least 300 ml during the 3rd stage of labor (after delivery of the baby). The exclusion criteria were: cases of multifetal gestation, myoma uteri, or hydramnios (amniotic fluid index > 20 cm) within four weeks before delivery, administration of magnesium sulfate, abnormal bleeding (e.g., platelet count < 150,000/mm^3 or development of disseminated intravascular coagulation), serious medical condition, such as heart disease, uncontrolled diabetes mellitus, asthma, epilepsy, thyrotoxicosis, and lack of antenatal care.

Before the study started, nurse representatives at each hospital had been trained for LUSC and act as mentors to other nurses in their hospitals. Women who intended to undergo vaginal delivery at the four participating hospitals received project instructions and were provided with an informed consent form. Following delivery of the newborn and the removal of residual amniotic fluid, each woman had a measuring bag inserted to assess blood loss before placental delivery. Women with blood loss collected in the measuring bag of at least 300 ml, who had also signed informed consent, were then randomized into two groups. The nurse on duty in the delivery room classified those women into the control group and the study group by picking up a sealed envelope with that had been randomly assigned to the groups in a block design (block of four). The control group received conventional treatment for PPH prevention while the study group received 20 minutes of LUSC performed by one nurse on duty in the labor room in addition to other conventional PPH prevention measures at the time of perineal repair.

After complete the perineal repair and 20 minutes of LUSC ended, birth attendant measured blood in bag to represented the 3rd stage of labor blood loss. All women were required to wear sanitary pad to record blood loss in the 4th stage of labor. The 4th stage of labor blood loss was obtained by measuring blood in the pad at 2 hours after delivery by the nurse in delivery room. Lower abdominal pain and pain of uterine contraction was asked by the nurse in delivery room and using visual analogue scale at 2 hours after delivery.

Conventional PPH prevention consisted of a uterotonic agent (oxytocin 10-40 units in 1,000 ml intravenous solution plus 10 units oxytocin as an intramuscular injection), placental delivery by the controlled cord traction method, and uterine massage[4,18-20].

LUSC was administered by compressing the suprapubic area covering the lower uterine segment using four digits (index to little finger) of one hand until bleeding had ceased for 20 minutes as shown in Figure 1. In some pregnant women who had a relaxed abdominal wall, nurses added counteracting pressure at the fundus to LUSC to increase the intrauterine pressure as shown in Figure 2[13]. Blood loss collected in the measuring bag represented the blood loss in the 3rd stage of labor, while blood was also measured in the 4th stage of labor by quantifying the blood lost in the two hours following delivery. If the sum of blood loss in the 3rd and 4th stages of labor exceeded 500 ml, it was defined as PPH.

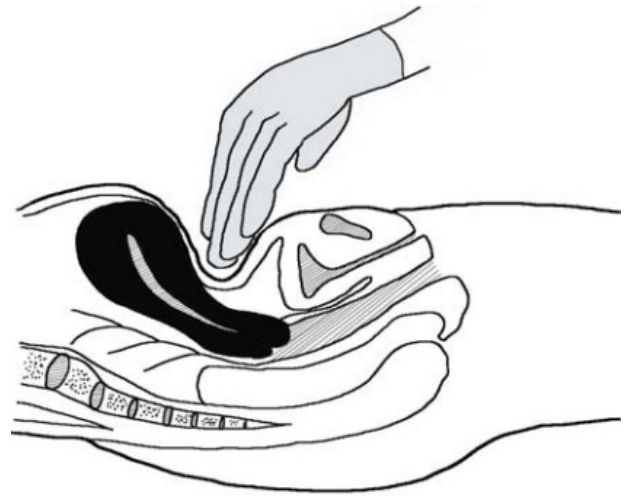

Figure 1 Lower Uterine Segment Compression (LUSC) method[13]

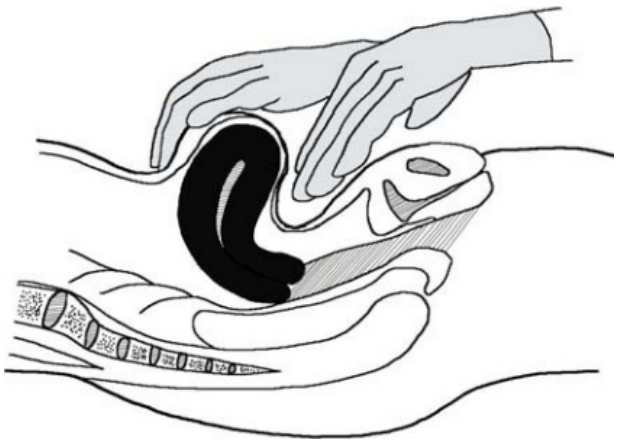

Figure 2 Lower Uterine Segment Compression (LUSC) method in women who had relaxed abdominal wall[13]

If PPH occurred in any patient in either group, they received treatment according to the guidelines of the hospital they delivered. PPH treatment consisted of intravenous crystalloid and/or blood component, empty bladder with urinary catheterization, uterine massage, oxytocin supplementation (if needed), and uterotonic agents, such as oxytocin, methylergometrine, and misoprostol. In some severe PPH cases, other methods could be applied, such as bimanual uterine compression, uterine packing or intrauterine balloon tamponade, laparotomy to apply a B-lynch compression suture, or hysterectomy[4,18,20].

The data were analyzed using parametric and nonparametric statistical methods in SPSS version 26 (IBM Corp., Armonk, NY, USA). Demographic data were presented as the mean ± SD. Continuous data were assessed for normal distribution using the Kolmogorov-Smirnov test before employing parametric statistics. Differences between continuous data were evaluated using the Student's t-test for normally distributed data and the Mann-Whitney U test for data that did not follow a normal distribution. Chi-square or Fisher's exact test was applied to compare categorical data. A p-value less than 0.05 was considered statistically significant.

The required sample size was calculated using the formula for a randomized controlled trial and referenced from the percentage of PPH cases at Chareonkrung Pracharak Hospital (9%), and estimated as a 50% reduction rate of PPH after using LUSC (4.5%). This study considered a = 0.05 as the statistical significance threshold, with b = 0.20 used for the power calculation. The total required sample number was determined to be 487 participants. Considering a possible 10% loss to follow-up, the final number sample size required per arm was thus 541 patients.

RESULTS

During the study period, a total of 1,128 patients with the 3rd stage bleeding exceeding 300 ml were identified. However, 34 patients declined participation, and 12 patients were excluded due to twin pregnancies (6 cases), hydramnios (2 cases), and hysterectomy (4 cases). The 4 cases of hysterectomy were excluded because of massive bleeding after delivery of baby (> 1,000 ml), 1 case from placenta accreta and 3 cases from uterine atony that unresponsive to medical treatment and uterine massage. All 4 cases could not record the amount of blood loss in the 4th stage of labor. Subsequently, 1,082 patients were enrolled in the study, and were split in to two groups, with 541 patients receiving conventional treatment for PPH prevention (control group) and 541 patients undergoing 20 minutes of LUSC in addition to other conventional PPH prevention measures (LUSC group) as shown in Figure 3.

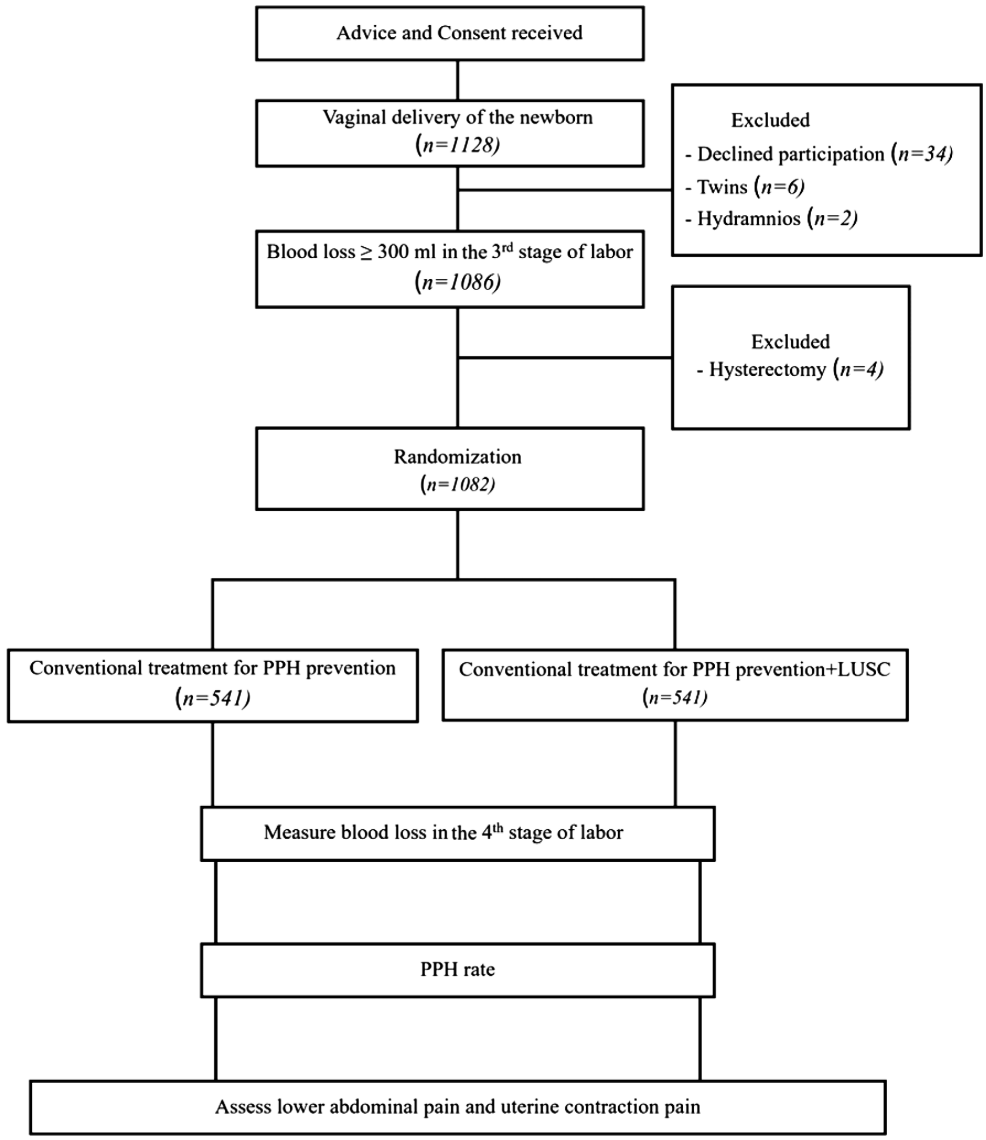

Figure 3 Consort flow diagram in this study

Table 1 presents the maternal demographic data for both the control group and the LUSC group. There were statistically significant differences in age and parity between the two groups. No significant differences were observed between the two groups in terms of gestational age, BMI, hematocrit level, platelet count, or history of PPH.

Table 2 presents data on the variable factors during the antepartum and intrapartum periods. No significant differences were observed in terms of the induction of labor, duration of oxytocin use, duration of the 1st stage of labor, neonatal birth weight, and episiotomy between the two groups. However, there were statistically significant differences in the duration of rupture of the membrane, duration of the 2nd and 3rd stages of labor, birth attendant, and the degree of perineal tear between the two groups.

Table 1 Maternal demographic data

Characteristics	Control group (n = 541)	LUSC group (n = 541)	P-value
Age (year); mean ± SD	28.70 ± 6.48	27.41 ± 6.22	0.001[t*]
Parity; n (%)			
0	255 (47.1)	314 (58.0)	0.006[c*]
1	198 (36.6)	166 (30.7)	
2	63 (11.6)	48 (8.9)	
3	22 (4.1)	9 (1.7)	
4	2 (0.4)	1 (0.2)	
5	1 (0.2)	2 (0.3)	
6	-	1 (0.2)	
Gestational age (week); mean ± SD	38.96 ± 1.34	38.89 ± 1.31	0.359[t]
Gestational age group; n (%)			
< 37 week	20 (3.7)	28 (5.2)	0.238[c]
≥ 37 week	521 (96.3)	513 (94.8)	
BMI (kg/m^2); mean ± SD	27.95 ± 4.59	27.70 ± 4.30	0.365[t]
BMI (kg/m^2); n(%)			
< 18.5	2 (0.4)	1 (0.2)	0.925[c]
18.5–22.9	69 (12.7)	66 (12.2)	
23–24.9	84 (15.5)	93 (17.2)	
25–29.9	233 (43.1)	229 (42.3)	
≥ 30	153 (28.3)	152 (28.1)	
Hematocrit; mean ± SD	36.21 ± 3.33	36.33 ± 3.13	0.539[t]
Platelet; mean ± SD	243,108.87 ± 78,469.80	241,213.49 ± 59,280.18	0.654[t]
Previous PPH; n(%)			
Yes	17 (3.1)	13 (2.4)	0.459[c]
No	524 (96.9)	528 (97.6)	

Abbreviations: BMI, body mass index; kg/m^2, kilogram per square meter; LUSC, lower uterine segment compression; n, number; PPH, postpartum hemorrhage; SD, standard deviation
Data are presented as number (%).
P-value corresponds to [t] Independent t-test, [c] Pearson chi-square
* Significant at p-value < 0.05

Table 2 Data on the variables in the antepartum and intrapartum periods

Characteristics	Control group (n = 541)	LUSC group (n = 541)	P-value	P-value Adjusted
Induction of labor; n (%)	389 (71.9)	385 (71.2)	0.788[c]	0.466
Duration membrane rupture (minute); mean ± SD	207.86 ± 205.39	257.15 ± 251.67	< 0.001[t*]	0.003*
Duration oxytocin use (minute); mean ± SD	168.18 ± 178.11	181.11 ± 195.05	0.255[t]	0.893
Duration the 1st stage of labor (minute); mean ± SD	477.92 ± 326.37	490.33 ± 343.85	0.543[t]	0.850
Duration the 2nd stage of labor (minute); mean ± SD	24.58 ± 23.47	28.17 ± 28.48	0.024[t*]	0.402
Duration the 3rd stage of labor (minute); mean ± SD	8.54 ± 10.72	7.07 ± 7.70	0.010 [t*]	0.041*
Birth attendant; n(%)				
Nurse	361 (66.7)	376 (69.5)	0.013[c*]	0.031*
Nurse student	47 (8.7)	55 (10.2)		
Medical student	43 (7.9)	30 (5.6)		
Resident	22 (4.1)	37 (6.8)		
Staff	68 (12.6)	43 (7.9)		

Table 2 Data on the variables in the antepartum and intrapartum periods (continued)

Characteristics	Control group (n = 541)	LUSC group (n = 541)	P-value	P-value Adjusted
Neonatal birth weight (g); mean ± SD	3,230.96 ± 402.67	3,209.75 ± 374.39	0.370[t]	0.497
Episiotomy[#]; n (%)				
No	53 (9.8)	42 (7.8)	0.287[c]	0.615
Median	76 (14.0)	66 (12.2)		
Mediolateral	414 (76.2)	432 (80.0)		
Degree of perineal tear[##]; n (%)				
No	452 (83.5)	431 (79.7)	0.014[c*]	0.011*
The 1st degree	23 (4.3)	17 (3.1)		
The 2nd degree	45 (8.3)	46 (8.5)		
The 3rd degree	18 (3.3)	34 (6.3)		
The 4th degree	3 (0.6)	13 (2.4)		
Mean volume of blood loss in the 3rd stage of labor; mean ± SD	469.74 ± 234.79	428.06 ± 180.25	0.001[t*]	0.002*

Abbreviations: g, gram; LUSC, lower uterine segment compression; n, number; SD, standard deviation
Data are presented as number (%).
P-value corresponds to [t] Independent t-test, [c] Pearson chi-square
* Significant at p-value < 0.05
[#] episiotomy = a surgical enlargement of the vaginal orifice by an incision to the perineum during the last part of the 2nd stage of labor to facilitate passage of the fetal head[21,22];
[##] perineal tear = damage of female genitalia during labor after spontaneous tear or episiotomy, classified as the 1st to the 4th degree depending on the severity of the tear[22,23].
P-value adjusted; P-value from adjusted by duration membrane rupture, duration the 2nd stage of labor, duration the 3rd stage of labor, birth attendant, degree of perineal tear and mean volume of blood loss in the 3rd stage of labor used multivariable logistic regression.

Table 3 presents the results related to bleeding after management in the 4th stage of labor was 90(50,150) ml in the control group and 50(40,70) ml in the LUSC group (p < 0.001). PPH occurred in 45.5% of cases in the control group, but only in 26.1% of cases in the LUSC group (p < 0.001). Lower abdominal pain and pain of uterine contraction of both groups were assessed by using the visual analogue score on a scale of 0-10, showed a significant difference between the groups (p = 0.006).

Table 3 Results after treatment

Variables	Control group (n = 541)	LUSC group (n = 541)	P-value
Mean volume of blood loss in the 4th stage of labor; median (Q1, Q3)	90 (50, 150)	50 (40, 70)	< 0.001[U*]
Mean volume of blood loss in the 3rd+4th stages of labor; mean ± SD	614.89 ± 341.34	482.54 ± 184.31	< 0.001[t*]
Postpartum hemorrhage; n (%)			
≥ 500	246 (45.5)	141 (26.1)	< 0.001[c*]
< 500	295 (54.5)	400 (73.9)	
Pain score; mean ± SD	3.83 ± 2.4	3.46 ± 1.96	0.006[t*]

Abbreviation: LUSC, lower uterine segment compression; n, number; SD, standard deviation
Data are presented as number (%).
P-value corresponds to [U] Mann–Whitney U test, [t] Independent t-test, [c] Pearson chi-square
* Significant at p-value < 0.05

DISCUSSION

The present study demonstrated that a 20-min application of LUSC could significantly reduce blood loss in the group experiencing post-delivery bleeding of more than 300 ml, which is at risk for PPH. In the non-LUSC group, the results indicated a blood loss in the 4th stage of labor more than blood loss in the LUSC group ($p < 0.001$). Furthermore, the rate of PPH in the LUSC group was significantly lower than in the non-LUSC group ($p < 0.001$).

All of variable in antepartum and intrapartum period that had statistically significant differences composed of the duration of rupture of the membrane, duration of the 2nd and 3rd stages of labor, birth attendant, and the degree of perineal tear between the two groups might be the confounding factors. When adjusted for confounding factors, the results were still the same. About the factor of birth attendant, in control group had more medical student than in LUSC group, it might be another reason for the higher blood loss due to lack of experience. The pain score of lower abdomen and uterine contraction in control group was higher than LUSC group, it shown that LUSC does not cause more pain than other conventional methods.

The comparison of all previous study was summarized in Table 4. In 2009, Chantrapitak et al. reported that in cases of PPH, a 10-minute application of LUSC could reduce blood loss by 105 ml compared to conventional treatment for PPH, representing a 47% reduction in blood loss[13]. Subsequently, in 2011, Chantrapitak et al. utilized a 10-minute LUSC intervention to prevent PPH. The blood loss in the LUSC group in their later study was 260.44 ml, whereas the non-LUSC group experienced a blood loss of 289.70 ml. Their findings demonstrated that LUSC reduced blood loss by 29.26 ml (10.1% reduction) and decreased the incidence of PPH from 6.8% to 2.9% in low-risk deliveries ($p = 0.02$)[14].

Consistent with these findings, Anansakunwat et al. reported in 2018 that a 20-minute application of LUSC could prevent PPH in low-risk deliveries, with a PPH rate of 2.0% in the LUSC group compared to 10.5% in the non-LUSC group ($p = 0.002$). Furthermore, the blood loss in the LUSC and non-LUSC groups was 263.2 ml and 304.3 ml, respectively, indicating a 13.5% reduction in blood loss in the LUSC group ($p = 0.046$)[15].

Table 4 Comparison of the results from the present study with those of previous studies

Source	Year	Treatment / Prevention	Number of patients (LUSC : non LUSC)	Results / Outcomes
Chantrapitak, et al.[13]	2009	Treatment by 10-minute LUSC	32 : 32	LUSC reduced blood loss by 47%
Chantrapitak, et al.[14]	2011	Prevention in low-risk delivery by 10-minute LUSC	339 : 338	LUSC reduced blood loss by 10% and PPH incidence from 6.8% to 2.9%
Anansakunwat, et al.[15]	2018	Prevention in low-risk delivery by 20- minute LUSC	153 : 152	LUSC reduced blood loss by 13.5% and PPH incidence from 10.5% to 2.0%
Chantrapitak, et al.[24]	2018	20 years retrospective		10 years earlier (1994–2003) PPH rate of LUSC doctor = 2.0% PPH rate of non-LUSC doctors = 3.9% PPH rate of non-LUSC nurses = 4.6% 10 years earlier (1994–2003) : 10 years later (2004–2013) PPH rate of non-LUSC nurses = 4.6% PPH rate of LUSC nurses = 2.2%
Present study		Prevention in high-risk delivery by 20- minute LUSC	541 : 541	LUSC reduced blood loss by 63.1% and PPH incidence from 45.5% to 26.1%

Abbreviations: LUSC, lower uterine segment compression; PPH, postpartum hemorrhage

In another study in 2018, Chantrapitak et al. reported on their 20 years of experience in this area. They compared the first 10 years' experience at their hospital, during which only one doctor used LUSC (42,450 deliveries) and the PPH rate was 2.03 ± 0.72%, and the rate with other doctors who did not use LUSC, with an average PPH rate of 3.90 ± 1.60% (p = 0.005). During that time, the PPH rate for cases delivered by nurses who did not use LUSC was 4.65 ± 0.60% (p < 0.001). Additionally, they compared the rates of PPH over two 10-year periods, from 1994 to 2003 and from 2004 to 2013. For the former period, the PPH rate for cases delivered by nurses who did not use LUSC was 4.65 ± 0.60%, whereas in the latter period, after the integration of LUSC into the delivery process, the PPH rate was reduced to 2.16 ± 0.74% (p < 0.001)[24].

In this study PPH rate was higher than PPH rate in general population because of this study selected the case of blood loss more than 300 ml in the 3rd stage of labor which was a group with the risk to turn to PPH (closer 500 ml than in the general population).

The strength of our study compose of LUSC do not need any special instrument, cost-effective and can be employed in any geographical area. This method can adapt to diverse healthcare settings and resource constraints. This multicenter study demonstrates that a variety of healthcare providers can performed this procedure. There was study limitation that this study was not control the use of uterotonic drugs that use in conventional treatment to prevent PPH, such as oxytocin, ergotamine, this may result in unequal amount of blood loss.

CONCLUSION

The findings of this study indicate that a 20-minute application of LUSC is effective for reducing blood loss and preventing PPH in high-risk patients who experience bleeding of more than 300 ml in the 3rd stage of labor. Notably, this method can be implemented in any delivery setting without incurring additional costs or requiring extra instruments. Given these advantages, LUSC has emerged as a viable and accessible option for preventing PPH in diverse healthcare settings. Its simplicity and efficacy make it a compelling choice for inclusion in PPH prevention strategies across various regions.

CONFLICT OF INTEREST

The authors confirm they have no conflicts of interest to declare.

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DATA AVAILABILITY STATEMENT

All data generated or analyzed during this study are included in this article. Further enquiries can be directed to the corresponding author.

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Original Article

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The Therapeutic Benefits of Reusi Dat Ton: Assessing Stress Reduction, Resilience, and Mobility Improvements Using a Stress Test, Cardiac Health Monitor, and Inertial Measurement Unit Technology

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ABSTRACT

OBJECTIVE: Reusi Dat Ton, also known as Thai Yoga, is a traditional therapeutic exercise recognized for its potential in managing health issues such as office syndrome and stress. This study aimed to evaluate the effects of Reusi Dat Ton on neck and shoulder range of motion (ROM) using inertial measurement unit (IMU) technology, and on stress levels assessed via heart rate variability and the Suanprung Stress Test-20 (SPST-20).

METHODS: Forty-five participants (21 males, 24 females) with a mean age of 35.73 years and a mean body mass index of 23.49 were evaluated pre and post intervention in a 20-minute five specific Reusi Dat Ton therapeutic exercises. Stress levels were assessed using the SPST-20 and a cardiac health monitor, while ROM was measured using the Ultium Motion system with IMU technology.

RESULTS: The Reusi Dat Ton intervention led to significant reductions in SPST-20 scores ($p < 0.001$) and heart rate ($p < 0.001$), along with significant improvements in stress resilience ($p < 0.01$) and right shoulder flexion ($p < 0.05$).

CONCLUSION: Reusi Dat Ton effectively reduced stress levels, enhanced stress resilience, and improved right shoulder mobility. These findings support its use as a therapeutic exercise for individuals with office syndrome and related conditions.

KEYWORDS: inertial measurement unit, range of motion, resilience, Reusi Dat Ton, stress

INTRODUCTION

Reusi Dat Ton, also known as Thai Yoga, is a traditional practice that incorporates breathing exercises, self-massage, dynamic movements, joint mobilization, postures, chanting, visualization, and meditation. The unique combination of elastic band resistance and diverse techniques offers substantial benefits for flexibility, strength, and overall fitness, contributing to physical and mental well-being[1,2].

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Numerous yoga techniques, particularly therapeutic exercises, have been widely studied to manage health conditions and improve well-being. Studies have shown that a combination of specific stabilization exercises with yoga training can minimize pain and improve lumbar stability and functional ability in chronic low back pain patients[3]. Yoga interventions have also been shown to decrease pain intensity, disability, and mood symptoms in adults with chronic nonspecific neck pain[4]. Regular yoga practice has been found to enhance muscular strength, body flexibility, respiratory and cardiovascular function, recovery from addiction, sleep patterns, overall well-being, and quality of life[5].

Yoga also demonstrated potential benefits in office syndrome and stress management, which are significant concerns in the workplace. Office syndrome, which arises from prolonged sitting and poor ergonomic postures, often leads to musculoskeletal issues in the neck and shoulders, resulting in pain and restricted range of motion (ROM)[6,7]. Moreover, chronic stress contributes to various health issues, including cardiovascular disease and depression[8]. Effective stress management is crucial in modern healthcare. It is often evaluated through heart-rate variability (HRV), which is a crucial indicator of autonomic nervous system (ANS) function that reflects the balance between sympathetic and parasympathetic activity[9-11]. HRV is not only a valuable tool for assessing cardiovascular health and autonomic regulation but is also recognized as an independent predictor of cardiovascular mortality. It has been linked to mental health conditions such as depression and anxiety. Recent advancements have enabled non-invasive HRV assessment through technologies like photoplethysmography, which emphasizes the importance of signal quality and processing methods for improved accuracy[12,13].

Previous studies have explored the effects of yoga on physical fitness. The results showed that Thai yoga training significantly improved body flexibility[14]. Additionally, yoga practices have been recognized for their comprehensive benefits in managing stress and improving physical, emotional, and mental well-being across diverse demographic groups, including college students, professionals in high-stress work environments, winter expedition participants, and athletes. In a study of college students, a classical yoga intervention significantly improved resilience in both males and females[15]. Stretch-based programs have also been shown to increase ROM, particularly among office workers with limited flexibility[16]. Furthermore, the integration of inertial measurement unit (IMU) technology—a system comprising accelerometers, gyroscopes, and magnetometers—offers a promising, cost-effective, and user-friendly approach to evaluating spinal motion and cervical ROM in both clinical and non-clinical settings[17-19].

Although various relaxation and stretching techniques are known to reduce stress and enhance flexibility, Reusi Dat Ton therapeutic exercises may offer a convenient, efficient, and holistic approach to addressing both issues simultaneously. While many studies have examined the effects of general yoga practices on flexibility and stress, limited research has specifically focused on Reusi Dat Ton, particularly in combination with modern assessment tools using IMU and HRV monitoring. There is a lack of empirical evidence on the use of Reusi Dat Ton as a targeted intervention for stress reduction and cervical/shoulder ROM improvement in populations affected by office syndrome or chronic stress. Therefore, this study aimed to evaluate the effects of Reusi Dat Ton therapeutic exercises on neck and shoulder ROM, using IMU technology, and stress levels, assessed via HRV and the Suanprung Stress Test-20 (SPST-20)—a validated psychological assessment developed by the Department of Mental Health, Thailand. This study aims to bridge the gap between traditional practices and modern health monitoring methods.

METHODS

Participants were recruited based on the prescribed inclusion criteria of age 25-45 years, full-time permanent employment for more than one year, and good overall health. The exclusion criteria included a history of musculoskeletal injuries or office-related syndromes, as indicated by a neck disability score over 24. This was assessed using the Thai version of the Neck Disability Index, a specific questionnaire used to evaluate disability due to neck pain. Neck disability scores are categorized as follows: 0–4 = no disability, 5–14 = mild disability, 15–24 = moderate disability, 25–34 = severe disability, and 35–50 = complete disability[20]. Additionally, individuals with cardiovascular ailments, cerebrovascular disorders, cognitive dysfunction, or Parkinson's disease were excluded. The final cohort consisted of 45 participants, comprising 21 males and 24 females, with an average (Avg.) age of 35.73 years (standard deviations (S.D.) = 5.52), an Avg. body mass index of 23.49 (S.D. = 3.49), and an Avg. neck score of 7.47 (S.D. = 5.13). Before commencement of the study, all individuals provided written informed consent. The study was conducted in accordance with the Declaration of Helsinki, and approved by the Medical Ethical Committee of Mahidol University under certificate of approval number MU-CIRB 2023/057.1004 on April 10, 2023.

The procedure of this study aimed to evaluate the effects of Reusi Dat Ton therapeutic exercises on neck and shoulder ROM and stress levels. ROM was measured using IMU technology with the Ultium Motion system (Noraxon, USA), while stress was assessed using the SPST-20 and heart rate variability (HRV), measured with a cardiac health monitor (Medicore Co., LTD, South Korea), pre- and post-intervention, as shown in Figure 1.

The exercise regimen consisted of five specific Reusi Dat Ton therapeutic exercises: (1) relief of migraine, (2) relief of nausea and vertigo, (3) relief of bodily discomfort (generalized weakness), (4) anti-dizziness, and (5) relief of giddiness, as shown in Figure 2. Each exercise was performed three times with 1-minute rest intervals between sets. The total duration for the five Reusi Dat Ton therapeutic exercises was approximately 20 minutes.

The SPST-20, developed by the Department of Psychiatric Health under the Ministry of Public Health, Thailand, is a questionnaire-based assessment tool used to evaluate stress levels. By comprising 20 items rated on a scale of 1 to 5, the SPST-20 classifies stress into four categories: low stress (0-24), moderate stress (25-42), high stress (43-62), and extreme stress (63-100)[21].

The Smart Pulse (Medicore Co., LTD, South Korea), used as a cardiac health monitor, functions as a robust cardiovascular screening tool by utilizing HRV and pulse wave measurements to evaluate both cardiovascular health and ANS function. In stress research, the HRV parameters had significant positive correlations with reactivity and recovery from mental and physical stress. Moreover, these HRV parameters can be used as a measure of stress resilience quantitatively[9,22]. This device provides comprehensive insights into stress levels, encompassing physical stress (rated on a scale of 1-100), mental stress (rated on a scale of 1-100), and stress resilience (rated on a scale of 1-100).

SPST-20 (5 minutes)	Cardiac health monitor (3 minutes)	IMU (5 minutes)	Reusi Dat Ton (20 minutes)	IMU (5 minute)	Cardiac health monitor (3 minutes)	SPST-20 (5 minutes)

Figure 1 The study consisted of pre- and post-intervention measurements, including Suanprung Stress Test-20 (SPST-20), cardiac health monitoring, and inertial measurement unit (IMU) recordings. The total duration of the procedure was approximately 46 minutes.

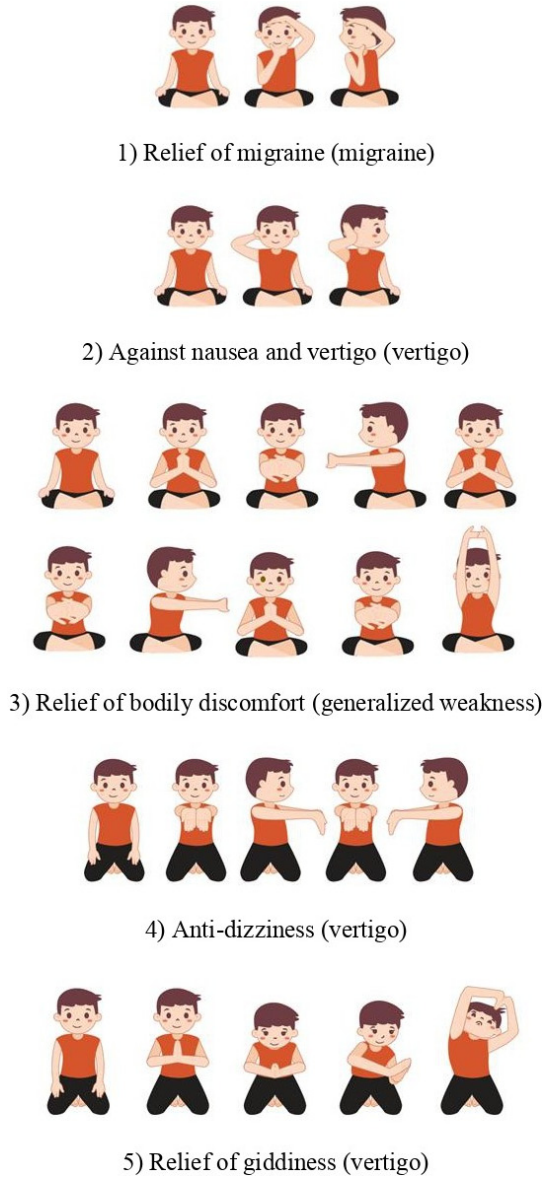

Figure 2 Five specific Reusi Dat Ton therapeutic exercises

Neck and shoulder movements were assessed using IMU. The IMU was a wireless communication, employing a sampling rate of 200 Hz and ± 3.0 degrees accuracy. Seven motion sensors were placed at the head, right upper arm, left upper arm, right forearm, left forearm, upper thoracic (T1), and lower thoracic (MyoMotion ISB-compliant modeling), as shown in Figure 3. MyoMotion ISB-compliant modeling is a motion capture system developed by Noraxon that utilizes IMUs to accurately record and analyze human movement. It follows the International Society of Biomechanics standards, which ensure consistent and reliable biomechanical data collection for human motion analysis in biomechanics and clinical research[23]. The Myo-Motion software module features a skeletal avatar and streaming of anatomical joint angles, orientation angles, and acceleration data. It was used for ROM measurements in neck flexion and extension, left and right neck lateral flexion, left and right neck rotation, left and right shoulder flexion, left and right shoulder extension, and left and right shoulder external rotation.

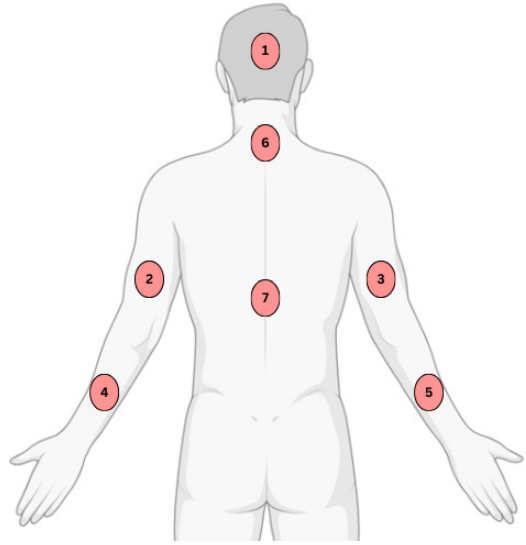

Figure 3 The locations of IMU are 1) head, 2) left upper arm, 3) right upper arm, 4) left forearm, 5) right forearm, 6) upper thoracic (T1), and 7) lower thoracic (T12).

Data analyses were conducted using IBM SPSS Statistics for Windows, Version 29.0.2.0 (IBM Corporation, Armonk, New York, USA). The normality of the datasets was evaluated using the Shapiro-Wilk test. Mean values and S.D. were calculated for pre-and post-Reusi Dat Ton therapeutic exercise. The effectiveness of the intervention was assessed using paired-sample t-tests, comparing mean outcomes pre- and post-intervention, with a confidence level set at 95.0%.

RESULTS

Paired samples t-tests were conducted to evaluate potential disparities in stress management among individuals using the SPST-20, and the cardiac health monitor between pre- and post-Reusi Dat Ton therapeutic exercises (Table 1). The results revealed significant changes in various parameters. The results of the SPST-20 showed a significant decrease in the SPST-20 score (Avg. = 34.60, S.D. = 10.80) compared to the pre-Reusi Dat Ton (Avg. = 43.73, S.D. = 13.05, t(44) = 6.69, p-value < 0.001). The results of the cardiac health monitor showed significant decreases in heart rate (Avg. = 72.73, S.D. = 9.86) compared to the pre-Reusi Dat Ton (Avg. = 84.27, S.D. = 10.56, t(44) = 10.93, p-value < 0.001). Furthermore, significant increases were observed in physical stress (Avg. = 66.44, S.D. = 22.54) compared to pre-Reusi Dat Ton (Avg. = 54.71, S.D. = 24.98, t(44) = -3.76, p-value < 0.001), mental stress (Avg. = 58.27, S.D. = 15.87) compared to pre-Reusi Dat Ton (Avg. = 44.82, S.D. = 18.59, t(44) = -3.79, p-value < 0.001), and stress resilience (Avg. = 72.09, S.D. = 24.65) compared to pre-Reusi Dat Ton (Avg. = 61.42, S.D. = 23.94, t(44) = -3.10, p-value < 0.01).

Table 1 Results of SPST-20, heart rate, physical stress, mental stress, and stress resilience pre-and post-Reusi Dat Ton therapeutic exercise

Parameter	Pre-Reusi Dat Ton	Post-Reusi Dat Ton	P-value
SPST-20	43.73 ± 13.05	34.60 ± 10.80	< 0.001***
Heart rate (bpm)	84.27 ± 10.56	72.73 ± 9.86	< 0.001***
Physical stress	54.71 ± 24.98	66.44 ± 22.54	< 0.001***
Mental stress	44.82 ± 18.59	58.27 ± 15.87	< 0.001***
Stress resilience	61.42 ± 23.94	72.09 ± 24.65	< 0.01**

Abbreviations: bpm, beats per minute; SPST-20, Suanprung stress test-20
Average ± Standard deviation, ** = p-value ≤ 0.01, *** = p-value ≤ 0.001

Paired sample t-tests were conducted to evaluate potential differences in the ROM using IMU technology between pre- and post-Reusi Dat Ton therapeutic exercises (Table 2). The ROM results showed an overall increase in various movements. For neck movements, the results for ROM showed increases in neck flexion (post-Reusi Dat Ton (Avg. = 43.10, S.D. = 6.60), pre-Reusi Dat Ton (Avg. = 43.12, S.D. = 7.48), t(44) = 0.03, p-value = 0.49), neck extension (post-Reusi Dat Ton (Avg. = 46.00, S.D. = 12.47), pre-Reusi Dat Ton (Avg. = 44.10, S.D. = 11.27), t(44) = -1.59, p-value = 0.06), left neck lateral flexion (post-Reusi Dat Ton (Avg. = 35.89, S.D. = 6.69), pre-Reusi Dat Ton (Avg. = 35.41, S.D. = 5.26), t(44) = -0.69, p-value = 0.25), right neck lateral flexion (post-Reusi Dat Ton (Avg. = 34.36, S.D. = 8.46), pre-Reusi Dat Ton (Avg. = 33.69, S.D. = 7.63), t(44) = 0.66, p-value = 0.26), left neck rotation (post-Reusi Dat Ton (Avg. = 61.27, S.D. = 14.44), pre-Reusi Dat Ton (Avg. = 58.99, S.D. = 10.44), t(44) = -1.46, p-value = 0.08), and right neck rotation (post-Reusi Dat Ton (Avg. = 64.84, S.D. = 13.92), pre-Reusi Dat Ton (Avg. = 64.45, S.D. = 11.15), t(44) = -0.30, p-value = 0.38.

The results of ROM of the shoulder flexion, extension, and rotation in Reusi Dat Ton therapeutic exercises (Table 3). For shoulder movements, ROM showed in-creases in left shoulder flexion (post-Reusi Dat Ton (Avg.M = 146.34, S.D. = 11.38), pre-Reusi Dat Ton (Avg. = 144.89, S.D. = 12.49), t(44) = -1.24, p-value = 0.22), left shoulder extension (post-Reusi Dat Ton (M = 41.48, S.D. = 8.42), pre-Reusi Dat Ton (Avg. = 42.29, S.D. = 10.45), t(44) = 0.60, p-value = 0.55), right shoulder extension (post-Reusi Dat Ton (Avg. = 41.13, S.D. = 9.45), pre-Reusi Dat Ton (Avg. = 41.39, S.D. = 10.43), t(44) = 0.22, p-value = 0.82), left shoulder external rotation: post-Reusi Dat Ton (Avg. = 69.29, S.D. = 15.13), pre-Reusi Dat Ton (Avg. = 66.65, S.D. = 13.16), t(44) = -1.60, p-value = 0.12), and right shoulder external rotation: post-Reusi Dat Ton (Avg. = 66.80, S.D. = 17.76), pre-Reusi Dat Ton (Avg. = 65.48, S.D. = 16.32), t(44) = -0.81, p-value = 0.42). Additionally, significant increases were observed in shoulder flexion (post-Reusi Dat Ton (Avg. = 145.37, S.D. = 10.92) and pre-Reusi Dat Ton (Avg. = 142.88, S.D. = 11.83), t(44) = -2.18, p-value < 0.05).

Table 2 Results of range of motion of the neck flexion, extension, and rotation pre-and post-Reusi Dat Ton therapeutic exercise

Parameter	Pre-Reusi Dat Ton	Post-Reusi Dat Ton	P-value
Neck flexion	43.12 ± 7.48	43.10 ± 6.60	0.978
Neck extension	44.10 ± 11.27	46.00 ± 12.47	0.120
Left neck lateral flexion	35.41 ± 5.26	35.89 ± 6.70	0.493
Right neck lateral flexion	33.69 ± 7.63	34.36 ± 8.46	0.511
Left neck rotation	58.99 ± 10.44	61. 27 ± 14.44	0.151
Right neck rotation	64.45 ± 11.45	64. 84 ± 13.92	0.763

Average ± Standard deviation

Table 3 Results of range of motion of the shoulder flexion, extension, and rotation pre-and post-Reusi Dat Ton therapeutic exercise

Parameter	Pre-Reusi Dat Ton	Post-Reusi Dat Ton	P-value
Left shoulder flexion	144.89 ± 12.49	146.34 ± 11.38	0.223
Right shoulder flexion	142.88 ± 11. 83	145.37 ± 10.92	< 0.05*
Left shoulder extension	42.29 ± 10.44	41.48 ± 8.42	0.549
Right shoulder extension	41.39 ± 10.43	41.13 ± 8.42	0.826
Left shoulder external rotation	66.65 ± 13.16	69.29 ± 15.13	0.117
Right shoulder external rotation	65.48 ± 16.32	66.80 ± 17.76	0.422

Average ± Standard deviation, * = p-value ≤ 0.05

DISCUSSION

This study aimed to evaluate the effects of Reusi Dat Ton therapeutic exercises in office workers. Our main findings are as follows: (1) significant reductions in the stress level of SPST-20 and heart rate (2) a significant increase in stress resilience in both physical and mental stress, and (3) a significant increase in shoulder flexion ROM. These findings may have implications for office workers or people with office syndrome symptoms to relieve stress and increase the shoulder flexion ROM.

The study findings indicated a significant impact on stress management, as evidenced by a reduction in heart rate and the SPST-20 after Reusi Dat Ton therapeutic exercises. Concurrently, an investigation into the effects of yoga practice revealed a decrease in the heart rate during sessions[24]. Moreover, a research involving para-yoga athletes highlighted a significant decrease in heart rate after two weeks of Nada yoga meditation[25]. Similarly, a study involving pre-diabetic individuals reported a substantial decrease in heart rate and an increase in parasympathetic dominance after adopting a six-month integrated yoga therapy approach[26]. Additionally, a comparative analysis between Hatha yoga practitioners and healthy controls emphasized that the yoga group exhibited a significantly lower HRV ratio, indicative of parasympathetic predominance[24].

This study found that Reusi Dat Ton significantly reduced stress levels and increased stress resilience. Yoga has been shown to effectively reduce heart rate through physiological mechanisms that enhance vagal tone and reduce sympathetic activity, leading to improved HRV and a more balanced ANS[27]. Additionally, yoga practices—particularly relaxation techniques and pranayama—help lower stress levels, a known contributor to elevated heart rates. Yoga has also demonstrated efficacy in stress management and in enhancing resilience in both male and female participants[15]. For example, yoga interventions have been shown to improve stress resilience among individuals working in isolated environments such as Antarctica[28]. However, in this study, both physical and mental stress initially increased as a result of Reusi Dat Ton exercises. These responses were evaluated using HRV and pulse wave measurements.

According to literature, office syndrome can affect several muscle inflammations, including the neck muscles, upper back and shoulder muscles, lower back muscles, forearm and wrist muscles, and hip flexors[6,29]. This could lead to a limited ROM and joint stiffness. Neck and shoulder movements are associated with symptoms of office syndrome such as limited ROM of neck rotation. Interestingly, the movements and positions in the Reusi Dat Ton therapeutic exercise, which this study selected, focused on the neck and shoulder joints. Relevant results from our study indicate that Reusi Dat Ton can improve shoulder flexion. Reusi Dat Ton promotes flexibility, muscle strength, and joint mobility through dynamic stretching and controlled movements, which can lead to increased shoulder ROM. Similarly, a study examining the effects of Reusi Dat Ton on vital capacity, flexibility, and ROM in healthy elderly individuals revealed significant improvements in shoulder flexion, hip extension, shoulder extension, and hip flexion after 12 weeks[30]. Furthermore, office workers experienced increased shoulder flexion after four days of Reusi Dat Ton practice[31,32]. Comparative analyses between Reusi Dat Ton and yoga regarding the enhancement of ROM in shoulder flexion, abduction, flexion, and extension have been conducted[33-35]. Additionally, Reusi Dat Ton demonstrated a decrease in pain, improved pain tolerance, and increased flexibility of the neck muscles[36,37]. These findings suggest that Reusi Dat Ton can effectively enhance the ROM of shoulder movements.

This study demonstrated methodological strength by integrating both subjective (SPST-20) and objective (HRV and IMU) assessments to evaluate stress and mobility outcomes. The use of

advanced technologies, such as the Smart Pulse HRV monitor and the Ultium Motion system, enhanced the precision and reliability of data collection. Notably, the study featured an innovative integration of Reusi Dat Ton with modern biomedical evaluation methods. However, the study is limited by a relatively small sample size, a short single-session intervention, and a homogeneous participant group, which may restrict the generalizability of the findings and limit conclusions regarding the long-term efficacy of the intervention.

Future research should include larger sample sizes, longer intervention periods, and the integration of real-time electromyography to capture detailed muscle activity, further validating the therapeutic potential of Reusi Dat Ton.

CONCLUSION

This study highlights the potential of Reusi Dat Ton therapeutic exercises to improve ROM in right shoulder flexion and reduce stress in individuals affected by office syndrome or chronic stress. The findings demonstrated a significant reduction in both heart rate and perceived stress levels, suggesting that Reusi Dat Ton therapeutic exercises may help enhance stress resilience. These exercises could be particularly valuable in addressing both the physical and psychological dimensions of stress-related conditions, ultimately supporting overall well-being.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest related to this research.

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DATA AVAILABILITY STATEMENT

Please contact the corresponding author for data availability.

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Original Article

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Predictive Factors for Failure of At-scene Cardiopulmonary Resuscitation in Adults with Non-Traumatic Out-of-Hospital Cardiac Arrest

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ABSTRACT

OBJECTIVE: To identify the predictive factors of at-scene cardiopulmonary resuscitation (CPR) failure in out-of-hospital cardiac arrest (OHCA) patients.

METHODS: A retrospective single centre, cross-sectional study methodology was employed, which collected from emergency medical services patient care reports of non-traumatic OHCA patients over 18 years old who underwent CPR for at least 20 minutes from 1 January 2017 to 31 December 2024. Univariate and multivariate analyses were employed, along with multiple logistic regression analysis to identify the predictive factors of at-scene CPR failure. Also the odds ratio (OR) and 95% confidence interval were reported.

RESULTS: During the study period, 455 OHCA patients met the inclusion criteria. Statistically significant predictive factors for CPR failure (after at least 20 minutes of CPR conducted at-scene) included: ACLS in OHCA patients (p-value < 0.05); asystole as initial arrest rhythms (adjusted OR = 4.68, 95%CI: 2.48-8.86, p-value < 0.001); unwitnessed arrest (adjusted OR = 3.51, 95%CI: 2.14-5.76, p-value < 0.001); unresponsive pupils (adjusted OR = 4.22, 95%CI: 1.95-9.10, p-value < 0.001); no prehospital advanced airway management (adjusted OR = 7.34, 95%CI: 2.47-21.82, p-value < 0.001); and no prehospital drug administration during CPR – including no amiodarone (adjusted OR = 2.41, 95%CI: 1.15-5.04, p-value = 0.020), and no atropine (adjusted OR = 9.22, 95%CI: 2.22-38.25, p-value = 0.002).

CONCLUSION: The study found 6 predictive factors for identifying failure after CPR for at least 20 minutes at the scene: asystole as the initial arrest rhythm, unwitnessed arrest, unresponsive pupils, no prehospital advanced airway management, and no prehospital administration of amiodarone and atropine during CPR. CPR team leaders may incorporate these factors when deciding when to terminate resuscitation at the scene.

KEYWORDS: emergency medical service, out of hospital heart arrest, out-of-hospital cardiac arrest, prehospital emergency care, return of spontaneous circulation

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INTRODUCTION

Out-of-hospital cardiac arrest (OHCA) is a critical challenge for first-responders and a cause of mortality[1]. It also impacts national public health and the economy. The worldwide average annual incidence in adults is 55 per 100,000 people[2], affecting developed and developing countries alike. For example, the United States of America experiences more than 350,000 cardiac arrest cases per year, with mortality rate of about 90%. Most cases occur in males and in the elderly who have comorbidities[3]. Among these, just 10% survived and were discharged and only 9% had favorable neurological outcomes[2]. In Asia, the annual OHCA incidence rate is 20-21 cases per 100,000 people. However, the mean rate of survival to discharge in Asia is just 8.8% and lower than that of Western countries[4]. The survival rate of OHCA patients in Asia averaged 3%, significantly less than in Australia, Europe, and North America which were 13%, 9%, and 6%, respectively[5]. The standard database of the Pan Asian Resuscitation Outcomes Study (PAROS) reported the rate of survival to discharge of OHCA patients resuscitated by emergency medical services (EMS) in PAROS member countries, as 6% in Thailand, 5.5% in Japan, 3.2% in Singapore, 10.7% in South Korea, 2.5% in Malaysia, and 7.3% in Taiwan[6]. These numbers indicate outcomes differ substantially across various EMS, medical, and public health systems, including hospital management, in each PAROS member nation[7]. Even though currently there has been much progress in EMS and cardiopulmonary resuscitation (CPR) technology, the survival rate at the scene remains low, averaging just 10–12%[8]. It should be noted however that in the studied area which was the Vajra Emergency Medical Services of Navamindradhiraj University in Bangkok, Thailand, the return of spontaneous circulation (ROSC) rate was high at 25.6%[9]. Previous systematic reviews and meta-analyses have reported on the predictive factors of ROSC in OHCA patients – such as witnessed arrest, a shockable rhythm as the initial cardiac rhythm[10] (especially ventricular fibrillation (VF)[9-10]) early epinephrine administration during CPR, and an EMS response time of less than 8 minutes[9]. The predictive factors of favorable neurological outcome included being young and male, initial cardiac rhythm being a shockable rhythm, witnessed arrest, bystander CPR, and shorter time to cannulation[11]. In contrast, patients with comorbidities like old age, initial cardiac rhythm being a non-shockable rhythm, particularly asystole, sepsis or septic shock and acidosis were the factors determining mortality and in-hospital CPR failure [12]. One of the essential factors affecting the outcomes of OHCA patients was the efficiency and outcome of CPR at the scene. EMS teams will perform intense CPR in accordance with the American Heart Association (AHA) global standard guidelines for resuscitation. However, if during CPR, patients remain unresponsive and do not develop ROSC, the AHA advanced life support (ALS) framework recommends CPR termination without hospital delivery if 4 conditions are met: (1) unwitnessed arrest, (2) no bystander CPR, (3) no ROSC after full ALS care in the field, and (4) no automatic external defibrillator (AED) shocks were delivered[13]. Previous meta-analysis found that when the 4 components of ALS were completed, the specificity was 96% for 30-day survival for predicting death[14]. Further, the positive predictive value was 99-100%, with an error of only 1%[15]. The ALS framework cannot provide complete information for the decision in the context of EMS adequately because of incomplete crucial data like, the consideration of patient demographic data, the data of EMS team treatment after fulfilled assistance for OHCA patients. The recommendations of the National Association of EMS Physicians suggest that CPR can be terminated in cardiac arrest patients receiving CPR, in accordance with AHA standard guidelines, after at least 20 minutes of CPR. In addition, EMS can terminate CPR if a patient does not experience ROSC and declare death[16]. Presently, there is a limited and insufficient number of

studies regarding the predictive factors of at-scene CPR failure to help support the additional decisions of prehospital emergency medical personnel, especially in the context of developing countries, such as Thailand. The EMS system in Thailand varies significantly across different regions, depending on the local context—such as urban versus rural areas. However, the on-scene management of OHCA patients follows the same principle nationwide, known as the "stay and play" approach. Where the staff at the scene who must make these critical decisions and the CPR commander are not physicians, but paramedics or emergency nurse practitioners (ENP). Thus, if these personnel can identify the predictive factors of at-scene CPR failure, after 20 minutes of CPR, it will benefit ethical clinical decision-making regarding whether to choose the continuation or termination of resuscitation (TOR). Although the current AHA guidelines provide internationally accepted standards for the consideration of TOR in patients with OHCA, these guidelines remain applicable in clinical practice today. However, we argue that there is still a significant knowledge gap regarding the predictive factors associated with unsuccessful CPR, particularly in OHCA patients who have undergone prolonged resuscitation efforts (i.e., after 20 minutes of CPR) without ROSC. This area represents an extension beyond what is currently addressed in the standard AHA guidelines.

The present study aims to identify the predictive factors of at-scene CPR failure, after 20 minutes of CPR, in non-traumatic adult OHCA patients.

METHODS

The retrospective cross-sectional study was conducted within the Vajira Emergency Medical Service (V-EMS) of the Vajira Hospital Faculty of Medicine at Navamindradhiraj University in Bangkok, Thailand. V-EMS is a responsible for EMS zone 1 (of 11 EMS zones in Bangkok) and dispatched from Erawan Center in Bangkok. V-EMS networks with 6 public and private hospitals within EMS zone 1, which covers 50 square kilometers, and serves 500,000 people[1].

For OHCA patients, V-EMS teams are dispatched to each case and include at least 3 members – generally a paramedic or an ENP as team leader, and emergency medical technicians. Paramedic or ENP team leaders would operate under off-line and on-line medical protocols, under emergency physicians' orders. For cardiac arrest cases in our area, the AHA guidelines (2020)[13] were applied by paramedics or ENPs with all V-EMS staff having earned AHA advanced cardiovascular life support (ACLS) provider certification. The prehospital management of non-traumatic OHCA patients employ the stay and play method for comprehensive life support, while for cases of traumatic OHCA, V-EMS will use scoop and run, which is the standard method for V-EMS operation.

This study was approved by the Institutional Review Board of the Vajira Hospital Faculty of Medicine at Navamindradhiraj University (COA 036/2568) and the Human Research Ethics Committee of the Thammasat University Faculty of Medicine (COA 054/2568). The informed consent requirement was waived because of the retrospective nature of the study and the fact all patient data were anonymized.

Adult OHCA patient data was collected from EMS patient care reports, which were coded with Thailand's emergency medical triage protocol and criteria based dispatch symptom group 6 (cardiac arrest) that were managed by the V-EMS unit of the Vajira Hospital Faculty of Medicine at Navamindradhiraj University in Bangkok, Thailand from 1 January 2017 to 31 December 2024. Eligibility criteria: Non-traumatic adult OHCA patients (e.g., over 18 years old) who received at least 20 minutes of ACLS in accordance with AHA ACLS guidelines[13], and were assisted by V-EMS. Exclusion Criteria: Adult OHCA patients who acheived ROSC within 20 minutes, and OHCA patients evaluated as dead by a team leader such that no resuscitation should be done; such as livor mortis or rigor mortis,

patients having do not attempt resuscitation orders, with cardiac arrest outside the scene, with unknown CPR duration by EMS team or bystander, with re-arrest, with CPR during transfer, and with incomplete data recorded or missing resuscitation data.

OHCA patient data was collected from EMS patient care reports, which contain the record of advanced EMS treatment administered by EMS dispatched by Erawan Center and is the standard form used by Bangkok advanced EMS. This form recorded of data of all EMS patients and all treatments administered by EMS teams, which were recorded by dispatchers, paramedics, or ENPs operating at the scene. The data was a part of remuneration for EMS units. All data were recorded in Microsoft Excel by the principal investigator. The data comprised gender, age, comorbidity, location type, the cause of arrest, the first arrest rhythm, witnessed arrest, pupillary response, bystander CPR, bystander AED use, response time, prehospital defibrillation, prehospital advanced airway management, prehospital drug administration during CPR, and CPR failure. At-scene CPR failure means that patients had no ROSC at the scene or died after CPR (according to AHA ACLS guidelines) 20 minutes from first medical contact.

A descriptive analysis was performed to examine the variable distribution. Continuous variables are presented as mean ± standard deviation or median and interquartile range, and categorical variables are presented as frequencies and proportions. When comparing the two groups, differences were evaluated using independent t-test or Mann–Whitney U test for numeric variables and Chi-square test or Fisher's exact test for categorical variables. We performed for the possible factors predicting at-scene CPR failure for OHCA patients. Univariable and multivariable analyses with multiple logistic regression analysis, odds ratios (ORs), and 95% confidence intervals (CIs), and p-value through backward elimination. The relevant factors identified in univariable analysis as statistically significant ($p < 0.2$) were used in the multivariable analysis.

All statistical tests were considered statistically significant at p-values ≤ 0.05. Stata version 17.0 (StataCorp College Station, TX, USA) was used for all analyses.

RESULTS

During the study period, 455 patients matched the eligibility criteria. Figure 1 shows the flowchart of OHCA patient inclusion. For the analysis of factors associated with at-scene CPR failure using crude analysis, differences between OHCA patients with and without CPR failure were compared and classified by the factors and patient characteristics. EMS time, and EMS treatment were statistically significantly different between OHCA patients with and without at-scene CPR failure (p-value < 0.05), including age, respiratory disease, the cause of arrest, the first arrest rhythm, witnessed arrest, pupillary response, bystander CPR, bystander AED application, response time, prehospital defibrillation, prehospital advanced airway management, and prehospital drugs administered during CPR (adrenaline, amiodarone, and atropine). The mean age of OHCA patients with and without at-scene CPR failure was 65.19 ± 18.41 and 60.90 ± 20.64 4 years, respectively (p-value = 0.027). Those at least 65 years of age represented 56.2% of patients with at-scene CPR failure and 43% of patients without (p-value = 0.009). Respiratory disease was found in 5.4% and 0.7% (p-value = 0.017). The cause of arrest was respiratory in 58.8% and 46.5% (p-value = 0.04). The first arrest rhythm was asystole in 79.9% and 42.3% (p-value < 0.001). Witnessed arrest was 28.4% and 68.3% (p-value < 0.001). Pupillary response was detected in 4.8% and 26.8% (p-value < 0.001). Bystander CPR was done in 40.6% and 61.3% (p-value < 0.001). Bystander AED application was performed in 6.1% and 16.9% (p-value < 0.001). Average response time was 13.21 ± 6.85 and 11.52 ± 5.69 minutes (p-value = 0.006). Prehospital defibrillation was done in

12.1% and 35.2% (p-value < 0.001). Prehospital advanced airway management via endotracheal intubation (ETI) was done in 80.5% and 95.8% (p-value < 0.001). Prehospital drug administration during CPR, including adrenaline (86.3% versus 97.2%, p-value < 0.001), amiodarone (6.7% versus 24.7%, p-value < 0.001), and atropine (1% versus 7.8%, p-value < 0.001) (Table 1).

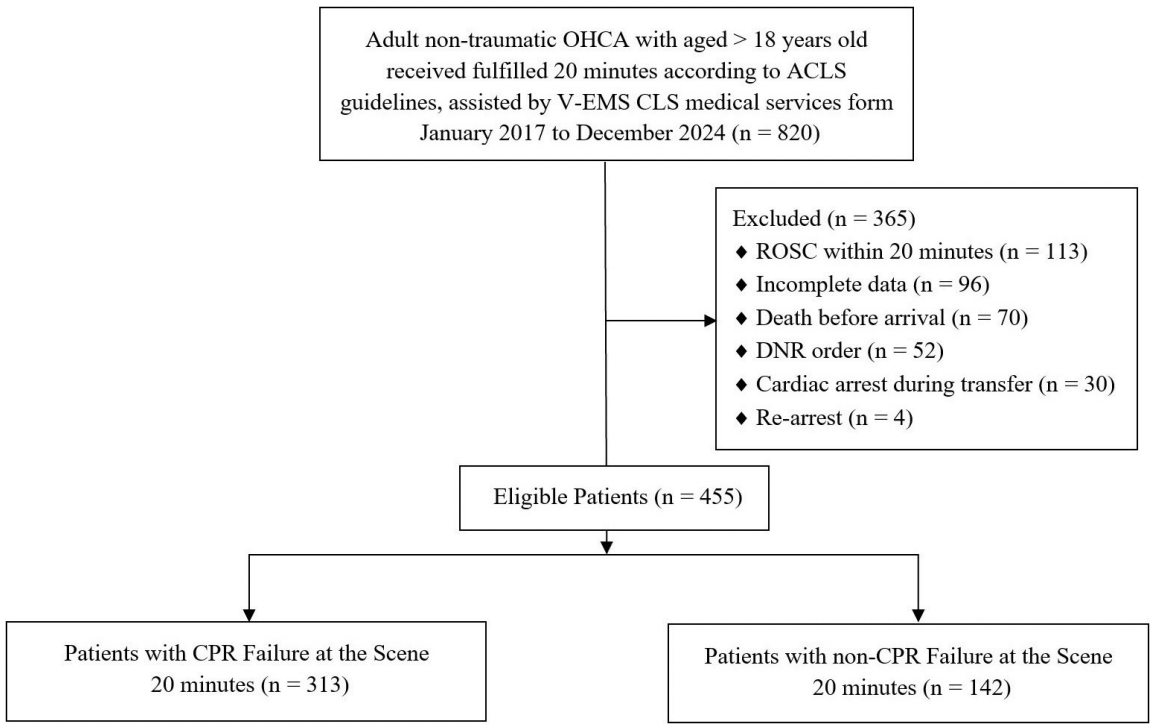

Figure 1 Study flowchart

Table 1 Factors associated with CPR failure at the scene 20 minutes after fulfilled ACLS (n = 455)

Factors	CPR Failure at the Scene 20 minutes		P-value
	Yes (n = 313)	No (n = 142)	
Gender			
Male	199 (63.6)	97 (68.3)	0.327[δ]
Female	114 (36.4)	45 (31.7)	
Age (years)	65.19 ± 18.41	60.90 ± 20.64	0.027[†]
< 65	137 (43.8)	81 (57.0)	0.009[δ]
≥ 65	176 (56.2)	61 (43.0)	
Co-morbidity	170 (54.3)	89 (62.7)	0.095[δ]
Hypertension	108 (34.5)	57 (40.1)	0.247[δ]
Diabetes mellitus	102 (32.6)	44 (31.0)	0.734[δ]
Coronary heart disease	45 (14.4)	25 (17.6)	0.376[δ]
Dyslipidemia	24 (7.7)	18 (12.7)	0.087[δ]
Renal diseases	22 (7.0)	12 (8.5)	0.593[δ]
Cancer	22 (7.0)	7 (4.9)	0.396[δ]
Respiratory disease	17 (5.4)	1 (0.7)	0.017[δ]
Stroke	4 (1.3)	1 (0.7)	1.000[§]
Other	26 (8.3)	19 (13.4)	0.093[δ]

Table 1 Factors associated with CPR failure at the scene 20 minutes after fulfilled ACLS (n = 455) (continued)

Factors	CPR Failure at the Scene 20 minutes		P-value
	Yes (n = 313)	No (n = 142)	
Location type			
Non-public	223 (71.2)	94 (66.2)	0.278[δ]
Public	90 (28.8)	48 (33.8)	
Cause of arrest			
Respiratory	184 (58.8)	66 (46.5)	0.040[δ]
Cardiac aetiology	72 (23.0)	46 (32.4)	
Other	57 (18.2)	30 (21.1)	
First arrest rhythm			
Asystole	250 (79.9)	60 (42.3)	< 0.001[δ]
Ventricular fibrillation	35 (11.2)	45 (31.7)	
PEA	28 (8.9)	37 (26.1)	
Witnessed arrest			
No	224 (71.6)	45 (31.7)	< 0.001[δ]
Yes	89 (28.4)	97 (68.3)	
Pupils response			
No	298 (95.2)	104 (73.2)	< 0.001[δ]
Yes	15 (4.8)	38 (26.8)	
Bystander CPR			
No	186 (59.4)	55 (38.7)	< 0.001[δ]
Yes	127 (40.6)	87 (61.3)	
Bystander AED			
No	294 (93.9)	118 (83.1)	< 0.001[δ]
Yes	19 (6.1)	24 (16.9)	
Response time (min)	13.21 ± 6.85	11.52 ± 5.69	0.006[†]
< 8	66 (21.1)	31 (21.8)	0.857[δ]
≥ 8	247 (78.9)	111 (78.2)	
Pre-hospital defibrillation			
No	275 (87.9)	92 (64.8)	< 0.001[δ]
Yes	38 (12.1)	50 (35.2)	
Pre-hospital advanced airway			
No	59 (18.8)	5 (3.5)	< 0.001[§]
ETT	252 (80.5)	136 (95.8)	
LMA	2 (0.6)	1 (0.7)	
Pre-hospital drugs during CPR			
Adrenaline			
No	43 (13.7)	4 (2.8)	< 0.001[δ]
Yes	270 (86.3)	138 (97.2)	
Sodium bicarbonate			
No	234 (74.8)	99 (69.7)	0.261[δ]
Yes	79 (25.2)	43 (30.3)	

Table 1 Factors associated with CPR failure at the scene 20 minutes after fulfilled ACLS. (n = 455) (continued)

Factors	CPR Failure at the Scene 20 minutes		P-value
	Yes (n = 313)	No (n = 142)	
Amiodarone			
No	292 (93.3)	107 (75.4)	< 0.001[δ]
Yes	21 (6.7)	35 (24.7)	
Calcium gluconate			
No	281 (89.8)	122 (85.9)	0.230[δ]
Yes	32 (10.2)	20 (14.1)	
Glucose			
No	292 (93.3)	132 (93.0)	0.896[δ]
Yes	21 (6.7)	10 (7.0)	
Atropine			
No	310 (99.0)	131 (92.3)	< 0.001[§]
Yes	3 (1.0)	11 (7.8)	

Abbreviations: ACLS, advanced cardiovascular life support; AED, automated external defibrillator; CPR, cardiopulmonary resuscitation; ETT, endotracheal tube; LMA, laryngeal mask airway; n, number; PEA, pulseless electrical activity
Data are presented as number (%), mean ± standard deviation or median (interquartile range).
P-value corresponds to [†]Independent samples t-test, [δ]Chi-square test or [§]Fisher's exact test.

For the univariate analysis with simple logistic regression, the statistically significant factors associated with at-scene CPR failure in OHCA patients (p-value < 0.05) were age (≥ 65 years; crude OR = 1.71, 95%CI: 1.14-2.55, p-value = 0.009), respiratory disease (crude OR = 8.1, 95%CI: 1.07-61.46, p-value = 0.043), the cause of arrest (respiratory; crude OR = 1.78, 95%CI: 1.12-2.83, p-value = 0.015), the first arrest rhythm (asystole; crude OR = 5.51, 95%CI: 3.13-9.70, p-value < 0.001), witnessed arrest (crude OR = 5.43, 95%CI: 3.53-8.34, p-value < 0.001), pupillary response (crude OR = 7.26, 95%CI: 3.84-13.74, p-value < 0.001), bystander CPR (crude OR = 2.32, 95%CI: 1.54-3.48, p-value < 0.001), bystander AED application (crude OR = 3.15, 95%CI: 1.66-5.96, p-value < 0.001), prehospital defibrillation (crude OR = 3.93, 95%CI: 2.43 - 6.38, p-value < 0.001), prehospital advanced airway management (crude OR = 6.36, 95%CI: 2.50-16.23, p-value < 0.001), and prehospital drug administration during CPR, namely adrenaline (crude OR = 5.49, 95%CI: 1.93-15.62, p-value = 0.001), amiodarone (crude OR = 4.55, 95%CI: 2.53-8.16, p-value < 0.001), and atropine (crude OR = 8.68, 95%CI: 2.38-31.61, p-value = 0.001) (Table 2).

Table 2 Univariable analyses and multivariable analysis for factors associated with CPR failure at the scene 20 minutes after fulfilled ACLS (n = 455)

Factors	Univariable analysis			Multivariable analysis		
	Crude OR[1]	(95%CI)	P-value	Adjusted OR[2]	(95%CI)	P-value
Gender						
Male	1.00	Reference				
Female	1.23	(0.81-1.88)	0.327			
Age (years)						
< 65	1.00	Reference				
≥ 65	1.71	(1.14-2.55)	0.009			

Table 2 Univariable analyses and multivariable analysis for factors associated with CPR failure at the scene 20 minutes after fulfilled ACLS (n = 455) (continued)

Factors	Univariable analysis			Multivariable analysis		
	Crude OR[1]	(95%CI)	P-value	Adjusted OR[2]	(95%CI)	P-value
Co-morbidity						
Hypertension	0.79	(0.52-1.18)	0.247			
Diabetes mellitus	1.08	(0.70-1.65)	0.735			
Coronary heart disease	0.79	(0.46-1.34)	0.377			
Dyslipidemia	0.57	(0.30-1.09)	0.090			
Renal diseases	0.82	(0.39-1.70)	0.594			
Cancer	1.46	(0.61-3.50)	0.398			
Respiratory disease	8.10	(1.07-61.46)	0.043			
Stroke	1.83	(0.20-16.48)	0.592			
Other	0.59	(0.31-1.10)	0.096			
Location type						
Non-public	1.27	(0.83-1.94)	0.278			
Public	1.00	Reference				
Cause of arrest						
Respiratory	1.78	(1.12-2.83)	0.015			
Cardiac aetiology	1.00	Reference				
Other	1.21	(0.68-2.16)	0.510			
First arrest rhythm						
Asystole	5.51	(3.13-9.70)	< 0.001	4.68	(2.48-8.86)	< 0.001
Ventricular fibrillation	1.03	(0.53-1.99)	0.935	2.03	(0.90-4.61)	0.089
PEA	1.00	Reference		1.00	Reference	
Witnessed arrest						
No	5.43	(3.53-8.34)	< 0.001	3.51	(2.14-5.76)	< 0.001
Yes	1.00	Reference		1.00	Reference	
Pupils response						
No	7.26	(3.84-13.74)	< 0.001	4.22	(1.95-9.10)	< 0.001
Yes	1.00	Reference		1.00	Reference	
Bystander CPR						
No	2.32	(1.54-3.48)	< 0.001			
Yes	1.00	Reference				
Bystander AED						
No	3.15	(1.66-5.96)	< 0.001			
Yes	1.00	Reference				
Response time (min)						
< 8	1.00	Reference				
≥ 8	1.05	(0.65-1.69)	0.857			
Pre-hospital defibrillation						
No	3.93	(2.43-6.38)	< 0.001			
Yes	1.00	Reference				
Pre-hospital advanced airway management						
No	6.36	(2.50-16.23)	< 0.001	7.34	(2.47-21.82)	< 0.001
ETT/LMA	1.00	Reference		1.00	Reference	

Table 2 Univariable analyses and multivariable analysis for factors associated with CPR failure at the scene 20 minutes after fulfilled ACLS (n = 455) (continued)

Factors	Univariable analysis			Multivariable analysis		
	Crude OR[1]	(95%CI)	P-value	Adjusted OR[2]	(95%CI)	P-value
Pre-hospital drugs during CPR						
Adrenaline						
No	5.49	(1.93-15.62)	0.001			
Yes	1.00	Reference				
Sodium bicarbonate						
No	1.29	(0.83-2.00)	0.261			
Yes	1.00	Reference				
Amiodarone						
No	4.55	(2.53-8.16)	< 0.001	2.41	(1.15-5.04)	0.020
Yes	1.00	Reference		1.00	Reference	
Calcium gluconate						
No	1.44	(0.79-2.62)	0.232			
Yes	1.00	Reference				
Glucose						
No	1.05	(0.48-2.30)	0.896			
Yes	1.00	Reference				
Atropine						
No	8.68	(2.38-31.61)	0.001	9.22	(2.22-38.25)	0.002
Yes	1.00	Reference		1.00	Reference	

Abbreviations: ACLS, advanced cardiovascular life support; AED, automated external defibrillator; CI, confident interval; CPR, cardiopulmonary resuscitation; ETT, Endotracheal tube; LMA, laryngeal mask airway; OR, odds ratio; PEA, pulseless electrical activity

For the multivariate analysis with multiple logistic regression and backward stepwise selection, statistically significant factors associated with at-scene CPR failure (p < 0.02) were selected from the univariate analysis and tested here. Such factors were age, comorbidity, (including dyslipidemia, respiratory disease, and other), the cause of arrest, the initial arrest rhythm, witnessed arrest, pupillary response, bystander CPR, bystander AED use, prehospital defibrillation, prehospital advanced airway management, and prehospital drug administration during CPR, namely adrenaline, amiodarone, and atropine. Statistically significant factors predicting at-scene CPR failure in OHCA patients (p-value < 0.05) were: the initial arrest rhythm (asystole; adjusted OR = 4.68, 95%CI: 2.48-8.86, p-value < 0.001), unwitnessed arrest (adjusted OR = 3.51, 95%CI: 2.14-5.76, p-value < 0.001), lack of pupillary response (adjusted OR = 4.22, 95%CI: 1.95-9.10, p-value < 0.001), no prehospital advanced airway management (adjusted OR = 7.34, 95%CI: 2.47-21.82, p-value < 0.001), and no prehospital drug administration during CPR, including no amiodarone (adjusted OR = 2.41, 95%CI: 1.15-5.04, p-value = 0.020) and no atropine (adjusted OR = 9.22, 95%CI: 2.22-38.25, p-value = 0.002) (Table 2).

DISCUSSION

The present study found 6 predictive factors of at-scene CPR failure 20 minutes after CPR; Firstly, the initial arrest rhythm was asystole. Our study found that OHCA patients with asystole as the initial arrest rhythm had a 4.68-fold greater risk of CPR failure compared to those whose initial rhythm was pulseless electrical activity (PEA). This finding was consistent with previous work reporting that cardiac arrest patients with asystole had a chance of CPR failure 1.63[17], 7.83[12], and 10.31[18] times greater than those with other cardiac rhythms. Therefore, cardiac arrest patients whose initial arrest rhythm was asystole have low survival rates and were associated with significantly greater risk of CPR failure[18]. Asystole is a non-shockable heart rhythm, so AED use is not indicated. This aligns well with AHA recommendations regarding BLS and ALS TOR, which state that the lack of AED shocks having been delivered can be used as one factor in the decision to terminate CPR without hospital delivery[13]. Secondly, the arrest was unwitnessed. The present study found that if OHCA patients who had unwitnessed cardiac arrests underwent CPR for 20 minutes, they would experience CPR failure 3.51 times more than those with a witnessed arrest. This finding was consistent with a retrospective single center-cohort study reporting that OHCA patients who had unwitnessed arrests had 4.91 times fewer ROSCs than those with witnessed arrest. Furthermore, this patient group had significantly increased chances of unfavorable neurological outcomes[18]. Moreover, a large systematic review and meta-analysis reporting that OHCA patients with unwitnessed arrests were associated with decreased survival with favorable functional outcome rates compared to those with a witnessed arrest[11]. Unwitnessed arrest is one of the AHA ALS-TOR factors when deciding for CPR termination without hospital delivery[13]. Thirdly, the absence of a pupillary response. The present study found that if OHCA patients without pupillary response underwent CPR for 20 minutes, they would have a CPR failure rate 4.22 times greater than those with pupillary response. We found that non-reactive pupils were a clinical indicator that could be used to assess central nervous system function in patients resuscitated from cardiac arrest. Many previous studies about the association between non-reactive pupils and CPR outcomes have found that non-reactive pupils during CPR are associated with CPR failure and reduced survival to discharge[19-20]. The European Resuscitation Council and European Society of Intensive Care Medicine guidelines in 2021 recommended that continuously non-reactive pupils during CPR and post-resuscitation might be associated with significantly increased mortality[21]. Fourthly, no prehospital advanced airway management. The present study found that OHCA patients who did not receive prehospital advanced airway management i.e. using only bag valve mask (BVM), together with CPR experienced CPR failure 7.34 times more often than those treated with an ETI. This finding was consistent with systematic reviews and meta-analyses comparing the use of BVM to ETI during CPR for OHCA patients, which reported that BVM performed worse than ETI in terms of ROSC (24% versus 48%; RR = 0.86), the rate of survival to hospital admission (21% versus 27%; RR = 1.037), and the rate of survival to discharge (6% versus 12%; RR = 1.476)[22]. Even though, the finding conflicted with a retrospective study from the large Thailand database of Information Technology of Emergency Medical Service, performed by the National Institute for Emergency Medicine, which reported no significant difference between the use of BVM and ETI in terms of ROSC, with BVM resulting in minimally higher ROSC rate than ETI (19.63% versus 15.56%; p-value = 0.148). The study's authors explained that the OHCA patients treated with BVM had less severe symptoms and most were immediately delivered to hospitals for faster treatment

compared to those treated with ETI[23]. However, BVM application in OHCA might not prevent aspiration and the risk of inadequate ventilation[24]. "Fifthly, no prehospital drugs during CPR, including no amiodarone administered. A possible explanation for this findings could be that for amiodarone usage, standard AHA guidelines recommended that antiarrhythmic drug, including amiodarone or lidocaine, be used for sustained VF and pulseless ventricular tachycardia refractory during CPR and defibrillation to help improve ROSC outcomes in cardiac arrest patients[13,25]. OHCA patients who did not receive amiodarone were probably categorized as non-refractory to CPR and defibrillation which might cause increased CPR failure at the scene, compared with those who were refractory to CPR and defibrillation[26]. Systematic review and network meta-analysis found that amiodarone usage increased the chance of prehospital ROSC (OR = 1.402, p = 0.015) but it did not increase survival to discharge (RR = 0.850, p = 0.284) or improve favorable neurological outcomes (OR = 1.114, p = 0.475), compared to placebo[27]. Finally, no prehospital drugs during CPR including no atropine administered. Patients who did not receive atropine were associated with a CPR failure rate 9.22 times greater than those who received atropine, which could be explained by a review of EMS patient care reports. In 3.1% of OHCA cases included in the study, patients received atropine before and during CPR due to either unstable bradycardia or organophosphate poisoning and were administered atropine as an antidote during CPR. In 2010, administering atropine during CPR was part of the standard treatment guidelines for cardiac arrest with asystole and PEA[28]. Presently, the AHA removed atropine from the standard guidelines because of there is no clear evident atropine administration helps improve ROSC outcomes and survival to discharge in most cardiac arrest patients, except those with pre-arrest due to symptomatic bradycardia, or organophosphates or carbamate poisoning[13,28].

The present study has many important limitations. Firstly, it is a retrospective cross-sectional study which employs data from a single center in the Bangkok, Thailand. Therefore, the study results may not be generalizable to other locales. The external validity of the clinical score requires further evaluation. Advancing the field may necessitate additional studies to confirm its applicability, such as those involving multi-center data. Secondly, the data was collected retrospectively from 2017 to 2024. During this period, there were 2 developments and changes to treatment guidelines which were AHA 2015 and 2020. The studied data might be influenced by the different AHA recommendations. Thirdly, the present study is restricted to just one short-term outcome – at-scene CPR failure. Additional studies which might make use of the score to predict long-term OHCA patient outcomes, such as survival to hospital discharge and neurological function outcomes. Fourthly, there might be unmeasured confounding factors associated with the studied outcomes. In the present study, all data collected from the retrospective review of EMS patient care reports. While, we try by all means to maintain neutrality, selection bias may have occurred. Lastly, the EMS patient care reports used for recording OHCA patient data in the studied areas did not comply with the Utstein OHCA standard template.

CONCLUSION

The present study found 6 predictive factors in identifying at-scene CPR failure (after at least 20 minutes of CPR), including the first arrest rhythms being asystole, unwitnessed arrest, unresponsive pupils, no prehospital advanced airway management, and no amiodarone and no atropine administration during CPR. CPR team leaders may incorporate these factors in their consideration of out-of-hospital TOR at the scene.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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DATA AVAILABILITY STATEMENT

The data sets generated and analyzed during the current study are not publicly available due to information, but They are available from the corresponding author on reasonable request answering the survey.

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