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# Impact of Smartphone-Based Video Monitoring with Pharmacist-Led Education to Enhance Inhaler Use and Asthma Control: A Randomised Controlled Study

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## Abstract:

**Objective:** This randomised controlled trial compared the effects of smartphone-based video follow-up combined with pharmacist-led education relative to standard care on clinical outcomes in patients with asthma.

**Material and Methods:** This randomised controlled trial was conducted at a hospital in Southern Thailand. Patients with asthma were randomly assigned to an intervention group (n=60), which received pharmacist education and follow-up via a smartphone video application, or a control group (n=57), which received standard asthma care. Outcome measures included asthma control, inhaler technique, asthma knowledge, medication adherence, and quality of life.

**Results:** The intervention group had significantly more patients with well-controlled asthma than the control group (48.3% vs. 17.5%; p-value<0.001). The intervention group also demonstrated significantly better scores in inhaler technique (mean±standard deviation (S.D.)=93.15±10.04 vs. mean=87.91±12.29; p-value=0.013), asthma knowledge (p-value=0.003), medication adherence (p-value<0.001), and quality of life (p-value=0.019) compared to the control group.

**Conclusion:** This study demonstrates that smartphone-based video monitoring of inhaler technique, combined with pharmacist-led education, is an effective strategy for asthma care.

**Keywords:** asthma, smartphone application, video, inhaler technique, pharmacist

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## Introduction

Asthma is a chronic respiratory disease that poses a significant global public health challenge. According to the World Health Organization, asthma accounted for approximately 455,000 deaths worldwide, as reported in 2024[1]. In Thailand, the Thai Asthma Council and Association reported over 3,000 asthma-related deaths annually, with an increasing trend in mortality[2]. Effective asthma control is primarily achieved through the use of inhaled medications, particularly inhaled corticosteroids[3]. However, incorrect inhaler technique remains a major barrier to optimal disease management[4,5], with studies indicating that up to 70% of patients perform at least one step incorrectly[6]. Research indicated that while patients may initially perform inhaler techniques correctly under clinical providers, errors frequently occur as early as the first day of home use and worsen progressively throughout longitudinal follow-up periods[7]. These issues are commonly attributed to inadequate comprehension and poor recall of instructions from healthcare professionals or a patient's lack of knowledge[8]. While education provided by healthcare professionals plays a crucial role in promoting correct inhaler use, it must be reinforced through regular follow-up and counseling to maintain proper technique over time.

Mobile technologies, especially smartphones, have emerged as promising tools in chronic disease management due to their accessibility and multifunctionality. Their increasing use in chronic disease monitoring offers enhanced opportunities to improve health outcomes[9]. Features in smartphones, such as video functionality and real-time communication, allow healthcare providers to remotely assess patients' inhaler technique and provide timely feedback when errors are observed. Evidence indicates that effective asthma management strategies should include comprehensive education about the disease and self-care, inhaler technique training, and continuous patient monitoring[5,10,11]. These approaches have been shown to improve asthma control and enhance patients' quality of life[12]. However, evidence remains limited regarding the effectiveness of pharmacist-led interventions that incorporate smartphone-based video follow-up for inhaler use.

Some studies have explored the use of patient-submitted videos for inhaler assessment, but often lacked real-time feedback[7]. Providing prompt feedback to patients may facilitate more accurate and effective inhaler use[13-15]. Several studies relied on telephone follow-ups, which may not accurately capture patients' actual inhaler technique[16,17]. Moreover, many previous studies had short follow-up periods (typically 6 weeks to 3 months), limiting their ability to evaluate long-term outcomes[12,18,19]. Longer follow-up periods could more effectively improve inhaler technique and asthma control. Therefore, this randomised controlled trial compared the effects of smartphone-based video monitoring of patients' inhaler use combined with pharmacist-led education relative to standard care on clinical outcomes, including asthma control, inhaler technique, asthma knowledge, medication adherence, and patients' quality of life.

## Material and Methods

### Study design

This study employed a randomised controlled trial design and was conducted at a hospital in Southern Thailand. The sample recruitment was performed from May to October 2022.

### Participants

Participants were eligible for inclusion if they met the following criteria: (1) a diagnosis of asthma, (2) age 18 years or older, (3) treatment with at least one inhaled corticosteroid medication for a minimum period of 1 month, (4) asthma control levels classified as "partly controlled" or "uncontrolled" according to the Global Initiative for Asthma guidelines (2020)[20], and (5) the ability to communicate via

a smartphone. Patients requiring intensive medical care for severe conditions, those with communication difficulties, psychiatric illnesses, or pregnancy were excluded from the study.

Sample size estimation was based on a previous study by Khdour et al.[16], which reported a difference in the proportion of patients with well-controlled asthma between the intervention (35.1%) and control (9.4%) groups at the end of the study. With a type I error of 0.05 and a power of 0.8, the calculated sample size was 39 participants per group. Accounting for an anticipated 30% loss to follow-up, the final target sample size was at least 56 participants per group. The research pharmacist employed a stratified randomisation method to allocate participants. Patients were stratified by asthma control level (partly controlled vs. uncontrolled), age (18-40 vs. >40 years), and disease duration (≤10 vs. >10 years), creating eight strata. Within each stratum, participants were randomly assigned to the intervention or control group using simple randomisation. Allocation concealment was maintained using opaque containers, with sequential card drawing by the independent research assistant.

### Intervention

***Intervention group*** (Figure 1)

The intervention group received standard care from the hospital, along with pharmacist-led education and follow-up on inhaler technique via smartphone video application. Participants were unblinded to the intervention. The intervention consisted of 2 components:

1. Patient education at baseline (month 0)

At the asthma clinic, the research pharmacist provided a single small-group education session (3–7 patients) at the initial visit, covering asthma, medications, inhaler use, treatment adherence, follow-up, and self-management. The session included a 10-minute educational video, with no further education during follow-up. Afterwards, pharmacists provided individualised training on inhaler technique. When patients demonstrated incorrect techniques, the pharmacist offered corrective feedback until the patient was able to perform each step of inhaler use correctly. Flashcards were distributed to patients to remind them of correct inhaler techniques at home. Patients were instructed to set up smartphone cameras for pharmacist monitoring of inhaler technique during home follow-ups via the LINE application.

2. Follow-up via smartphone video at home setting

One week after the initial education session, the second author, who was the hospital pharmacist at the study site, monitored patients' inhaler techniques via smartphone-based video. If incorrect techniques were identified, the pharmacist immediately provided feedback and correction until the patient displayed proper technique. Each video follow-up session lasted between 3 and 10 minutes. The frequency of video follow-up depended on the patient's inhaler proficiency, as follows:

Scenario 1: If a patient demonstrated correct inhaler use during the video, they would be monitored every month. After 3 consecutive months of correct technique, the follow-up interval would increase to every 2 months. However, if any mistakes were found in the inhaler technique during a session, monitoring in scenario 2 would apply.

Scenario 2: If a patient performed at least one incorrect step in their inhaler technique, they would be monitored weekly until they were able to consistently and correctly use the inhaler for 2 consecutive weeks. After this, the follow-up frequency would shift to monthly, as detailed in Scenario 1.

### Control group

The control group received standard hospital care with routine asthma clinic visits every 3 months. At each visit, nurses assessed symptoms and provided education.

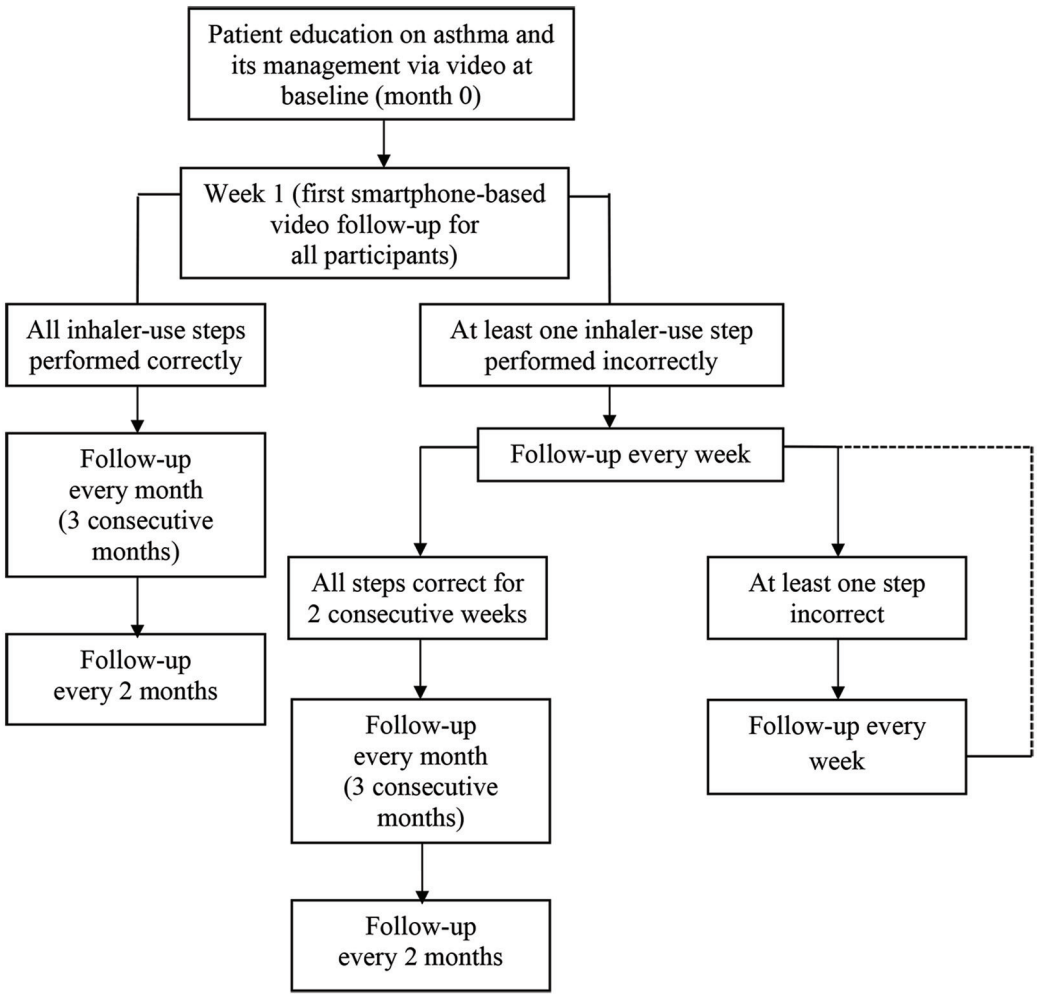


**Figure 1** Pharmacist-led intervention with smartphone-based video follow-up for inhaler use

Pharmacists conducted individualised inhaler technique assessments. When errors were detected, they provided corrective instruction through demonstration until proper technique was achieved, with reassessment at the subsequent visit. Physicians performed clinical examinations and adjusted treatment as needed. Pharmacists then dispensed medications, verified prescriptions, counselled patients on medication use, and provided additional instruction for modified regimens.

**Data collection**

The primary outcomes of this study were asthma control levels assessed at baseline, month 6, and month 9, as well as the frequency of emergency room (ER) visits due to asthma exacerbations during the previous 6 months, measured at baseline and month 9. Secondary outcomes included inhaler technique skills and adherence to inhaled corticosteroid therapy evaluated at baseline, month 6, and month 9, in addition to knowledge about asthma and

its management, and patient quality of life measured at baseline and month 9. Outcome assessment and data analysis were performed by the research pharmacist who had knowledge of participants' group assignments.

### Instruments

Instruments used in this study were as follows:

Asthma Control Assessment Tool[20,21]. It consists of 4 questions regarding daytime and nighttime asthma symptoms, frequency of bronchodilator use, and the impact of asthma on physical activities during the past 4 weeks. Response options are "Yes"=1 point and "No"=0 points. A score of 0 was classified as well-controlled asthma, scores of 1–2 as partly controlled asthma, and scores of 3–4 as uncontrolled asthma.

Inhaler Technique Assessment Tool[22]. Each correctly performed step is scored as 1 point, while incorrectly performed or omitted steps receive 0 points. Higher scores indicate better inhaler technique.

Asthma Knowledge and Medication Use Questionnaire[23]. This questionnaire consists of 14 items with 3 response options: "Yes," "No," and "Do not know." A correct answer is scored as 1 point, while an incorrect answer or a "Do not know" response is scored as 0 points. Higher scores reflect better asthma knowledge and medication use. The questionnaire has a Cronbach's alpha coefficient of 0.60.

Medication Adherence Measure for Inhaler (MAM-I)[24]. This tool includes 7 items assessing forgetfulness and missed doses when using inhaled corticosteroids. Response options range from never, 1-5 times/month, 6-10 times/month, and >10 times/month for items 1 to 5 and never, rarely, sometimes, and often for items 6 to 7. For each item, scores were recoded from 3 to 0, 2 to 1, 1 to 2, and 0 to 3. Higher total scores represent better adherence to inhaled corticosteroids. The Cronbach's alpha coefficient is 0.78.

Mini Asthma Quality of Life Questionnaire (Mini AQLQ)[25]. The questionnaire includes 15 items covering 4 domains: symptoms, activity limitations, emotional function, and environmental stimuli. Each item is rated on a 7-point Likert scale (1=severely impaired to 7=not impaired at all). Higher scores are associated with better quality of life. The tool has a Cronbach's alpha coefficient of 0.80.

Educational Video on Asthma and Medication Use, based on the global strategy for asthma management and prevention (2020)[20] and Thai Asthma Guideline in Adults (2020)[21].

Inhaler Technique Flash Cards, developed according to the standardised recommendations for inhaler use from the Professional Competency Standards for Pharmacists (Core Competencies) manual (2019)[22].

All research instruments were the Thai version and validated by three experts, including a physician, a pharmacist, and a nurse from the asthma clinic. Reliability testing was conducted with 30 asthma patients prior to data collection. Cronbach's alpha coefficients for the Asthma Control Assessment Tool[20,21], Asthma Knowledge and Medication Use Questionnaire[23], the MAM-I[24], and the Mini AQLQ[25] were 0.514, 0.564, 0.848, and 0.843, respectively.

### Analyses

Descriptive statistics were employed to summarise demographic and clinical data. Between-group differences were analysed using the Chi-square test for categorical variables, the Mann-Whitney U test for ordinal data, and the independent samples *t*-test for continuous variables. When participants were measured at more than 2 time points, the Friedman test was applied to categorical variables, whereas repeated measures ANOVA with Bonferroni adjustment was used for continuous variables. Within-group comparisons over time were conducted using McNemar's test for categorical variables and the paired *t*-test for continuous variables. A p-value of less than 0.05

was used to determine statistical significance. The effect sizes of outcomes such as inhaler technique skills and inhaler adherence were interpreted according to Cohen's guidelines, where values of 0.2, 0.5, and 0.8 represent small, medium, and large effects, respectively[26]. The analyses were conducted using Statistical Package for the Social Sciences (SPSS) version 22 (IBM Corp., Armonk, NY, US).

### Ethics approval

Ethical approval for this study was obtained from the Human Research Ethics Committee in Social Sciences and Behavioural Sciences, Prince of Songkla University (PSU IRB 2022 - St - Pharm 015).

### Trial registration number

The Thai Clinical Trials Registry, https://www.thaiclinicaltrials.org/ (TCTR20220811002).

## Results

A total of 130 patients with asthma were randomly allocated to either the intervention group or the control group, with 65 participants assigned to each (Figure 2). During the study, five participants from the intervention group and eight from the control group were excluded. As a result, 60 participants remained in the intervention group and 57 in the control group for the final analysis.

### Characteristics of the study sample

The majority of participants in both the intervention and control groups were female (over 80%). The mean age was 50.08±11.80 years in the intervention group and 53.04±9.91 years in the control group (p-value=0.147). The mean duration of asthma was 15.10±11.31 years in the intervention group and 13.61±9.66 years in the control group (p-value=0.447). Most participants had no comorbidities (over 50%). There were no significant differences between the two groups in terms of sex, age, educational level, smoking history, duration of asthma, comorbidities, or use of controller medication (p-value>0.05) (Table 1).

### Clinical outcomes

At the beginning of the study, the intervention and control groups did not differ significantly in proportions of asthma control levels (well-controlled, partly controlled, and uncontrolled), ER visits for acute asthma exacerbations in the previous 6 months, inhaler technique scores, asthma knowledge scores, inhaled corticosteroid adherence scores, or quality of life scores (p-value>0.05) (Tables 2-5).

### Asthma control and ER visits

At month 6 and month 9, the intervention group had a significantly higher proportion of well-controlled asthma than the control group (p-value=0.026 and p-value<0.001, respectively). At the end of the study, only the intervention group showed a significant improvement in the proportion of well-controlled asthma compared to baseline (p-value<0.001) (Table 2).

The proportion of ER visits did not differ significantly between the intervention and control groups (p-value=0.710) at the end of the study. However, only the intervention group demonstrated a significant reduction in the proportion of ER visits for acute asthma exacerbations compared to baseline (p-value=0.021) (Table 3).

### Inhaler technique

The intervention group had significantly higher inhaler technique scores than the control group at month 3, month 6, and month 9 (p-value<0.001, p-value=0.009, and p-value=0.013, respectively). The effect size was large and highest at month 3, followed by a medium effect size at month 6 and month 9 (effect size=0.74, 0.49, and 0.43, respectively) (Table 4).

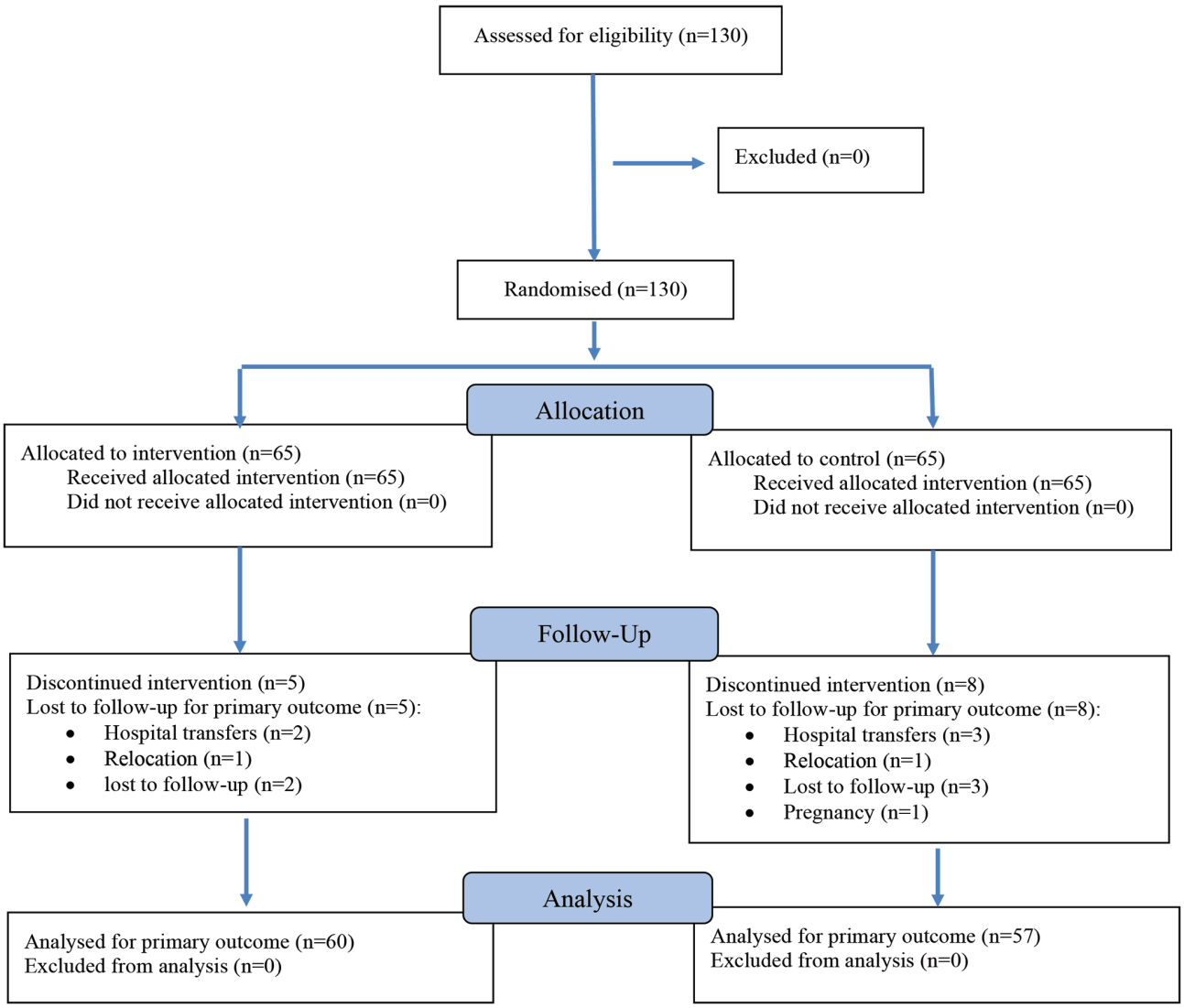


**Figure 2** Flow diagram of the study participants

### Knowledge on asthma and management

At the end of the study, the intervention group had significantly higher knowledge scores than the control group (p-value=0.003), with a medium effect size of 0.56. Additionally, the intervention group achieved significantly higher asthma knowledge scores compared to baseline (mean=11.33±1.80 vs. mean=10.05±2.00; p-value<0.001). In contrast, the control group exhibited no significant change in scores (mean=10.32±1.80 vs. mean=9.93±2.17; p-value=0.183).

**Table 1** Baseline characteristics of the participants (n=117)

| | Intervention group (n=60) | Control group (n=57) | p-value |
|---|---|---|---|
| Sex, n (%) | | | 0.367 |
| Male | 7 (11.7) | 10 (17.5) | |
| Female | 53 (88.3) | 47 (82.5) | |
| Age (years) (mean±S.D.) | 50.08±11.80 | 53.04±9.91 | 0.147 |
| Education, n (%) | | | 0.895 |
| Primary school | 33 (55.0) | 33 (57.8) | |
| Secondary school | 15 (25.0) | 12 (21.1) | |
| Bachelor's degree | 6 (10.0) | 7 (12.3) | |
| Others | 6 (10.0) | 5 (8.8) | |
| Smoking status, n (%) | | | 0.382 |
| Never smoked | 51 (85.0) | 45 (78.9) | |
| Former smoker | 8 (13.3) | 8 (14.0) | |
| Current smoker | 1 (1.7) | 4 (7.0) | |
| Asthma duration (years) (mean±S.D.) | 15.10±11.31 | 13.61±9.66 | 0.447 |
| Comorbidities, n (%) | | | 0.241 |
| No | 42 (70.0) | 34 (59.6) | |
| Yes | 18 (30.0) | 23 (40.4) | |
| Diabetes | 3 (5.0) | 7 (12.3) | 0.197 |
| Hypertension | 11 (18.3) | 15 (26.3) | 0.299 |
| Dyslipidaemia | 11 (18.3) | 17 (29.8) | 0.145 |
| Chronic kidney disease | 3 (5.0) | 6 (10.5) | 0.314 |
| Others | 5 (8.3) | 5 (8.8) | 1.000 |
| Inhaled corticosteroids received, n (%) | | | 0.513 |
| Budesonide MDI | 32 (53.3) | 23 (40.4) | |
| Salmeterol/fluticasone MDI | 25 (41.6) | 29 (50.8) | |
| Salmeterol/fluticasone Accuhaler | 3 (5.0) | 5 (8.8) | |

S.D.=standard deviation, MDI=metered dose inhaler

### Inhaler adherence

The intervention group had significantly higher inhaled medication adherence scores than the control group at month 3, month 6, and month 9 (p-value<0.001, p-value=0.047, and p-value<0.001, respectively). The effect size was high at month 3 (0.65), decreased to medium at month 6 (0.34), and increased again to high at month 9 (0.63) (Table 5).

### Quality of life

At the end of the study, the intervention group had significantly higher scores than the control group in overall quality of life, symptom domain, and environment domain (p-value=0.019, p-value=0.005, and p-value=0.030, respectively). The intervention group had a significant increase in overall quality of life scores compared to baseline (mean=5.80±0.97 vs. mean=5.35±0.95; p-value<0.001). On the contrary, no significant differences were detected in the control group (mean=5.36±1.05 vs. mean=5.26±0.84; p-value=0.442) (Table 6).

**Table 2** Comparisons of asthma control within and between groups

| Measuring time | Level of asthma control | Intervention group (n=60) n (%) | Control group (n=57) n (%) | p-value[a] |
|---|---|---|---|---|
| Baseline | well-controlled | 0 | 0 | 0.422 |
| | partly controlled | 39 (65.0) | 41 (71.9) | |
| | uncontrolled | 21 (35.0) | 16 (28.1) | |
| Month 3 | well-controlled | 13 (21.7) | 10 (17.5) | 0.257 |
| | partly controlled | 34 (56.6) | 29 (50.9) | |
| | uncontrolled | 13 (21.7) | 18 (31.6) | |
| Month 6 | well-controlled | 18 (30.0) | 8 (14.0) | 0.026 |
| | partly controlled | 35 (58.3) | 37 (64.9) | |
| | uncontrolled | 7 (11.7) | 12 (21.1) | |
| Month 9 | well-controlled | 29 (48.3) | 10 (17.5) | <0.001 |
| | partly controlled | 26 (43.3) | 36 (63.2) | |
| | uncontrolled | 5 (8.3) | 11 (19.3) | |
| p-value[b] | | <0.001 | 0.090 | |

[a]Mann-Whitney U test for comparing two independent groups, [b]Friedman test for within-group comparison among four assessment times

**Table 3** Comparisons of emergency room (ER) visits within and between groups

| Measuring time | ER visits n (%) | | p-value[a] |
|---|---|---|---|
| | Intervention group (n=60) | Control group (n=57) | |
| Baseline | 23 (38.3) | 23 (40.4) | 0.823 |
| Month 9 | 13 (21.7) | 14 (24.6) | 0.710 |
| p-value [b] | 0.021 | 0.064 | |

[a]Chi-square test for between-group comparison, [b]McNemar's test for within-group comparison

**Table 4** Comparisons of inhaler technique scores between groups (total score=100)

| Measuring time | Inhaler technique scores Mean±S.D. | | p-value[a] | Effect size |
|---|---|---|---|---|
| | Intervention group (n=60 ) | Control group (n=57) | | |
| Baseline | 85.90±10.20 | 84.92±11.76 | 0.629 | |
| Month 3 | 92.41±10.53 | 84.00±11.30 | <0.001 | 0.74 |
| Month 6 | 90.93±12.53 | 84.77±12.53 | 0.009 | 0.49 |
| Month 9 | 93.15±10.04 | 87.91±12.29 | 0.013 | 0.43 |

[a]Repeated measures ANOVA with Bonferroni test

**Table 5** Comparisons of inhaler adherence scores between groups (total score=21)

| Time | Inhaler adherence scores Mean±S.D. | | p-value[a] | Effect size |
|---|---|---|---|---|
| | Intervention group (n=60 ) | Control group (n=57) | | |
| Baseline | 16.90±3.22 | 16.32±3.35 | 0.338 | |
| Month 3 | 18.60±1.89 | 16.96±2.51 | <0.001 | 0.65 |
| Month 6 | 18.32±2.15 | 17.44±2.58 | 0.047 | 0.34 |
| Month 9 | 18.75±1.93 | 17.25±2.40 | <0.001 | 0.63 |

[a]Repeated measures ANOVA with Bonferroni test, S.D.=standard deviation

**Table 6** Comparisons of quality of life scores between groups (mean±S.D.) (total score=7 for overall quality of life score and each domain)

| Quality of life score | Intervention group (n=60) | Control group (n=57) | p-value[a] |
|---|---|---|---|
| Overall quality of life score | | | |
| Baseline | 5.35±0.95 | 5.26±0.84 | 0.601 |
| Month 9 | 5.80±0.97 | 5.36±1.05 | 0.019 |
| p-value[b] | <0.001 | 0.442 | |
| Symptom domain | | | |
| Baseline | 5.32±1.08 | 5.08±1.19 | 0.255 |
| Month 9 | 5.86±1.11 | 5.19±1.44 | 0.005 |
| Activity domain | | | |
| Baseline | 6.02±1.00 | 6.05±0.91 | 0.877 |
| Month 9 | 6.15±0.99 | 6.07±0.90 | 0.632 |
| Emotion domain | | | |
| Baseline | 5.28±1.52 | 5.24±1.40 | 0.888 |
| Month 9 | 5.79±1.20 | 5.33±1.49 | 0.068 |
| Environment domain | | | |
| Baseline | 4.58±1.37 | 4.54±1.18 | 0.887 |
| Month 9 | 5.23±1.32 | 4.71±1.21 | 0.030 |

[a]Independent sample *t*-test, [b]Paired *t*-test

## Discussion

This randomised controlled trial compared the effects of monitoring patients' inhaler use via smartphone video combined with pharmacist-led education relative to standard care on clinical outcomes in patients with asthma. The results showed that this intervention significantly improved asthma control, inhaler technique skill, and knowledge of asthma and management. Furthermore, the intervention group exhibited greater adherence to inhaled corticosteroids and improved quality of life compared to the control group.

This study found that the intervention group, which received follow-up via a smartphone video in combination with pharmacist-provided education, had significantly better asthma control and inhaler technique compared to the control group receiving usual care. These findings are consistent with the study by Wang et al.[12], in which the intervention group received asthma education through video and monthly telephone follow-up regarding inhaler technique for 3 consecutive months. The study reported significantly greater improvement in asthma control in the intervention group compared to the control group (difference between post- and pre-intervention: mean=3.50±4.65 vs. mean=0.69±3.50; p-value<0.01), as well as correct inhaler technique in 7 out of 9 steps (p-value<0.05). Similarly, the study by Sriglun et al.[19] provided the intervention group with inhaler technique training and follow-up using video via the LINE application. Participants submitted video demonstrations of their inhaler technique in week 2, week 3, and week 6, compared to those receiving standard nursing care. At week 6, the intervention group achieved significantly superior asthma control scores compared to the control group (mean=0.90±0.65 vs. mean=1.29±0.59; p-value=0.02), with lower scores indicating better asthma control. Additionally, the intervention group exhibited significantly higher accuracy in inhaler technique (mean=6.65±0.80 vs. mean=5.32±1.05; p-value< 0.01). In the study by Polhan et al.[27], the intervention group received asthma education and inhaler technique training via the LINE application, with follow-up using patient-submitted videos in week 1 to week 3. Over the 6-week study period, the intervention group achieved significantly better asthma control compared to the control group (mean=0.56±0.61 vs. mean=1.50±0.76; p-value<0.001), with lower scores showing better asthma control. Comparative analysis of inhaler technique could not be performed as this parameter was not assessed in the control group.

It has been reported that, despite receiving training on the correct use of inhalers and having undergone assessment, 50% of patients still require re-instruction in inhaler techniques[28]. The effective method for teaching patients proper inhaler use is the teach-back method. When the causes of incorrect inhaler use are identified promptly, and real-time feedback is provided, patients can significantly improve their inhaler technique[13-15]. In this study, the intervention group had previously received training and assessment on correct inhaler technique at the hospital. After returning home, the research pharmacist followed up on the patients' inhaler technique skills using smartphone-based video. Real-time feedback was given immediately when incorrect use was observed, and repeated follow-ups were subsequently conducted. This approach may have contributed significantly to the intervention group's superior inhaler technique skills compared to the control group, with statistically significant differences observed from month 3 until the end of the study.

However, at the end of this study, the proportion of ER visits due to acute asthma exacerbation in the intervention group was not significantly different from that in the control group (p-value=0.710). In contrast, the study by Khdour et al.[16] reported that the intervention group had significantly fewer ER visits due to asthma exacerbation (29 out of 102 patients) compared to the control group (58 out of 98 patients) (p-value=0.01). This difference may be attributed to the fact that the previous study[16] had a larger sample size in both the intervention and control groups than the current research (60 and 57 patients, respectively) and a longer study duration of 12 months, compared to the 9-month duration of the present study. These factors may have allowed the previous study to have more power to detect differences in the proportion of patients requiring ER visits due to asthma exacerbations.

This study found that medication adherence in the intervention group was significantly higher than that in the control group. The large effect sizes observed at month 3 and month 9 suggest that the intervention produced a meaningful improvement in adherence. Although the effect size dropped to small at month 6, possibly reflecting a temporary reduction in intervention intensity, reduced participant engagement mid-intervention, and/or external factors temporarily affecting patients' medication adherence[29]. The educational content delivered via video likely improved patients' understanding of their condition, its treatment, and the importance of consistent inhaler use. Additionally, regular video monitoring may have reinforced adherence behaviours. These findings align with those in the study by Khdour et al.[16], which showed that after patients received asthma education and inhaler technique with follow-up telephone calls, the intervention group had significantly better medication adherence compared to the control group (60.7% vs. 50.0%; p-value=0.020). A study by Amorha et al.[30] on pharmacist-led educational intervention demonstrated that the intervention group had significantly higher inhaler adherence than the control group at both month 3 (mean=6.81±1.51 vs. mean=4.94±2.29; p-value=0.001) and month 6 (mean=7.28±1.11 vs. mean=5.13±2.36; p-value<0.001). Good inhaler adherence has been associated with better asthma control[31]. When patients achieve good asthma control, this leads to improved quality of life (r=-0.749; p-value<0.05)[32]. The current study also found that quality of life in the intervention group was significantly better than in the control group.

The lack of participant blinding may have influenced behaviour and self-reported outcomes due to increased motivation or the Hawthorne effect, leading to more socially desirable behaviours. Additionally, unblinded outcome assessment by the research pharmacist may have introduced observer bias, particularly for inhaler technique evaluation; however, standardised assessment criteria were used to mitigate this risk[33,34]. Several limitations should be acknowledged. First, the study was conducted at a single centre, which may limit the generalisability of the findings. Second, the small sample size may have been insufficient to detect differences in outcomes, such as ER visits. Third, most participants used metered dose inhalers (MDIs), with relatively few using dry powder inhalers (Accuhalers), limiting the applicability of results across all inhaler types. Fourth, participant blinding was not possible due to the study intervention, potentially introducing performance and self-reporting bias[33,35]. Finally, unblinded outcome assessors may have increased the risk of observer or assessment bias. Future multicentre studies should include larger, more diverse populations across different inhaler devices to enhance generalisability. Blinded or independent outcome assessments with objective measurements would reduce bias and strengthen validity.

## Conclusion

The integration of smartphone-based video follow-up with pharmacist-provided education significantly improved asthma control compared to standard care. Notable improvements were also observed in inhaler technique, asthma knowledge, medication adherence, and quality of life. These findings suggest that combining digital health tools with professional support can enhance asthma management and should be considered a valuable strategy in routine clinical practice.

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## Conflict of interest

The authors declare no conflicts of interest.

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