Effect of Gamified Health Education on Medication Compliance of Chinese School-Age Children with Asthma

Hui Zhao[1]

Abstract

This study aimed to investigate the effect of gamified health education on asthma medication compliance in school-age children with asthma. This non- equivalent control group design was conducted on 90 Chinese school-age children with asthma between January and August 2021. A consecutive sampling technique was used to allocate 90 participants to both experimental and control groups. The experimental group was given gamified health education, while the control group had no intervention, to compare the changes in medication compliance between the experimental and control groups. The Morisky Drug Compliance Scale (MMAS-8) was used to compare changes in drug compliance between the experimental group and the control group. The compliance of asthma children in the intervention group was statistically significant compared with that in the control group (z= -6.104, less than 0.01). With the intervention of gamified health education, the compliance of asthma children in the experimental group was significantly better than in the control group, proving that the use of gamified health education can significantly improve the medication compliance of children with asthma. Using gamified health education to promote medication compliance of children with asthma at school age is recommended.

***Keywords**: Nurse, Gamification, School-age children with asthma, Medication compliance*

Introduction

In recent decades, the prevalence of asthma has increased with urbanization and industrialization, with an estimated 339 million asthmatics worldwide, accounting for 4.3% of the world's population (World Health Organization). The third epidemiological survey of childhood asthma in China found that the current incidence and cumulative prevalence of asthma among children aged 0 to 14 in Chinese cities increased by 50.6% and 52.8%, respectively, compared with 10 years ago. By 2025, it is predicted that about 100 million children worldwide will have asthma, which has become one of the urgent public health problems to solve (Serebrisky & Wiznia, 2019). The increasing number of children with asthma significantly burdens the children and the national health care system (Wu & Qiao, 2020).

Medication compliance in Chinese children with asthma affects their level of asthma control. In clinical treatment, health education and treatment training are mostly extensive in content and single in form, patients' treatment and training compliance are poor, and the level of asthma control is not high. It is very important to find ways to improve medication

[1] **Corresponding Author:** 151072262@qq.com

compliance in children with asthma, which is also the focus of clinical research in our country (Zhang, 2022).

With the increasing popularity of mobile technology in society, the study of health workers has made a certain development, gaming health application can increase the fun of participants, is a kind of means to improve participants' participation and adherence (van Gaalen, Brouwer, & Georgiadis, 2021). However, there are few studies on mobile apps for asthmatic children, and there are almost no relevant studies in China. So far, no researcher has conducted relevant studies on the compliance of gamified mobile apps for Asthmatic children in China.

The importance of this study is to explore a new mode of health education to improve the compliance of asthma in children. It will also improve the clinical treatment effect of children with asthma, reduce the economic pressure and mental burden of children with family, avoid the waste of medical resources, and encourage the development of the gaming health education for children.

Methodology

Ethical considerations

Before conducting the study, ethical approval was obtained from the ethics committee of far eastern university (FEU-ERC Code: 2020-2021-067, adopted on August 4, 2020). Written informed consent was obtained from each participant after providing a comprehensive explanation of the study's objectives. Participants were reassured that their information would be kept confidential and that their identities would remain anonymous.

Study design and setting

A quasi-experimental study with a non-equivalent control design was conducted in the pediatric wards of 2 tertiary hospitals in Yangzhou, China. The study was conducted between July 2022 and October 2022 and utilized consecutive sampling method.

Sample and size

The sample size of this study was 90. There were 45 in the experimental group and 45 in the control group. The sample size of this study is based on the quasi-experimental study on health education of Chinese school-age children with asthma conducted by Wu and Qiao, 2020. Then, the researcher divided the listed all participants into two groups in recorded order, the first group is the experimental group, and the second group is the control group. There were 45 participants in each group. The reason for choosing consecutive sampling in this study is that continuous sampling was less time-consuming and cannot waste too much time. researcher can quickly collect data and leave enough time for analysis without causing any rush. Continuous sampling is the most valuable sampling method, it can guarantee the results, researcher can go from one sample to another, to meet the research purpose and validate the previously obtained data.

Inclusion criteria

The population of this study are school-age children with the following inclusion criteria: (1) Children aged from 6 to 12 years old (Zhang, 1994); (2) In line with the diagnostic criteria of Pediatric Bronchial Asthma Diagnosis and Prevention Guidelines formulated by the Respiratory Group of the Pediatric Society of the Chinese Medical Association (Bao & Cheng, 2016), and the condition was stable; (3) The patient was hospitalized for more than 1 week; (4) The child agrees to use the ASTHMAXcel Adventures app; (5) Have the ability to complete the cost research and inquiry paper, and can complete

the inquiry paper in written or oral form and (6) Parents are the main caregivers and are willing to guide their children to use mobile apps and help them fill in the questionnaire.

Exclusion criteria

The exclusion criteria of this study are as follows: (1) Children with intellectual and cognitive dysfunction; (2) Children using oxygen supplement; (3). Children with other acute or chronic severe diseases or comorbidities; and (4) Asthmatic children in ICU.

Research Instruments

In this study, the researcher used questionnaires before intervention with participants. The questionnaire consists of the following two parts. The first part is a self-made questionnaire for general information about children with asthma, such as gender, family status, etc. The second part is the questionnaire about medication compliance of children with asthma, including whether medication is taken on time and the correct dose, etc. The researcher also conducted a post-intervention medication compliance questionnaire for children with asthma, including whether the medication was taken on time and at the correct dose. The questionnaire, *General Information Questionnaire for Asthmatic Children*, was designed by the researcher according to the study's purpose, including participants' gender, Family support, Household income, and so on.

Morisky medication adherence scale

To evaluate the medication status of asthmatic children, the Chinese translation of the Morisky medication adherence scale (Morisky et al., 1986) was used. The scale has been used to measure patients' compliance with various diseases such as asthma, hypertension, heart failure, and diabetes. The Langbach coefficient is 0.87, and the criterion-related validity correlation coefficient is 0.77. Therefore, the study has reliable reliability and validity. The scale contains a total of 8 items. Each item has a minimum score of 0 and a maximum score of 1. The full score is 8. The grade is divided according to the score. A score of 8 indicates good compliance, a score of 6-7 indicates medium compliance and a total score of less than 6 indicates poor compliance.

Intervention

In this study, the intervention tested was health education for Chinese school-age children with asthma using ASTHMAXcel Adventures (Hsia et al, 2020). This is an app developed by Albert Einstein College of Medicine that combines animation with asthma information. Children with asthma were taught health education through short asthma educational videos and interactive games to increase their desire to learn through this fun, interactive learning. This application has five levels, and only the second and third levels are studied in this study. After clicking to enter the selected level, an educational video appears. In the education video, a doctor teaches a child health education knowledge through description and playing the video. After the health education video, a small game appears in which the knowledge content mentioned in health education appears. In this application software, the health education of the second level explains common symptoms and medications of asthma, the importance of medication compliance, why to take medication, how to take medication, when to take medication, frequency of medication, dosage of medication, and precautions after medication. The health education video of the third level carefully explains how to use aerosol inhalation therapy and how to use a spacer, and their precautions.

Figure 1 *ASTHMAXcel Adventures mobile application sample images*

After clicking on the selected level, an educational video appears, as shown in Figure 4. In educational videos, doctors teach health education to children by describing and playing videos.

Figure 2 *ASTHMAXcel Adventures mobile application sample images*

After the health education video, a small game appears, as shown above. During this game, questions about knowledge mentioned in the health education video appear.

In this study, the intervention steps were divided into the following six steps：

1. Before the intervention. First, the researcher downloaded the application software on their mobile phones to ensure that the software could be used normally and provided participants with mobile devices using the application software.

2. Before implementing gamified health education, researchers went to the ward of the participant's hospital to request the patient's and their family's consent. During the intervention, the child and their family members will go to a specialized health education room in the pediatric department, where the researcher will accompany and supervise the child throughout the process. The health education room is opposite the pediatric ward and at most 20 meters from the farthest ward.

3. Before the intervention, the researcher also asked the participants whether they were ready for the intervention. If the answer was yes, the researcher first explained to the participants and to their mothers the following parts (if the answer was no, the researcher discussed with the participants the appropriate time to take the steps):

(1) The definition of asthma and the importance of drug use to asthmatic children was explained, and the purpose of this study was stated (the purpose of this study is to explore whether game talk health education promotes drug compliance in school-age asthmatic children).

(2) The participants were reassured that the study would cause no harm.

(3) The participants were reassured they would not spend any money during the study. (Similarly, the researcher did not pay any fees to the participants).
(4) Introduce the steps and contents of this intervention

There were two health education videos on the second level. The two videos explain common symptoms of asthma and medication, the importance of medication compliance, reasons for medication, method of medication, time of medication, frequency of medication, dosage of medication, and precautions after medication. After the explanation, there is a small game in which health education content at this level appears. After the game, click the third level. The health education video of the third level explains the principle of atomization inhalation therapy and how to use the spacer. There is also a small game after the explanation. The problem of the health education content of the level appears in the game. The game is over, and the health education is over.

After ensuring that the participants did not have doubt about this study, the researcher first measured the basic data of all participants, such as gender, family status, etc., and then measured the compliance of the participants in the experimental group by using the Morisky Medication Compliance Questionnaire (the questionnaire is free. The content of the questionnaire has 8 multiple-choice questions, such as whether the participants forget to use the medicine. Is it difficult to remember to use the medicine on time? Is it self-decompression and withdrawal during the treatment? According to the scores, the participants show low, medium, and high compliance) In the measurement process, participants filled out questionnaires independently. The on-site questionnaire collection method is used to collect the measured questionnaire, and then the participants guide the participants to carry out game talk health education.

In the process of this study, the researcher continuously gave oral incentives to participants to strengthen their self-confidence.

In this study, children with asthma used the application three times a day, each time starting one hour before medication, with a total intervention time of not more than 2 hours per day. The researcher accompanied participants in using the application software to ensure their correct and smooth use of the software. If the participants need help understanding something, the researcher will provide them with detailed explanations to understand the content of gamified health education for the children.

The participants were given two interventions a week in this study. After every intervention, the researcher used the Morisky Medication Compliance Questionnaire to measure the medication compliance of all participants. In the measurement process, considering that the participants are school-age children, the participants' mothers can answer the questionnaire instead of the participants. After the measurement, the participants immediately collected data, calculated the overall data of the participants, compared the medication compliance of the experimental group before and after the intervention, and compared the medication compliance of the control group and experimental groups medication compliance.

In the process of this intervention study, the researcher has the roles of educator, health promoter, protector, and communicator. The researcher is a licensed maternal and childcare researcher qualified to conduct a professional study on the participants. In the research process, the researcher conducted health education on drug treatment for school-age asthmatic children to improve the compliance of asthmatic children, promote the recovery of children's symptoms and improve the prognosis of children. During the research, the physiological and psychological changes of asthmatic children were observed throughout the whole process to provide a comfortable and safe environment for children and protect children from any harm and threat. The researcher used appropriate communication methods

to communicate with nurses, doctors, children's parents, and children in the ward to understand the children's situation better. The communication content includes collecting data and transmitting the information.

Data Collection Procedure

In this study, the researcher submitted a research proposal to the Ethics and Research Committee of the Far Eastern University for approval to conduct the study. The researcher sought the approval of the software supplier and hospital manager for this study, and the researcher contacted the gatekeeper to get the list of all participants. The gatekeeper in this study is the head nurse of the Department. In this study, the researcher ensured that there was no conflict of interest, prejudice, or coercion with the gatekeeper. The researcher went to each room of the participants who passed the inclusion and exclusion criteria of the study to explain the study and provide informed consent. After the researcher provided a detailed introduction to the study and each participant and their caregivers voluntarily signed a paper version of the informed consent form, the researcher included the participants in this study. As mentioned earlier, the researcher divided the participants into an experimental group and control group through enumerative sampling. In the data collection process of this study, considering that the participants were school-age children. The researcher and participants' parents accompanied the participants throughout the process. Data collection was done in three phases (The General Information Questionnaire for children with asthma was used to obtain the basic information of the children, and the Morisky Medication Adherence Scale was used to obtain the level of medication adherence of the children): First was to collect the general information and the medication compliance of each participant before the intervention.

The intervention has been done for the experimental group. The second phase of data collection is to collect the medication compliance of all participants after the first day of intervention. The third phase of data collection is to collect the medication compliance of all participants after the second day of intervention. During the conduct of the intervention, the researcher followed the principles of ethics, confidentiality, non-harm, and voluntariness. In the process of collecting data, participants answered the questionnaire alone. But considering that the participants are school-age children, they can let the participants' mothers guide them if they have questions about the questionnaire. The on-site questionnaire collection method was used to collect the measured questionnaire. The researcher checked the completeness of the questionnaire, and once complete, the researcher recorded the information. The questionnaire was recovered immediately after the completion of on-site filling. After collecting the data, the researcher checked whether the questionnaire was completed and filled in as required. If there is a mistake or missing fill-in, it was promptly supplemented and corrected. Once this was done, the researcher l recorded the information.

On the other hand, for the control group, the researcher was not given intervention the researcher also measured the medication compliance of the participants when the experimental group measured the medication compliance after the first and second interventions. In the process of collecting data, participants answered the questionnaire alone. But considering that the participants are school-age children, they could let their mothers guide them if they had questions about the questionnaire. The on-site questionnaire collection method was used to collect the measured questionnaire. The questionnaire was recovered immediately after the completion of on-site filling. After collecting the data, the researcher checked. whether the questionnaire was completed and filled in as required. If there were a mistake or missing fill-in, it would be timely supplemented and corrected as required. Once this was done, the researcher recorded the information.

Results and Discussion

The research questions and information about the study's results; its analysis and interpretation of data gathered will be discussed using statistical measures. This includes a narrative discussion of the results, the analysis of data, and their implications.

Table 1 *Profile of School-age children with asthma (n=90）*

Variables		Frequency	Percent(%)
Gender	Male	64	71.10
	Female	26	28.90
Family status	Non only child	43	47.80
	Only child	47	52.20
Annual household income	10000-79999	52	57.80
	80000-149999	27	30.00
	>150000	11	12.20

Table 1 shows the baseline data of all participants by using descriptive analysis. The analysis is grouped according to the gender, family status, and family income of all participants. In this study, as Naeem and Silveyra (2019) point out, the prevalence of asthma in men and women is different throughout their lives. The Global Asthma Network (2018) explains that boys are more likely to develop asthma than girls. This may be related to higher airway tone (or airway reactivity) in boys than in girls, which can lead to more narrowing of the airway in boys (pp. 20-21). However, this gender difference can be gradually eliminated in adults, and the allergic asthma remission rate is higher in boys than in girls (Global Asthma Network, 2018, p. 20). Among the 90 Chinese school-age children with asthma in this study, 64 are boys (71.10%) and 26 girls (28.90%).

Results from this study confirm these global findings. The results show that the prevalence of boys is higher than girls, and boys are more likely to suffer from asthma than girls. The prevalence rates of only-children (52.20%) and non-only children (47.80%) had no significant difference. According to this study's results, the prevalence rate of only- children was slightly higher than that of non-only children.

A good family income helps patients better understand common sense related to asthma, facilitates communication between doctors and patients, and is more likely to accept the idea of long-term use of medication to control asthma and prevent future risks. Patients with low family economic levels may have less and limited understanding of disease cognition and prevention knowledge and may be more passive in the prevention and control of asthma disease, thus reducing patients' medication compliance (Centers for Disease Control and Prevention, 2023; Xia, et al., 2021). Patients with asthma have a high social and economic burden. Studies have shown that socioeconomic barriers are prominent among asthmatic patients, which lead to poor quality of health care (Kolbe, 1997). In our study, nearly half (57.80%) of the participants said their family income was less than 80000 yuan. According to Kolbe (1997), the lower the family income of school-age children with asthma, the higher the prevalence of school-age children with asthma.

Our results show medication compliance of patients was positively correlated with family income. The long course and easy recurrence of asthma means that children in the onset stage often need repeated hospitalization, and when the disease is well controlled and turns into a chronic stage, drugs are needed for a long time. Due to this, medical expenses are high, although most families pay for the expenses through medical insurance or the new rural

cooperative medical system. However, the reimbursement does not cover some expensive drugs, so more parents said they cannot meet their child's medical expenses. Poor family economic status can affect the treatment and follow-up of children, and their parents have high work mobility and are relatively unstable, with a low level of attention to the disease. After symptoms are relieved, they voluntarily stop taking medication to reduce the positive burden on the family and reduce treatment compliance. The researcher also found that low-income family members often have high life pressure, and long-term psychological burden would increase the smoking rate of parents in the family, resulting in children often inhaling second-hand smoke. Second-hand smoke is an important risk factor for childhood asthma, suggesting that more attention should be paid to patients with relatively low economic levels in clinical work, and appropriate and effective health education, medication guidance, and follow-up management should be carried out to improve their treatment compliance.

Research Question No. 5: Is there a significant difference in medication compliance when participants are grouped according to the demographic variables?

Table 2 *Medication compliance analysis of participants when grouped according to demographic variables*

Basic information		Medication compliance			t	P
		poor	Medium	Good		
Gender	Male	58 71.60%	5 83.30%	1 33.30%	2.53	0.28
	Female	23 28.40%	1 16.70%	2 66.70%		
Age	8	19 23.50%	0 0.00%	1 33.30%	1.85	0.17
	9	11 13.60%	2 33.30%	0 0.00%		
	10	20 24.70%	0 0.00%	0 0.00%		
	11	19 23.50%	0 0.00%	1 33.30%		
	12	12 14.80%	4 66.70%	1 33.30%		
Family status	Non-only child	41 50.60%	1 16.70%	1 33.30%	2.84	0.24
	Only child	40 49.40%	5 83.30%	2 66.70%		
Annual household income	10000-79999	46 56.80%	5 83.30%	1 33.30%	3.21	0.52
	80000-149999	25 30.90%	1 16.70%	1 33.30%		
	More than 150,000	10 12.30%	0 0.00%	1 33.30%		

Table 2 shows whether there is a statistical difference in medication adherence among children with asthma grouped by baseline data. In this study, the gender p-value was 0.282,

the family status p-value was 0.242, and the annual income p-value was 0.522. P values of the above demographic data were all greater than 0.05, indicating that there was no statistically significant difference in the scores of these variables. Thus, accepting the null hypothesis, there was no significant difference in medication adherence among participants when grouped according to their demographic data. Most children from low family income are the potential population with poor medication compliance, so it is necessary to take some intervention strategies to improve their medication compliance.

Research Question No. 3: What is the medication compliance of school-age children before the intervention in:

a. the control group
b. the experimental group?

Table 3 *Comparison of medication compliance between two groups before gamified health education intervention=90)*

Group	Poor compliance	Medium compliance	Good compliance
Experimental group	40 (88.90%)	3 (6.70%)	2 (4.40%)
Control Group	41 (91.10%)	3 (6.70%)	1 (2.20%)

Table 3 shows the medication compliance data between the experimental and control groups before intervention. In this survey, the questionnaire was used to analyze the medication compliance of the two groups of participants. According to the results shown the latest research results on asthma compliance in China, Wei (2022) investigated the drug compliance of children with bronchial asthma and found that the proportion of children with asthma with high drug compliance was only 55.83%, while the proportion of children with asthma with low drug compliance was 44.17%, which just proves that the drug compliance of children with asthma needs to be improved.

Of the 90 participants in this study, 45 were in the experimental group, and 45 were in the control group. Of the 45 participants in the experimental group, the majority (88.90%) had low compliance. Fewer people have moderate (6.70%) and high (4.40%) compliance. The participants' compliance in the control group was like that of the experimental group, and most (91.10%) participants had low compliance. Fewer people have moderate (6.70%) and high (2.20%)compliance. It shows that although there is a series of measures to improve the medication compliance of children with asthma, the medication compliance of school-age children with asthma in China is generally low.

In this study, according to the long-term contact with children, the researcher found that children were physically and mentally immature and had poor self-control ability. In addition, the complexity and long-term nature of the treatment and the discomfort caused by the outbreak of the disease will lead to the reduction in compliance with medication, affect the smooth implementation of aerosol inhalation treatment, is not conducive to the rehabilitation of the disease, and even cause the deterioration of the disease. In addition, some parents of children with asthma in China said that the children's low compliance with medication would increase the number of asthma attacks, exacerbate the severity of asthma, increase the number of emergency visits and hospitalizations, and increase the number of days of absenteeism. Because of the anti-recurrence of asthma and the limitation of exercise, the children's inferiority complex often leads to their inferiority complex, limiting their normal communication with children of the same age. The parents of the children themselves worry that the asthma attacks will increase their psychological pressure. Frequent treatment

and care of children with asthma will increase the number of days of absenteeism and affect their normal lives and work. Many medical expenses are also a heavy economic burden for them and will disrupt their original life arrangements, affecting their quality of life. Improving the medication compliance of children with asthma in China is urgent.

Research Question No. 4: Is there a significant difference in the medication compliance of Chinese school-age children between the control and experimental group before the gamified health education?

Table 4 *Comparison of medication compliance between two groups before gamified health education intervention*

Group	Poor compliance	Medium compliance	Good compliance	Z	P
Experimental group	40 (88.90%)	3 (6.70%)	2 (4.40%)	-0.37	0.710
Control Group	41 (91.10%))	3 (6.70%)	1 (2.20%)		

Table 4 shows the different analysis of drug compliance between the experimental group and the control group before gamified health education intervention. A surveyby Chang (2021) on the compliance status of children with asthma based on the Internet platform, China Children Asthma Action Plan, showed that 36.9% of children with asthma had poor compliance, and children with higher compliance reported a higher proportion of asthma control. Research by Wang et al., (2019) shows that only 25.8% of children have high medication compliance, and a significant correlation exists between medication compliance and asthma control. That is, the higher the medication compliance of children, the better the level of asthma control. The above research results indicate that children with asthma generally have poor medication compliance, which is associated with poor asthma control and exacerbation of asthma diseases.

In Table 4 above, among the 45 participants in the experimental group, 40 participants had low medication compliance, 3 participants had moderate medication compliance, and only 2 participants had high medication compliance. Of 45 participants in the control group, 41 had low medication adherence. Three participants had moderate medication compliance and only one participant had high medication compliance. Z value = -0.37, P is 0.71andPvalue is greater than 0.05, The above explanations indicated that medication compliance was similar and at a low level between the two groups before the intervention, and there was no statistical significance in medication compliance between the two groups before intervention. Follow-up analysis is available.

In this study, the researcher found that the psychological bearing capacity of children is poor, and the face of mechanical operation when inhaling atomization, easily produces tension, fear, and other bad psychological. Atomized inhalation can cause children to produce a sense of stifling, the drug will stimulate the throat to a certain extent, induce a variety of discomfort, and promote the children's conflict, coupled with the disease being prolonged and difficult to cure, repeated attacks, can cause adverse reactions, treatment compliance is significantly reduced. On the other hand, children with asthma need long-term medication, but long-term aerosol inhalation of glucocorticoids can cause adverse reactions such as respiratory discomfort, hoarseness, oral candida infection, and even lead to systemic obesity, digestive tract ulcers, etc., which has a serious impact on the health of children. Some parents resist long-term medication, voluntarily stop medication, reduce the amount of medication,

and reduce treatment compliance. In addition, the samples of this study are all children with mild or stable asthma. Parents of children with mild asthma may not pay enough attention to them and are easy to despise and ignore them, thus reducing treatment compliance. The symptoms of moderate and severe children are relatively serious, and the frequency of acute attacks is high, which is easy to be attached to great importance by parents, which is helpful to follow the doctor's advice on time and dosage, and the treatment compliance is relatively good. Aiming at the problem of poor treatment compliance among children with asthma, this study aimed to improve the compliance of medication treatment for children with asthma through the intervention of gamified health education, thereby improving the efficacy.

Research Question No. 5: Is there a difference in the medication compliance of school-age children before and after the intervention in the:

5.1. Control group
5.2. Experimental group?

Table 6 *Comparison of medication compliance before and after gamified health education intervention in asthmatic children in control group*

Variables	M	SD	t	p
Pre-intervention	2.97	1.51	-14.33	<0.001
Post-intervention	5.86	0.75		

The comparison of medication compliance of children with asthma in the experimental group before and after gamified health intervention and the comparison data of medication compliance of children with asthma in the control group before and after gamified health intervention are shown in Table 5 and Table 7. In this study, the questionnaire was used to compare the pre-intervention medication compliance and post-intervention medication compliance between the two groups.

American play therapy expert Garry (2020) believes that "toys are children's vocabulary, and games are children's language." Therefore, this study combines children's natural love for playing games and combines education with entertainment. We recommend adding more game elements in the design of intervention plans, such as asthma-related games, role-playing animated videos, etc., and use these games that appeal to the psychological characteristics of school-age children with their medication treatment. By establishing reward mechanisms to stimulate the interest of children, thereby we predict a great improvement in their medication compliance. Garry (2020) suggests that in hospitals, nurses can provide regular health education to help children understand healthy behaviors, which can also help them correct bad behaviors. At the same time, providing health education for accompanying staff can correct children's behavior, strengthen interpersonal communication to actively gain children's cooperation with medication treatment and improve psychological trauma such as crying, irritability, and shock.

In this study, the experimental group received gamified health education. In Table 5, the value of t was -17.37, and the value of p was less than 0.01. Therefore, it indicated that there was a significant difference in medication compliance between children before and after gamified health education intervention in the experimental group. The medication compliance of children after gamified health education was better than that before gamified health education. In this study, there was no intervention for the control group, and the two-time points measured by the children were the same as those measured by the experimental

group, so the two time points were used in the experimental group before the gamified intervention and after the gamified health intervention.

In Table 6, the value of t was -14.33, and the value of p was less than 0.01. Therefore, there was a significant difference between the medication compliance of the control group before and after gamified health education intervention and the medication compliance of the children after gamified health education was better than that before gamified health education intervention. The compliance of both groups after gamified health education was higher than that before gamified health education.

Research Question No. 6: Is there a significant difference in the medication compliance of Chinese school-age children between the control and experimental group after the gamified health education?

Table 7 *Comparison of the first medication compliance (The fourth day of admission) between the two groups after gamified health education intervention*

group	Poor compliance	Medium compliance	Good compliance	Z	P
Experimental group	34 (75.60%)	11 (24.40%)	0 (0.00%)	-1.96	0.04
Control Group	41 (91.10%)	4 (8.90%)	0 (0.00%)		

Table 8 *Comparison of the second medication compliance (The fifth day of admission) between the two groups after gamified health education intervention*

group	Poor compliance	Medium compliance	Good compliance	Z	P
Experimental group	0 (0.00%)	34 (75.60%)	11(24.40%)	-6.10	0.001
Control Group	24 (53.30%)	21 (46.70%)	0 (0.00%)		

Tables 7 and 8 compare experimental and control medication compliance following gamified health education. This research gave the experimental group gamified health education. First-time medication compliance was examined after the experimental group session, and 75.60% of individuals reported low compliance. Fewer (24.40%) had moderate compliance. Moreover, half (75.6%) of patients reported moderate medication compliance in the second assessment. Compliance improved significantly in those with greater compliance (24.40%) and nearly no poor compliance. The first medication compliance test of the control group's youngsters found that most (91.10%) had low compliance, and few (8.90%) had moderate compliance. The second time, 53.30% of participants reported low compliance. Moderate compliance (46.70%) and good compliance were rare in children. The experimental group had much higher asthmatic kid compliance than the control group. The difference between the two groups in the intervention has statistical significance, the experimental group

is better than the control, and the statistical analysis found that z value =-1.96 and the P-value of the first measurement after the intervention was 0.04, Zvalue = -6.10 and the P-value was 0.001, and P-value of the two difference analyses was less than 0.05.Medication compliance increased in both groups with intervention time, although the experimental group increased quicker.

Two explanations may explain this disparity. School-age youngsters are curious and comprehend things well. Children can self-protect if suitable intervention techniques engage them. Gamified health education's interest, practicality, autonomy, and creativity can engage children and allow them to participate in health education independently through cartoon animation and collective games, subtly transforming disease control and improving medication compliance. Due to time constraints, children received traditional oral education on asthma which was delivered quickly. An inhaled glucocorticoid was used when receiving medication plans for the first time, but this alone did not improve patients' asthma symptoms or parents' trust in the medical staff. Parents have a limited comprehension of health education information, so they need to comprehend the necessity of long-term compliance with standardized medicine. To increase treatment acceptability and asthma-related information and medication awareness, a better intervention was needed. Most children's parents are nervous when they see a doctor since the prescription will be removed if symptoms improve. Most of the children in this trial had moderate asthma, thus inhaled ICS medicines had less of an impact, and their families were passive. This reduces asthmatic medication compliance.

Our research improved asthma medication compliance in school-aged children according to the measure of Keller's ARCS paradigm (Keller and John, 1999). The ARCS learning motivation paradigm motivates students through Attention, Relevance, Confidence, and Satisfaction. Since 2015, the idea of ARCS motivation has grown fast in China, with the most publications appearing in 2021. After introducing this idea and exploring and practicing it in teaching, it was found to improve student learning motivation. People now favor positive practice rather than a passive wait-and-see approach. The researcher first made gamified health education more engaging for youngsters, capturing their interests and sparking their enthusiasm about learning. Second, gamified health education's asthma information is tailored to children with asthma's needs and objectives, helping them stay optimistic. Thirdly, animated movies in gamified health education help pupils learn and apply it. Children can easily win the game and feel they can succeed with medicine by answering asthma-related questions. Fourthly, praise the youngster along the asthma learning process to make them happy and want to learn more. The researcher increases asthma medication compliance in school-age children using the ARCS approach and gamified health education.

This study also improved children's medication compliance by using Kolb's experiential learning theory (Kolbe et al., 1997). First, school-age children are different from other students. Due to their physical and mental development, children cannot immediately understand abstract and generalized concepts and adult experiences. They must employ experiential learning activities. Only by experiencing external objects can children speculate and reason and build the proper cognitive framework. Children acquire and transmit experience better through direct perception and personal experience. Thus, this study uses gamified application software to provide gamified health education for children with asthma, which respects children's learning styles, gives school-age children hands-on operation and direct experience, and improves children's thinking, reaching multiple levels of application, analysis, integration, evaluation, and innovation and achieving deep learning. For asthmatic kids, learning is about solving practical challenges. Gamified health education differs from passive learning. Experience-based learning activities can help youngsters have good emotional experiences, which will boost their initiative and sustainability to integrate

knowledge and solve issues autonomously. Thirdly, gamified health education is non-compulsion, free, and autonomous for youngsters, which is best for deep learning. Allow kids to play freely. Children learn and explore through games. Allowing children to play freely, independently, and happily is essential for profound learning. They are encouraged to operate and experience by hand and can get close to various game activities, such as building blocks and dressing up games, to get a better understanding of the external world and the ability to solve new challenges with higher-order thinking. Thus, experiential learning activities scaffold deep learning in early children, boosting asthma medication compliance in school-age children. Gamified health education should be utilized in clinical asthma education for children to increase medication compliance.

Limitations of the study

This study's intervention time is short, thus additional data is needed to verify that gamified health education improves asthmatic children's medication compliance. Future research can use gamified health education to improve the compliance of children with different diseases, study whether they have the same effect, and appropriately extend the intervention time to study how different times affect asthma compliance or other children's compliance or self-control.

Conclusion

Medication compliance in school-age children with asthma was at a low level in this study. However, the intervention means of gamified health education effectively improved the compliance of asthma medications. It is suggested that gamification components can be added to health education to improve the compliance of children to achieve good asthma management, which is worthy of the attention of nurses and doctors.

Recommendations

In light of the conclusion drawn from the study, the following are recommended:

Nursing Practice

1. The results of this study can guide medical workers to use gamified health education to improve the medication compliance of children with asthma so as to improve their asthma control level and quality of life and promote their normal social activities. In addition, it can reduce the psychological pressure and economic burden on parents. In addition, it can also reduce the work pressure of doctors and nurses and improve the satisfaction of children and their families in the hospital.

2. The results of this study can remind clinical nurses that school-age children are at the stage of curiosity about things and have a high understanding ability. If appropriate intervention measures arouse children's interest and enthusiasm, children can be stimulated to learn knowledge. Interesting teaching attaches importance to the interest, practicality, autonomy, and creativity of teaching. In the case of attracting children's attention through cartoon animation, collective games enable them to participate in health education imperceptibly complete the transformation of disease control role to improve their medication compliance.

3. In the process of gamified health education in this study, the software used was downloaded and used for free. This can help asthma families with lower economic levels acquire relevant knowledge about asthma, widely improve the compliance of children, improve their prognosis, reduce the number of admissions, and thus reduce the economic burden on their families.

Nursing Education

1. In this study, it was found that for school-age asthma patients, the level of medication knowledge in asthma patients significantly impacts their medication compliance. It is easy to see that the more children understand asthma medication, the more comprehensive they will be aware of the importance of medication for asthma treatment. Even if they encounter problems during medication, they tend to make correct judgments. Therefore, this study suggests that targeted and personalized health education should be provided for school-age children's medication knowledge in clinical practice. In clinical practice, nurses use innovative health education methods, such as gamified health education methods, to attract children's attention, encourage younger children to actively participate, recognize the importance of self-participation, and help improve their compliance level while reducing the care burden on parents.

2. The results of this study also provide a new idea for nursing education, improving the level of nursing education, reducing the pressure of nursing education, reducing the workload and difficulty of nurses, and conducive to establishing a good doctor-patient relationship. By combining new health education methods with clinical treatment and games, the children's lung function, medication compliance, and quality of life can be effectively improved to reduce recurrence and reduce the impact of disease on study and life, to benefit most children and families.

3. The results of this study can remind health educators to provide health education for children based on their cognitive, behavioral, and psychological characteristics. School-age children have strong imitation abilities and relatively active thinking. By conducting health education such as video simulation and game simulation, it is beneficial for children to apply the knowledge they have learned in daily life to situations of disease management, thereby learning to solve problems. Improve children's medication.

4. This study provides a more suitable health education method for health workers to educate children with asthma after leaving the hospital and during outpatient visits, allowing them to learn happily and improve their medication compliance and self-management level without being limited by location.

Nursing research

1. This study may increase the research interest of Chinese nurses in gamified health education or medication compliance of school-age asthma children and encourage them (including the researchers themselves) to conduct more different studies on gamified health education or medication compliance of school-age asthma children in China.

2. This study may help researchers who want to further study gamified health education as a reference and provide new directions. It also provides a reference value for pediatric healthcare workers and other departments' research on medication compliance in children.

3. Future studies can focus on studying children with moderate and severe asthma. To explore the effect of smartphone application software on promoting the health behavior of such children and their parents and the effect evaluation of medication compliance.

4. Different people's different health beliefs also affect the compliance of inhaled glucocorticoids in children with asthma. In future studies, by acquiring more samples from different regions and different health beliefs through multi-center, the effect of gamified health education on compliance among people of different regions and health beliefs is discussed to obtain more accurate research results.

5. Gamified health education in this study can improve children's medication compliance to a certain extent, but children's medication compliance is affected by various factors. Through this study, more researchers are encouraged to pay more attention to children's medication compliance, continue to explore the factors that affect children's medication compliance, and

then take targeted intervention measures to improve the medication compliance of children with asthma.

6. Due to the characteristics of children's growth and cognitive development, different age groups have different levels of knowledge, and the reasons for poor compliance with inhaled glucocorticoids are also very different. A well-designed smartphone app to promote medication adherence could target asthmatic children of all ages. Therefore, future studies will explore the effect evaluation of smartphone application software on inhaled medication compliance of asthmatic children of different ages.

7. Similar studies can be used for a longer period to ensure the accuracy of the studies.

AUTHOR INFORMATION

Hui Zha is a graduate of Far Eastern University's Master of Arts in Nursing. She works in the First Affiliated Hospital of Yangzhou University where she is mainly engaged in maternal and infant care. She maintains her interest in clinical nursing research.

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