

## Effect of Gamified Electronic Application on Selected Outcomes among School Age Children with Asthma

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### Abstract

**Background:** Gamification is receiving attention because of its apparent benefits and usefulness, particularly in the context of chronic illness and patient self-management on a daily basis. Children with asthma benefit from game-based learning in terms of knowledge acquisition, skill development, self-care engagement, and motivation. **Aim** the study aimed to evaluate the effect of gamified electronic application on selected outcomes among school age children with asthma. A quasi-experimental one group pretest-posttest research **design** was utilized. **Setting:** The study was conducted in the pediatric chest outpatient clinic at Cairo University Specialized Pediatric Hospital. **Sample:** a purposive sample of 60 children with asthma was participated in the study. **Data collection tools:** a structured demographic interview sheet, asthma knowledge questionnaire and childhood asthma control test. **Results:** after implementing gamified electronic application all of asthmatic children have satisfactory level of knowledge in posttest compared to no child in the pretest. Less than two third of asthmatic children properly control asthma in posttest compared to all children were poorly controlled in the pretest. There were highly statistical significant difference was found between total asthma control test scores and total knowledge scores of asthmatic children in pre and posttest. **Conclusion:** gamified electronic application is a feasible, acceptable and effective method in health education and management for school age children with asthma as it has a positive effect on improving the children's knowledge and improves asthma control. **Recommendation:** Integration of the gamified electronic application for school age children with asthma and incorporated into follow up plan to get the best outcomes for children.

**Keywords:** Gamified electronic application, school age children with asthma, and selected outcomes.

## Introduction

One of the most prevalent conditions affecting the airways is bronchial asthma. It is a global public health issue. About a thousand people die from asthma every day, and the number of those who have asthma is growing. Asthma is a chronic inflammatory process that is aggravated by airflow and is a severe co-morbid condition that affects the airway. Asthma symptoms include dyspnea and tightness in the chest, while wheezing and recurrent attacks of dyspnea are the main ones. (Yousef, Imam, Mahmmoud & Alrifai, 2021).

Up to 300 million people worldwide suffer from asthma and it predicted to reach 400 million by 2025 (Aqi, Rowlands & Rathbone, 2021). An estimated one in every 250 fatalities worldwide is thought to be related to asthma. Even while asthma cannot be cured, with the right care, its clinical symptoms can be largely controlled (Said, et al, 2022). In Egypt, asthma prevalence is rising (20.6%) (Zedan. et al, 2023).

It is commonly acknowledged that asthma is a complex respiratory condition with underlying risk factors that are both environmental and hereditary. Exposure to common allergens and various forms of indoor and outdoor air pollution have been associated with the syndrome. In addition, viral infections, upper respiratory tract infections, secondhand smoking, and the "common cold" are prominent causes of risk. A large portion of asthma morbidity is caused by denial that one has a chronic illness, inadequate comprehension of the illness's course and how to take

medication, ignorance of how to utilize inhalers, and poor self-management. Every one of the aforementioned elements is receptive to asthma education, according to several studies conducted globally that have assessed the efficacy of mothers and children education (Ibrahim, Ahmed, Ahmed, 2019).

Ineffective asthma management is linked to several detrimental consequences for children and families. For instance, they have lower educational attainment, higher instances of absenteeism from school, and more educational demands. As a result, caregivers also miss work and face financial difficulties. Life-threatening attacks and severe symptoms are experienced by certain children. Every year, a number of avoidable fatalities occur. Alarmingly, the National Review of Asthma Deaths (NRAD) discovered that there were several major preventable contributing factors in nearly all pediatric instances, raising the possibility that these fatalities were avoidable. There are numerous aspects that make the diagnosis and management of asthma in children challenging (Martin, Townshend & Brodlie, 2022).

Children who have poorly controlled asthma contribute extensively to health care systems and government costs spent on managing asthma. Asthma management programs are advised by management recommendations because they have been demonstrated to help with asthma control, enhance quality of life, and lower healthcare utilization. Nonetheless, poor medication adherence and a poor perception of symptoms are common

among young people and adolescents with asthma, which may be a result of less than ideal participation in asthma care and education. More recently, creative ways to teach this age group self-management and education have been investigated through the use of programs on smartphones and tablets (O'Connor, Tai & Carson-Chahhoud, 2021).

The implementation of asthma management recommendations has been associated with a decrease in asthma morbidity. These guidelines emphasize patient education, the monitoring of asthma symptoms, and the optimization of medication and adherence through thorough understanding of the afflicted children and their caregivers. Nonetheless, providing guideline-based asthma therapy in outpatient settings is hampered by significant time constraints and other issues. The prevalence of electronic devices among patients and caregivers has led to a rise in the utilization and accessibility of mobile health applications for asthma. Developing digital health techniques to control pediatric asthma is becoming more and more popular. According to studies, teenagers were generally open to using apps for managing their asthma, but they wanted more interesting and instructive material that would enable self-tracking and encourage independence (Hsia, et al, 2020).

In recent times, the public and private health sectors have rapidly expanded their use of mobile applications to address public health challenges, owing to the global increase in the use of smartphones and digital literacy. Gamification is one of

the main features of mobile health applications. The application of game components in tasks that are not typically connected with gaming is known as gamification. These gaming features include, but are not restricted to, vibrant graphics, point systems, leaderboards, in-game incentives, avatars, and narrative missions (Tran, Smith, El-Den & Carter, 2022).

The two facets of the idea and gamification dynamics are achievement challenges and social interaction (motivator: belonging, social acceptability, app as a social actor). The gameplay and mechanics of the app revolve around the progression of a Warrior, who is a beginning and can reach level 1, to an Inspirer, who can reach level 10 and can encourage Warriors to increase their adherence (motivators: cooperation, competition, recognition). The mechanisms of the game also promote social engagement and are based on achievement points and badges (triggers). The primary elements of the game consist of points that players receive for completing specific tasks (motivator: pleasure, positive reward), such as adding a new medication, remembering to take prescriptions on time, responding to symptom questionnaires, or receiving positive feedback from other players (Jácome, et al, 2021).

Both the academic community and the business community are paying close attention to the application of gamification in the healthcare sector. It is used in a variety of fields, such as healthcare, to promote motivation, encourage behavioral change, and improve participation.

Gamification is receiving attention because of its apparent benefits and usefulness, particularly in the context of chronic illness and patient self-management on a daily basis. Gamification has the potential to alleviate the burden of vital but repetitive tasks associated with chronic conditions. Developers may therefore find it interesting to gamify health and fitness apps. (AlMarshedi, Wills & Ranchhod, 2017). Applications for medication adherence with gamification components raise adherence rates for various chronic illnesses. (Altwayrib, Win & Freeman, 2023).

The goal of management programs is to empower patients, improve patient empowerment, encourage active participation in care, and support adherence to strategies that may prevent symptoms and complications. These strategies are just a few of the techniques used to improve patient education and behavior overall. Information about the biology of asthma, instruction in self-monitoring symptoms, advice on avoiding triggers, and regular reviews of medication and device techniques are all common components of asthma self-management programs. In addition to instruction, a personalized written action plan that is routinely evaluated by medical specialists should be part of guided self-management. (O'Connor, Tai & Carson-Chahhoud, 2021).

So, the role of the pediatric and community health nurse is to add to the body of knowledge for school age children with asthma and their families to use such electronic games that improve self-

management and control of asthma. In addition, collaborate with multidisciplinary sectors including healthcare providers, families, school personnel and community members to identify and implement evidence based management programs via advanced mobile applications such as games. So, the aim of the current study is to assess the effect of gamified electronic application on selected outcomes among school age children with asthma.

### **Significance of the study**

Asthma is a chronic illness that lasts a lifetime. In children, it is the most frequent chronic disorder, and the symptoms are typically more severe (Trivedi & Denton, 2019). In Egypt, the incidence of asthma among school children in the Nile Delta region is about 7.7%. Asthma is relatively communal in Egypt, and possibly under diagnosed and under treated, mostly among children from less wealthy families (Magzoub, et al, 2019). According to studies conducted in Egypt, the prevalence of asthma is 9.4% in Cairo schools for students aged 11 to 15 and 8.2% in another study involving children aged 3 to 15 (Al-Jawaldeh & Abul-Fadl, 2021).

A study conducted by Ghonem, (2022) highlighted on the overall point incidence of childhood bronchial asthma among elementary school students in El-Menoufia governorate was 6.5%, indicating a significant increase over the previous 20 years when compared to the findings of a similar study conducted 20 years prior, which found that the incidence of bronchial asthma in elementary school students in Menoufiya governorate was 2.2%, with a triple increase in prevalence

during this time. This clarifies the scope of the bronchial asthma epidemic in the neighborhood.

Children with asthma may benefit from game-based learning that includes aspects of child psychology in order to develop their knowledge, skills, motivation, and involvement in self-care. It has been observed that among children with HIV/AIDS, cancer, and asthma applications, serious games foster good attitudes and acceptance. Through the use of game-based learning, kids can develop their analytical thinking skills and problem-solving abilities while receiving appropriate training and feedback (Whiteley et al, 2019).

After extensive literature review by the researchers; almost of the national and international studies clarifies the wide spread of asthma in Egypt among school age children so the current study will add to the nursing body of knowledge and highlight the importance of educational games in management of disease and controls its consequences on children health.

#### **Operational definition:**

The selected outcomes in the context of this study include knowledge of the school age children regarding asthma in addition to the asthma control measures as reported by the child and his/her mother.

#### **Aim of the study**

The aim of the current study was to assess the effect of gamified electronic application on selected outcomes among school age children with asthma.

#### **Research hypotheses:**

To fulfill the aim of the study, the following hypotheses were formulated:

- H1: The posttest mean knowledge scores of school age children with asthma after implementing the gamified electronic application are expected to have higher than pretest mean scores.
- H2: The posttest mean asthma control scores of school age children with asthma after implementing the gamified electronic application are expected to be higher than pretest mean scores.

#### **Subjects and Method**

##### **Research Design:**

A quasi – experimental one group pretest-posttest design was utilized in this study. A quasi-experimental study strategy does not use randomly assigned groups; instead, it manipulates an independent variable to see how it affects the dependent variable. A single instance is observed twice—once before the intervention and once after it—using a single group pretest-posttest design. It is assumed that modifications to the desired objective are the outcome of the intervention or therapy (Thomas, 2022).

##### **Setting:**

The study was conducted in the pediatric chest outpatient clinic, in the second floor at in Cairo University Specialized Pediatric Hospital (CUSPH). The clinic receives children from all over Egypt who have any respiratory problems and provide care and follow up for children.

##### **Sample:**

A purposive sample of 60 children with asthma and their mothers were participated in the study. The sample size was

calculated based on the following formula (<http://www.ifad.org/gender/tools/hfs/anthropometry>):-

$$n = \frac{T^2 \times p(1-p)}{m^2}$$

Description: n = required sample size.

t = confidence level at 95% (standard value of 1.96).

p = estimated prevalence of children with asthma in 2023 at CUPH (0.72).

m = margin of error at 5% (standard value of 0.05).

$$n = \frac{(1.96)^2 \times 0.72(1-0.72)}{(0.05)^2} = 60$$

#### **Inclusion criteria:**

Children diagnosed with asthma.

-Children aged from 6 to 12 years (Ghonem, 2022).

-Child or mother should have a mobile phone.

#### **Exclusion Criteria:**

- Children with other chronic disease such as (tumors, epilepsy and pulmonary heart disease)

#### **Tools of Data Collection:**

After reviewing the related national and international literature, data was collected through three tools: a structured interview sheet, asthma knowledge questionnaire and asthma control test.

#### **The first tool: A Structured Demographic Interview Sheet:**

- It was developed by researchers and included 14 items. It was divided into 3 parts:

**Part I:** included 5 questions concerned with data of the mothers' personal characteristics as age, education, occupation, parents' consanguinity, income and residence.

**Part II:** involved 4 questions concerned with data of the child personal characteristics as age, gender, child rank in the family and number of siblings.

**Part III:** comprised of 8 questions about child medical history as family history of asthma, underlying cause of asthma, duration of disease..ect.

#### **The second tool: Asthma Knowledge Questionnaire:**

It was used as pre –posttest. Based on Luckie, et al, (2017), the tool was modified and translated and back translated to Arabic language. It includes 27 questions. It included questions on asthma etiology, signs and symptoms, medications, control....etc. The questions were answered with yes or no.

Scoring: A yes response was given 1 score and no =0. The total score was 27 and 60% and more of total score was considered a satisfactory level of knowledge and less than 60% of total score was considered unsatisfactory level of knowledge.

#### **The third tool: Childhood Asthma Control Test (ACT)**

It was used as pre –posttest. It was adapted from Nathan, et al (2004) and translated and retranslated to Arabic language by the researchers. It included 7 questions: the child responded to the first four questions (1 to 4) such as: How is your asthma today? - How much of a problem is your asthma when you run, exercise or play sports?- Do you wake up during the night because of your asthma?..ect and the mothers responded to the last three questions (5 to 7) such as : During the last 4 weeks, on average, how many days per month did your child have any daytime

asthma symptoms? - How many days per month did your child wake up during the night because of asthma?..ect. The first four questions (1-4) were scored from 0 score for very bad or all of the time response to 3 score for very good or none of the time response. The last three questions (5-7) were scored from 0 score for every day response to 5 score for not at all response. The total score was 27 and a cutoff score of 19 or less identified that children poorly controlled asthma. This tool aimed to assess the asthma control measures before and after application of the program.

#### **Validity and Reliability**

The developed, modified, translated and back translated tools submitted to three experts in community health nursing and pediatric nursing to assess the content validity. Cronbach's Alpha will be used to determine the internal consistency of the tools.

#### **Procedure:**

The study was carried out with formal approval from the Cairo University Faculty of Nursing Research Ethics Committee and associated committees. An official permission was obtained from the director of Cairo University Specialized Pediatric Hospital (CUSPH) and from the heads of pediatric chest out-patient clinic. Prior to the study commencing, the researcher explained the purpose and methodology to the participants. (the mothers and the school age children). The mothers written consent to participate in the study was requested, along with their cell phone number for ease of communication either in implementation or evaluation phases.

The study was carried out on 3 phases: assessment phase, implementation and evaluation phases.

#### **(1) Preparatory phase:**

This phase included filling in the structured interview sheet by the researchers on individual bases and assessment of school age children knowledge questionnaire and control test regarding asthma at the selected outpatient clinic and the participant's responses was filled in by the researchers. The researcher did field visit two days / week from 9-1pm in waiting area of the pediatric chest outpatient clinic. The time consumed to fill the structured interview questionnaire and assessment of school age children knowledge questionnaire and control test was about 30- 40 minutes.

#### **(2) Planning and implementation phase:**

Based on assessment results and review of related literatures, the gamified electronic application was developed by the researchers. The gamified electronic application was implemented on three sessions in the form of cartoon pictures represented as a train start by definition, signs and symptoms, triggers ....ect. The application aimed to raise knowledge about asthma and enhance control measures. The Gamified application which called asthma game was given to school age children and their mothers in the form of game through pre-designed educational materials. The participants were divided into ten subgroup to ensure acquiring and proper understanding of all the participants. The gamified application had comprehensive knowledge about asthma (definition, triggers, signs and symptoms

that appears on child and treatment techniques) in form of puzzle, true and false, matching and memory game. The first session, the researchers guided the child to choose asthma definition and triggers icons. In the second session, the researchers guided the child to choose signs and symptoms and treatment icons. Feedback was taken during each session from the game as it was designed based on questions. The third session, the child played again all icons of asthma game which include (definition, triggers, signs and symptoms and treatment techniques) to ensure that the child understand each items and can answer the questions alone without guidance. Each session spent from 30-40 minutes. The application was presented on the researcher personal computer to each sub group of the participants and sent the application link to the mothers on what's up program.

### (3) Evaluation phase:

In this phase, evaluating the effectiveness of gamified electronic application was done. The same tools were applied immediately after the program application with the same children and their mothers who participated previously in the study to evaluate the effect of the application on degree of knowledge and asthma control. The tools were filled in by the researchers through direct interview or through the use of the cell phone to avoid the drop out of the study subjects.

#### **Ethical considerations**

The Research Ethics Committee was formally approved the proposed study's conduct. Participation in the study was voluntary and based on subjects'

acceptance (the mothers and their school age children) to give informed consent; where informed consent was signed by the subjects' after reading all its details. The ethical considerations was included explaining the purpose and nature of the study, stating the possibility to withdraw at any time without any consequences, confidentiality of the information where it was not be accessed by any other person without taking permission of the participants. It was also included the benefits and any expected harms.

#### **Statistical Design**

Upon completion of data collection, data was computed and analyzed using statistical package for the social science (SPSS), version 22 for analysis. The P value was set at 0.05. Descriptive statistics tests as numbers, percent, mean  $\pm$  standard deviation ( $\pm$  SD), used to describe the results. Appropriate inferential statistics as t test, F test and = r test.....ect will be used as well multiple line regression analysis.

#### **Results**

**Table (1)** reveals that, more than two fifth of the mothers (46.7% ) aged between 20 and less than 30 years old followed by 36.7% aged from 30 to less than 40 years old. More than half of the mothers 56.7% were secondary education and house wives. More than two fifth of parents (42%) had negative consanguinity. In addition to 66.7% of mothers came from urban area.

**Table (2)** shows that, more than three quarters (76.7%) of the asthmatic children were males. More than half on children (60%) aged between 10-12 years old and 30% ordered the second in the family.



**Table (3)** clarifies that, more than two thirds (66.7%) of the asthmatic children didn't have family history of asthma and 63.4% complained of asthma for more than 3 years. Regarding level of asthma, 58.3% had moderate asthma attacks. Moreover, more than half of school age children (53.3%) with bronchial asthma were exposed to smoking in family house and 70% of them reported that asthma symptoms increase on winter. In relation to common symptoms of the asthma attack, the highest percentage of children (66.7%) reported cough followed by 60% difficult breathing and wheezing. More than two third of children (66.7%) clarified that asthma symptoms increases outdoor. More than half of children (56.7%) were absent from school due to asthma attacks. As regards precipitating factors that increase risk to asthma attack the vast majority of children (93.3%) reported odors such as smoking and dust followed by 63.3% respiratory infection and weather changes. **Table (4)** indicates that after implementing gamified electronic application all of asthmatic children have satisfactory level of knowledge in posttest compared to no child in the pretest with p value 0.000. Less than two third (63.3%) of asthmatic children properly control asthma in posttest compared to no child in the pretest. While poor asthma control level represented all children in pretest compared to more than one third (36.7%) in the posttest with p value 0.000.

**Table (5)** illustrates that, After implementation of gamified electronic

application highly statistical significant difference was found between total knowledge scores of asthmatic children in pre with Mean± SD 4.27±3.05 and posttest with Mean± SD 31.80±2.81 (p= 0.000) and in all knowledge dimensions scores. This result answers the research hypothesis number one.

**Table (6)** illustrates that, after implementation of gamified electronic application highly statistical significant difference was found between total asthma control test scores of asthmatic children in pre and posttest (P= 0.000). This result answers the research hypothesis number two.

**Table (7)** shows that, there was a positive statistical significant correlation between total knowledge scores and total asthma control test scores with P value 0.0001.

**Table (8)** shows that, there was a positive statistical significant correlation between age and gender of asthmatic children and total asthma control test scores with (P value 0.03& 0.001respectively). There were negative statistical significant correlation between total knowledge scores and asthmatic children age and gender.

**Table (9)** shows that, there was a positive statistical significant correlation between total knowledge scores and mother age, education, job and place of residence with (P value 0.01, 0.001, 0.049 and 0.03 respectively).

**Table (1) Percentage Distribution Mothers of Children with Asthma Personal Data (N=60).**

Mothers age	No.	%
<20 yrs.	0	0.0
20-<30 yrs.	28	46.7
30-<40 yrs.	22	36.7
40 years and more.	10	16.6
<b>Mothers education</b>		
Can't read and write	0	0.0
Just read and write	0	0.0
Preparatory education	10	16.7
Secondary education	34	56.7
University education	16	26.7
<b>Mothers' occupation</b>		
House wife	34	56.7
Working mother	26	43.3
<b>Presence of consanguinity</b>		
Yes	18	30.0
No	42	70.0
<b>Place of residence</b>		
Rural	18	30.0
Urban	40	66.7
Industrial	2	3.3

**Table (2) Percentage distribution of asthmatic children personal data (N=60).**

Children Gender	No.	%
Male	46	76.7
Female	14	23.3
Children age		
6-<8	0	0
8-<10	24	40.0
10-12	36	60.0
Order of asthmatic child in the family		
The First	12	20.0
The Second	18	30.0
The third	16	26.7
The Fourth	14	23.3

**Table (3) Percentage distribution of medical history of asthmatic children (N=60).**

<b>Family history related to asthma</b>	<b>No.</b>	<b>%</b>
Yes	20	33.3
No	40	66.7
<b>The Duration of disease</b>		
Since birth	2	3.3
<1 year	0	0.0
1-<3 years	20	33.3
3 years and more	38	63.4
<b>Presence of smokers in the family house</b>		
Yes	32	53.3
No	28	46.7
<b>Seasonal variation and asthma attacks *</b>		
Summer	18	30.0
Autumn	10	16.7
Winter	42	70.0
Spring	0	0.0
<b>Severity of asthma</b>		
Mild	15	25
Moderate	35	58.3
Sever	10	16.7
<b>Common Symptoms of the asthma attack*</b>		
Cough	40	66.7
Difficulty breathing	36	60.0
Wide nose	6	10.0
Wheezing sound	36	60.0
Chest narrowing	14	23.3
<b>Symptoms worsening</b>		
At home	20	33.3
Outdoors	40	66.7
<b>Asthma attack effect on school attendance</b>		
Yes	34	56.7
No	26	43.3
<b>Precipitating factors that increase risk to asthma attack*</b>		
Respiratory infection	38	63.3
Exercise	10	16.7
Odors or dust	56	93.3
Emotions	2	3.3
Weather changes	38	63.3
Foods	6	10.0

\*No mutual number for these questions.

**Table (4) percentage distribution of asthmatic children total knowledge level and total asthma control test level in pre and posttest (N=60)**

Total Knowledge level	Pretest		Posttest		X <sup>2</sup>	P
	No.	%	No.	%		
Unsatisfactory	60	100.0	0	0.0	60.0	0.000*
Satisfactory	0	0.0	60	100.0		
<b>Total asthma control level</b>						
poorly controlled asthma	60	100.0	22	36.7	27.8	0.000*
properly /Good controlled asthma	0	0.0	38	63.3		

\*significant at p-value<0.05

**Table (5) Difference between the mean scores of knowledge questionnaire dimensions and total knowledge scores in pre and posttest (N=60)**

Asthma Knowledge questionnaire	Pretest	Posttest	Difference	
	Mean± SD	Mean± SD	T Test	p value
Definition and characteristics of asthma	0.10±0.40	3.67±0.61	26.806	0.000*
Causes of asthma	0.37±0.61	3.73±0.58	21.864	0.000*
Predisposing factors of asthma	1.30±1.15	8.40±1.07	24.757	0.000*
Signs and symptoms of asthma	1.57±1.10	5.70±0.70	17.349	0.000*
Causes that increase severity of asthma	0.13±0.43	3.67±0.66	24.615	0.000*
Treatment and Medication of asthma	0.30±0.60	2.90±0.40	19.748	0.000*
Prevention of asthma	4.27±3.05	31.80±2.81	36.360	0.000*
<b>Total knowledge questionnaire</b>	<b>4.27±3.05</b>	<b>31.80±2.81</b>	<b>36.360</b>	<b>0.000*</b>

\*significant at p-value<0.05.

**Table (6) Difference between the mean scores of asthma control test in pre and posttest among the asthmatic children (N=60).**

Asthma control test	Pre test	Posttest	T Test	p value
Mean± SD	10.47±3.94	20.97±4.35	9.799	0.000*

\* The mean difference is significant at the 0.05 level.

**Table (7): Correlation between Total Knowledge scores and Total Asthma control test scores**

Variables	R	P
Total Asthma control test scores Total Knowledge scores	0.81	0.0001*

**Table (8): Correlation between demographic characteristics of studied children and mean score of knowledge and Total Asthma control test scores after implementing gamified electronic application**

Demographic data:	R	P
Total Asthma control test scores Age of asthmatic child	0.27	0.03*
Total Asthma control test scores Gender of asthmatic child	0.31	0.001*
Gender Total Knowledge scores	0.11	0.2
Age Total Knowledge scores	0.13	0.14

\*significant at p-value<0.05

**Table (9): Correlation between personal characteristics of the mothers and total knowledge scores**

Demographic data	Total Knowledge scores	
	R	P
Age	0.22	0.01*
Education	0.31	0.001*
Job	0.2	0.049*
Place of residence	0.19	0.03*

\*significant at p-value<0.05

### Discussion

The results of this study showed that more than two fifth of the mothers aged between 20 and less than 30 years old. Regarding level of education more than half of the mothers 56.7% were secondary education. This result was in the same line with Fathala, Okby, Mansour & Hassan (2022) who found that 75% of studied mothers were between 25 - < 30 years. In terms of education, mothers who were studied had secondary education in more than one-third of the cases.

These preceding results were congruent with the results of the study done by Alsayed et al. (2023) in Saudi Arabia, which aimed to assess levels of knowledge and common practices among 393 caregivers of pediatric patients with asthma and revealed that 37.9% of them had a secondary level of education. These results were in line with a study conducted by Rishi et al. (2022) who discovered that 27.5% of the mothers obtained secondary school educations. However, these previous findings were in contrast to the findings Hashim et al. (2022), who investigated asthmatic children's self-care practices and knowledge and illustrated

that most of the students' mothers and fathers were illiterate.

Regarding mothers' place of residence more than two third of mothers were came from urban area. Also more than half of mothers were house wives. This result in accordance with Mohammed, A Abdel-Salam, & Mohamed (2023) who studied effect of educational program based on PRECEDE PROCEED model on mothers' performance regarding care of children with asthma and established that most of studied mothers didn't work and less than three quarter of studied mothers were living in urban areas. In the same line the study prepared by Grant & Wood (2022) who stated that The burden of asthma in children living in urban settings is particularly significant, resulting in more frequent occurrences of asthma, worsening symptoms, more acute asthma visits and hospitalizations, and higher asthma symptoms.

Concerning consanguinity more than two fifth of parents had negative consanguinity in study group. Agreement with these findings the study done by Khatab, Hassan, El-Hameed, et al (2020) who concluded that parental consanguinity does

not increase the risk of bronchial asthma in children.

It is evident from the current study that more than three quarters (76.7%) of the asthmatic children were males and more than half on children (60%) aged between 10-12 years old. These findings were in accordance with Lizzo, Goldin & Cortes (2024) who stated that according to Centers for Disease Control and Prevention (CDC), the prevalence of asthma in children rises with age, from 1.9% in those under 4 to 7.7% in those between 5 and 14 years old. Instances are higher in boys than in girls under the age of twenty. Similar findings were reported by Yahya et al. (2022) who investigated the prevalence of asthma among school students, and indicated that boys have a higher incidence of asthma than girls. These results are consistent with that of Mohammed et al. (2020), who accompanied a study aimed at estimating the prevalence of bronchial asthma among school-aged children in Sohag Governorate, Egypt. Their study found that the risk of asthma was 1.1 times higher in males than in females. These findings are in contrast to the study conducted by Yusuf et al. (2022) who studied the association between environmental exposure and asthma and initiated that a higher incidence of asthma were among in females compared to males.

Regarding family history, the current study exposed that more than two thirds of the asthmatic children didn't have family history of asthma. This finding is in same line with Sheha (2023) who noticed that more than half (54.8%) of the sample had a

negative family history of asthma. This finding is in contrast to the study conducted by Alahmadi, et al. (2019) revealed that Most of the sample stated that they had a family member suffer from asthma. More than half of studied with bronchial asthma were exposed to smoking in family house. These results match those of Ahmed & Mohammed (2022) who noticed that more than three-quarters of studied children their children were exposed to passive smoking at home. From the researchers point of view these results may be due to long time children with asthma spent at home which worsen the disease in presence of smoking at home.

As regards level of asthma, 58.3% had moderate asthma attacks. This finding confirmed with the results obtained by Ghonem (2022) who studied the frequency of bronchial asthma among school children and concluded that slightly less than half (49.1%) had intermittent asthma. The current study revealed that less than three quarters of studied children reported that asthma symptoms increase on winter and more than two third of children asthma symptoms increases outdoor. This result in accordance with Ebrahim, Soliman, & Mohamed, (2020) who studied Nursing interventions for school-age children in a rural region who suffer from bronchial asthma and reported that 92.1% had asthmatic attacks in winter and in 67.1% of children with asthma, the symptoms worsened outside. This result may be due to variation of asthma trigger in different seasons and increases on fall and winter because of climate change and



children have to go outdoor for school or other social activities.

Similarly to the results McDermott-Levy, Pennea, & Moore (2023) who revealed a relationship between fast falling temperature and an increased risk of asthma exacerbations and increase in asthma hospitalization for children with asthma symptoms when exposed to outside. Other study supported the results the study titled reducing the impact of winter on students with asthma that carried by Lepkowska (2019) who observed that children with asthma may face a variety of additional challenges throughout the winter.

As regards precipitating factors that increase risk to asthma attack the vast majority of children reported odors such as smoking and dust followed by less than two third respiratory problems and weather changes. These results goes in the matching line with a study conducted by Hassan, Abusaad, & Mohammed (2022) who examine how the Buteyko breathing technique affects the management of asthma severity. and found that smoking and dust contribute to the majority of children's asthma.

The preceding findings similar to Ahmed & Mohammed (2022) and Perera, & Abeysena (2019) who concluded that more than half of mothers reported that strong odor and weather changes increase the chance of an asthma attack in the most of studied children can cause asthma attack for their children. This finding also congruent with Lizzo, et al, 2024 who determined that asthma triggers including

respiratory infections, allergen exposure, and irritants in the environment.

The current study showed that the highest percentage of children reported had cough followed by 60% of children had difficulty of breathing and wheezing. The finding goes with the opinion of Ebrahim, et al, (2020) who proved that the present respiratory symptoms, coughing were reported by 61.8% of children with asthma, while wheeze was reported by 44.7%. These finding were coincided with that of Elnady,et al.(2019) who noticed that 40% of children have at least one episode of asthmatic symptoms like coughing, wheezing, and dyspnea.

According to the current study findings, more than half of children were absent from school due to asthma attacks. This is consistent with a study Toyran, et al,2020 which examined asthma control affects school absence, achievement and quality of school life and observed that Asthma control status was found to be effective on school absence ( $p < 0.001$ ) and on school success ( $p < 0.001$ ).In the same context the study done by Johnson, et al(2019) who showed that even after taking into consideration additional health and social hazards, asthma records from the school health center and student reports accounted for 14% to 18% of the absences. From the researchers point of view asthma is a chronic illness that interferes with children school activities because of side effects such frequent hospital visits, medication administration, and limitations on physical exercise. The disruption of routines by these issues may have an impact on the daily lives of parents and children.

The present study highlighted that after implementation gamified electronic application of all of asthmatic children have satisfactory level of knowledge in posttest compared to no one in the pretest with highly statistical significant difference was found between total knowledge scores of asthmatic children in pre and posttests. Less than two third (63.3%) of asthmatic children properly control asthma in posttest compared to all children were poorly controlled in the pretest. There were highly statistical significant difference was found between total asthma control test scores of asthmatic children in pre and posttests.

The previous results supported by Karakul, et al.(2024) who examined the effect of mobile game training designed for asthmatic children on asthma management and quality of life and determined that mobile game training designed for children is an effective method in improving quality of life, increasing children's ability to use inhaler medications, reducing asthma symptoms and treatment needs, in addition, recommended that using mobile game training designed for children with asthma had positive outcomes.

Moreover Sarasmita, et al (2021) who conducted a study to develop and design a mobile game for Indonesian asthmatic children that includes an asthma self-management program and found that lack of knowledge regarding asthma and non adherence to medications in children are associated with high rates of morbidity and mortality. Application mobile game simplifies children's understanding of the disease and increasing the level of

knowledge and children satisfaction. Similarly Hsia, et al. (2020) who studied the effect of developing and evaluating ASTHMAXcel adventures (gamified mobile application for pediatric patients with asthma) concluded that ASTHMAXcel Adventures improved asthma control, knowledge, and quality of life, and reduced emergency department visits with high satisfaction scores.

These results correspondingly corroborated the findings of Cheung & Ng (2021) learning activities become more enjoyable when children use mobile applications as a game and a tool for instruction. Among the reasons for this include the fact that, in addition to being entertaining, digital games also help to promote interaction during class, overcome students' lack of interest, offer chances for introspection and respect, and result in beneficial behavioral changes. Numerous studies have determined that families, teenagers, and younger people can effectively prevent and treat asthma by using mobile health applications for asthma control (Davis et al., 2021 & Fedele et al., 2021). The researchers explained these outcomes by pointing out that children learned more about asthma as a result of implementation of gamified application and as a result, their real practices for control asthma improved.

The study results clarified that there were a positive statistical significant correlation between total knowledge scores and total asthma control test scores. In the same line Sheha, et al (2023) who found that a high statistically significant relation between students' knowledge and practice total

score level post-intervention. These results were in accordance with the results of a study conducted by Hashim et al. (2022) and El-Fadl & Sheta (2019), who stated that there were high statistically significant positive correlations between patients' total knowledge and their total practice post program implementation. Also in agreement with the finding of Kulikova et al. (2021) & Weinstein et al. (2021) who proved that as asthmatic child's level of knowledge about disease management increases, their compliance with the care and treatment process of the disease also increases and improve asthma control and quality of life.

There were a positive statistical significant correlation between age and gender of asthmatic children and total asthma control test scores. There were a positive statistical significant correlation between total knowledge scores and mother age, education, job and place of residence. Parallel with these findings a study done by Sheha, et al (2023) who reported that there was statistically significant relationship between the post-practice scores of children and their gender, as well as their parents' education level. There was statistically significant relationship between students post knowledge scores with parent's education. Likewise, the results of Ebrahim et al. (2020) who found that a statistically significant relation between children's sex, mother's education and children's knowledge. From the researchers' point of view, the children who are older are more likely to be aware of the application and apply knowledge for asthma control and educated mothers are

more expected to be aware of asthma control measurement and to apply it to their children than uneducated mothers.

### **Conclusion**

Drawing upon the results of this study, it can be concluded that gamified electronic application is appropriate as one of the methods in health education for school age children as it has a positive effect on improve the children' knowledge and asthma control after application implementation compared to before. The formulated study hypothesis is supported by the acquired outcomes.

### **Recommendations**

Based on the current study results the following recommendations are suggested;

- Creating a plan for a regular implementing of gamified electronic application for children with asthma that would be held in inpatient, emergency rooms, outpatient clinics and schools.
- Raising the awareness of pediatric and community health nurses through training workshops to enhance understanding how to apply training programs using mobile games that attract asthmatic children's attention and directly reflect on adherence of asthma.
- Further comparative research studies to compare the effect of implementing of gamified electronic application and other methods of teaching such as video-base methods, web application-base methods on children' knowledge and practice regarding asthma control.

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