
Smartphone App Based Preventive Program for Mothers regarding Chemical Substance Injuries among their Children

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Abstract:

Background: Availability of smartphones has opened opportunities for expansion and application of mobile-based educational programs which facilitate mothers' education regarding chemical injuries as these injuries significantly affect children's health. **Aim:** This research aimed to assess the impact of smartphone app based preventive program for mothers regarding chemical substance injuries among their children. **Research design:** The study's aim was achieved by using a quasi-experimental design. **Setting:** The research was carried out at Pediatric Outpatient Clinic of Benha University, Benha Teaching, and Benha Specialized Pediatric Hospitals. **Sample:** A purposive sample was used to select 90 mothers. **Tools:** Two tools were used. **I:** A structured interview questionnaire that included characteristics of the studied sample, knowledge and self-reported practices regarding chemical substance injuries and prevention. **II:** Scale to measure attitude of mothers regarding prevention of chemical substance injuries and smartphone app-based preventive program. **Results:** Positive statistically significant correlations were found between mothers' knowledge, reported practices and attitude regarding chemical substances injuries and prevention of complications at pre and post implementation of smart phone app based preventive program. **Conclusion:** Smartphone app-based preventive program have significantly helped to improve knowledge, enhance practice, and modify attitude of mothers regarding chemical substance injuries among their children. **Recommendations:** Smartphone app-based preventive program should be provided to mothers to improve their knowledge and practices regarding other home injuries.

Keywords: *Chemical Substance Injuries, Mothers, Preventive Program & Smartphone.*

Introduction:

Over the past two decades, new digital technologies including smartphones and internet have been introduced and expanded around the world. Most mobile phones today are smartphones with the additional ability to access internet and install applications. Globally, the percentage of people who subscribe to mobile internet increased from 6.3% in 2008 to 74.2% by 2019 (Mancuso, 2021). The traditional method of knowledge transfer is being replaced by information technology (Awalia et al., 2020).

Smartphones are mostly considered as a significant and economical medium for delivering interventions related to health (Yong et al., 2021). World Health Organization has suggested implementing mobile educational apps as comprehensive educational tools for the health care systems (Behboudi et al., 2021). Additionally, the world is currently dealing with Coronavirus disease (COVID-19) pandemic, appearance of other infectious diseases and recommendations to observe social distance, educational systems and communities are emphasizing virtual education more than ever (Peyravi et al., 2020).

Home injuries among children adversely affect families and entire communities (Hazazi et al., 2021). Most chemical injuries are seen among children under five years old, and most accidents occur at home (Yadav et al., 2021). Exposure to a corrosive substance often acidic or alkaline results in chemical injury (Nguyen et al., 2021). The most widely exposed substances to children are cosmetics and personal care products, followed by detergents and analgesics. Most of these exposures are unintentional (Chen et al., 2021).

Chemicals are utilized in homes as cosmetics, preservatives, fuel, detergent and pharmaceutical products; therefore, chemicals usefulness cannot be overstated. Unintentional chemical consumption among this age group may have been influenced by availability, easy access to these substances, storage, absence of parental supervision, accessibility of opening and consumption (Nwachukwu et al., 2019). Additionally, a variety of chemical additives are utilized in plastic products, like toys for kids to get or enhance product features, including material elasticity or hardness (Aurisano et al., 2021).

Burn injuries and poisoning from harmful toxins that can be found in a handbag, below the kitchen, in medications cabinets, inside garages, in gardens are

the most common types of chemical injuries (Thenmozhi et al., 2020). A true ocular emergency is chemical injury to the ocular surface that requires immediate and comprehensive intervention since, if not handled correctly and quickly, it can lead to vision loss. This form of injury frequently results from using household cleaning products (Korkmaz et al., 2021).

Preventative actions should be taken by mothers at home, as mothers play a vital role in promoting children's health. Mothers are forever in close contact with children at home, particularly from infancy through preschool (Alrimawi et al., 2019). Mothers' information and performance regarding first aid is especially necessary in injury intervention for pediatrics (Mahrous et al., 2019).

Nurses should educate parents about how to prevent home accidents, especially chemical injury. Providing mothers with knowledge on precautionary measures in the house is crucial for both minimizing the incidence of child injuries and severity, as many of the negative effects can be avoided if mothers are aware of what to do (Dhanasekaran et al., 2021).

Significance of study:

Around the world, 830,000 children die each year from accidents at home, equal daily 2,300 child deaths (Thenmozhi et al., 2020). Most injury-related mortality take place in low- and middle-income nations, particularly in rural regions where injury prevention awareness is poor (Siu et al., 2019). The highest incidence (32%) of childhood home injuries was in Egypt (Mohammed et al., 2020).

Household cleaning products have been the third most often exposed substance among children aged five years and under with 111,148 cases of exposure. Cosmetics and personal care items (11.4%), household cleaning agents (10.5%), analgesics (8.97%), and pesticides (3.5%) are the most frequent causes among children less than five years. 83.1% of cases had exposure to poisonous substances through ingestion, followed by dermal (7.15%), inhalation/nasal (6.76%), and ocular pathways (4.39%) (Gummin et al., 2020).

Aim of study:

This research aimed to assess the impact of smartphone app based preventive program for mothers regarding chemical substance injuries among their children.

Research hypotheses:

The smartphone app-based preventive program will improve mothers' knowledge, practices, and attitudes towards chemical substance injuries among their children.

Subjects and Method

Research design: A quasi-experimental research design was used.

Research Settings: The researchers conducted the study at Pediatric Outpatient Clinic of Benha University, Benha Teaching, and Specialized Pediatric Hospitals which affiliated to Egyptian Ministry of Health and Population.

Sample: A purposive sample of mothers and their children for three months (n= 90) were selected from the previously mentioned settings with certain criteria including: Mothers have a child ≤ 5 years and more than 9 months, educated mothers, have smart phone and ability to use Face book app.

Tools of Data Collection:

The researchers used the following two tools:

Tool one: A structured Interview Questionnaire:

It was prepared using relevant studies from books, articles, papers, journals, and webpages, and it was written in straight forward Arabic and classified into three parts.

Part 1: Characteristics of the studied sample:

Demographic characteristics of mothers: It contained age, educational level, occupation, residence, number of children.

Personal characteristics of children: It contained age, gender, child ranking, history of previous chemical injury and its type.

Part 2: Mothers' knowledge regarding chemical substance injuries: Composed of 21 questions in the form of multiple choices questions divided into 5 groups of questions as chemical substance injuries (5) questions, chemical poisoning (4) questions, prevention of chemical poisoning and complications in children (6) questions, chemical burn (4) questions and prevention of chemical burn and complication in children (2) questions.

Scoring system:

Mothers' knowledge scoring system was following: 2 score for a complete answer, 1 score for an incomplete answer and 0 score for don't know responses. The scores of each item were added together, and the result was divided by the total number of items to provide a mean score. These results were transformed into a percentage score. The total knowledge score was rated as good if it was greater than 75% (> 31 points), average if it was between 50% and 75% (10–31 points), and poor if it was less than 50% (10 points).

Part 3: Self-reported practices of mothers regarding prevention of chemical substance injuries among their children:

It was adapted from Nour et al., (2018) &Thenmozhi et al., (2020) composed of 41 items and included 4 dimensions as follows; first dimension was prevention of chemical poisoning in children (7

items), second dimension was first aid for chemical poisoning (15 items) that divided into poisoning by ingestion of household detergents (4 items), ingestion of medications (4 items), inhalation of chemicals (4 items) and contact chemicals with the eyes (3 items), third dimension was prevention of chemical burn in children (7 items) and fourth dimension was first aid of chemical burn (12 items).

Scoring system:

Mothers' reported practices were scored with 1 for done practices and 0 for not done. The sum of the different item scores were divided by the total number of items to obtain the mean score. These findings were transformed into a percentage score. If total practice score was > 60% (>25 points), it was recognized satisfactory; and considered unsatisfactory if it was ≤ 60% (≤ 25 points).

Tool two: Scale to measure the attitude of mothers: It included two parts as follows;

Part 1: Mothers attitude regarding prevention of chemical substance injuries: A Likert Scale adapted from Sackitey, & El Seifi et al., (2018) to measure attitude of mothers about prevention of chemical substance injuries. It was translated to Arabic and measured by 3-point Likert scale (agree, uncertain and disagree). It included (13 items).

Part 2: Mothers' impressions Likert scale for smartphone app-based preventive program for chemical substance injuries in their children:

It adapted from Matin et al., (2020) to measure mothers impressions related to Facebook phone app-based preventive program by using Likert scale (agree, uncertain and disagree) and contained (7 items).

Scoring system:

Attitude scores were assessed as 2 score for agree, 1 score for uncertain and 0 score for disagree. If the total attitude score was > 60% (>24 points), it was deemed positive. If it was ≤ 60% it was deemed negative (≤24 points).

Tools validity:

Five juries of staff nursing experts from Benha University, three of them were professors in Pediatric Nursing and two of them were professors in Community Health Nursing. They assessed clarity, comprehensiveness, relevance, simplicity, and accuracy. The layout, format, and arrangement of the questions were submitted for discussion. All the required modifications were taken into consideration.

Reliability assessment:

Reliability tests were performed on the designed and validated tools. Results from tests and retests using Cronbach's alpha revealed that all items were statistically different. The internal consistency of tool one was 0.996, tool two was 0.997 and tool three was 0.993.

Ethical consideration:

Approval from the Ethical and Research Committee at Faculty of Nursing in Benha University was acquired (approval date 16/2/2022). After presenting the nature and objectives of the research, hospitals directors and the head of the outpatient units gave their approval for the study's implementation. After briefly explaining the study's objectives to each mother, written consent was obtained from them before the interview began. Mothers had been notified of their ability to withdraw from participation in the study, and their obtained information was confidentiality secured.

Pilot Study:

A pilot study was conducted on 10% of the specified sample (9) mothers with their children, to evaluate the tools for clarity, feasibility, applicability as well as the time required to complete each item. Only a few changes were made in response to the obtained results of the pilot study (some unnecessary or repeated questions were removed).

Field of work:

Gathering data lasted from the beginning of April 2022 until the end of June 2022. The current research was carried out in four phases.

Smart phone app based preventive program construction:

Assessment phase: The researchers visited the study settings two days a week (from 9:00 am to 12:00 pm). Every mother who participated in the study was questioned by the researchers for their phone number and Facebook account. Then each mother was provided with a questionnaire sheet to evaluate their knowledge, practices, and attitude in relation to prevention of chemical substance injuries. This pretesting period lasted for four weeks.

Development phase: The program was developed using the pre-program assessment's actual results. The contents of the program were prepared by researchers in the light of actual needs assessment of studied mothers after reviewing the related literature. The guided booklet and multimedia android images and educational videos were designed by researchers using simple Arabic language. This was provided for mothers through face book phone app group at link <https://fb.me/g/3r6yq2YM4/7IpXUsMP>.

Implementation phase:

Mothers were continuously encouraged and provided positive reinforcement to interact through Facebook phone application. Data collection lasted for six weeks. Each mother attended 5 sessions. These sessions were divided into 3 theoretical and 2 practical sessions. To remind mothers of the time of sessions on the Facebook phone app, text messages are delivered to them prior to the sessions. Facebook phone app was used in providing lectures for

mothers. Each theoretical session lasted for 45 minutes, and the practical session lasted for 50 minutes. **The first theoretical session** was about chemical substance injuries in children (meaning, high risk age, methods of chemical injury, types of chemical substances and types of chemical injuries). **The second theoretical session** was about chemical poisoning in children (meaning, causes, signs & symptoms, complications, prevention, and prevention of complications of chemical poisoning). Meanwhile, **the third session** was about chemical burn in children (def, causes, signs & symptoms, complications, prevention, and prevention of complications of chemical burn). Regarding practical sessions, **the first session** was about prevention of chemical poisoning and prevention of its complications in children and **the second session** was about prevention of chemical burn and prevention of its complications in children. Numerous teaching techniques, including lectures and group discussions,

through the Facebook phone app, were used. To support mothers fully realizing, various illustrated images and videos were utilized.

Evaluation phase:

To evaluate mothers' knowledge, practices and attitude post smart phone app based preventive program, a posttest was conducted through Facebook phone app and mothers were asked to fulfill it after program implementation using the same pretest data collection tools. This phase took around two weeks.

Statistical analysis:

The study data was arranged, classified, and evaluated after it had been collected. Frequencies, percentage, mean scores, standard deviation, paired t test, Cronbach alpha, chi-square test and correlation test were used for statistical purposes. Tables and figures were formed by using SPSS version 26 to present data. A statistically significant difference was considered if $P < .05$. A highly statistically significant difference was considered if $p \leq 0.01$.

Results:

Table (1): Distribution of the studied mothers regarding their demographic characteristics (n=90)

Demographic characteristics of mothers		No.	%
Age / years			
18-		33	36.7
25-		43	47.7
35-		14	15.6
$\bar{x} \pm S.D$ 30.38±5.408			
Educational level			
Secondary education		49	54.5
University education		39	43.3
Postgraduate studies		2	2.2
Occupation			
Housewife		68	75.6
Working		22	24.4
Residence			
Urban		39	43.3
Rural		51	56.7
Children numbers			
1-		15	16.7
2-		40	44.4
3+		35	38.9

Table (2): Distribution of studied children according to their personal characteristics (n=90).

Personal characteristics	No.	%
Age / years		
>1	5	5.6
1->3	59	65.6
3-5	26	28.9
$\bar{x} \pm S.D$ 2.0344±1.1892		
Gender		
Female	31	34.4
Male	59	65.6
Child ranking		
1 st	15	16.7
2 nd	39	43.3
3 rd	17	18.9
4 th	18	20.0
Previous chemical injury		
Yes	24	26.7
No	66	73.3
* Type of chemical substance (n=24)		
Household cleaning agents	17	70.8
Inhalation of chemicals	4	16.7
Medications	9	37.5

*More than one answer

Table (3): Mean scores of mothers' knowledge about chemical substance injuries and their prevention pre and post smart phone app based preventive program (n=90)

Knowledge Dimensions	Max score	Pre-program	Post-program	t-test	P-value
		Mean +SD	Mean +SD		
Chemical substance injuries	10	4.1000±3.47074	8.7000±2.58105	15.499	.000**
Chemical poisoning	8	2.8333±2.96515	6.9889±2.09061	14.523	.000**
Prevention of chemical poisoning	2	.7222±.80766	1.8222±.46393	13.385	.000**
Prevention of chemical poisoning complications	10	3.7889±3.74614	8.7111±2.53180	14.365	.000**
Chemical burn	8	3.2111±3.03350	7.2556±1.86969	13.683	.000**
Prevention of chemical burn	2	.7889±.67864	1.7556±.48136	16.681	.000**
Prevention of chemical burn complications	2	.7667±.77966	1.8111±.44707	13.809	.000**

(**) highly statistically significant at (p<0.001)

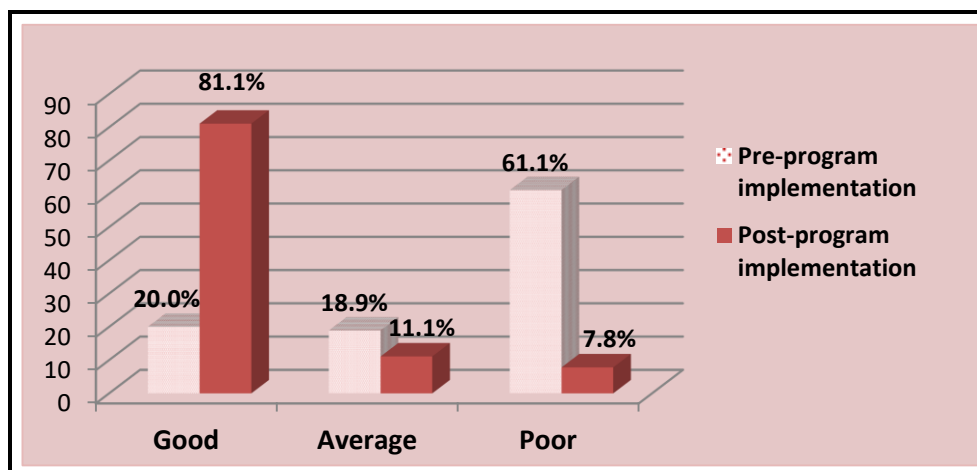


Figure (1): Distribution of studied mothers according to their total level of knowledge about chemical substance injuries and their prevention pre and post smart phone app based preventive program (n= 90)

Table (4): Mean scores of mothers' practices regarding prevention of chemical substance injuries and prevention of their complications pre and post smart phone app based preventive program (n=90)

Practice dimensions	Max score	Preprogram	Post program	t-test	p-value
		Mean +SD	Mean +SD		
Prevention of chemical poisoning	7	1.1889±2.28279	6.1111±2.0248	17.435	.000**
First aid of chemical poisoning:					
Ingestion of household detergent	4	.3444±1.0074	3.2111±1.5469	16.086	.000**
Ingestion of medications	4	.4000±.88432	3.4889±1.07311	23.768	.000**
Inhalation of chemicals	4	.6333±1.4177	3.3889±1.3298	15.103	.000**
Contact chemicals with the eyes	3	.5222±1.0410	2.6111±.89561	16.316	.000**
Prevention of chemical burn	7	1.0444±2.04396	5.9778±1.9486	19.407	.000**
First aid of chemical burn	12	1.4556±3.28483	9.9778±4.0668	17.487	.000**

(**) highly statistically significant at (p<0.001)

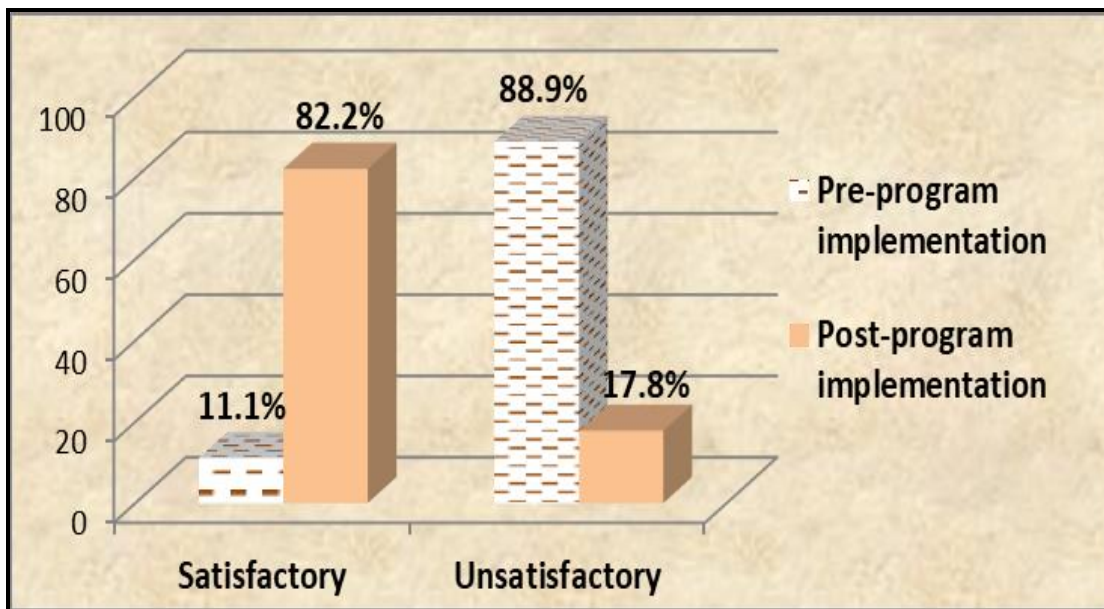


Figure (2): Distribution of studied mothers regarding their total level of practices regarding prevention of chemical substance injuries and their complications pre and post smart phone app based preventive program (n= 90)

Table (5): Mean scores of mothers' attitude towards chemical substance injuries, their prevention and smartphone app program pre and post smart phone app based preventive program (n=90).

Attitude dimensions	Max score	Pre-program	Post-program	t-test	p-value
		Mean +SD	Mean +SD		
Chemical substance injuries	14	4.344± 5.099	10.322 ± 4.998	11.742	.000**
First aid for prevention of chemical substance injuries complications	8	4.100 ± 4.401	10.655 ± 2.972	13.805	.000**
Smartphone app based preventive program for chemical substance injuries	14	5.222±4.796	12.588± 3.524	13.996	.000**

(**) highly statistically significant at (p<0.001)

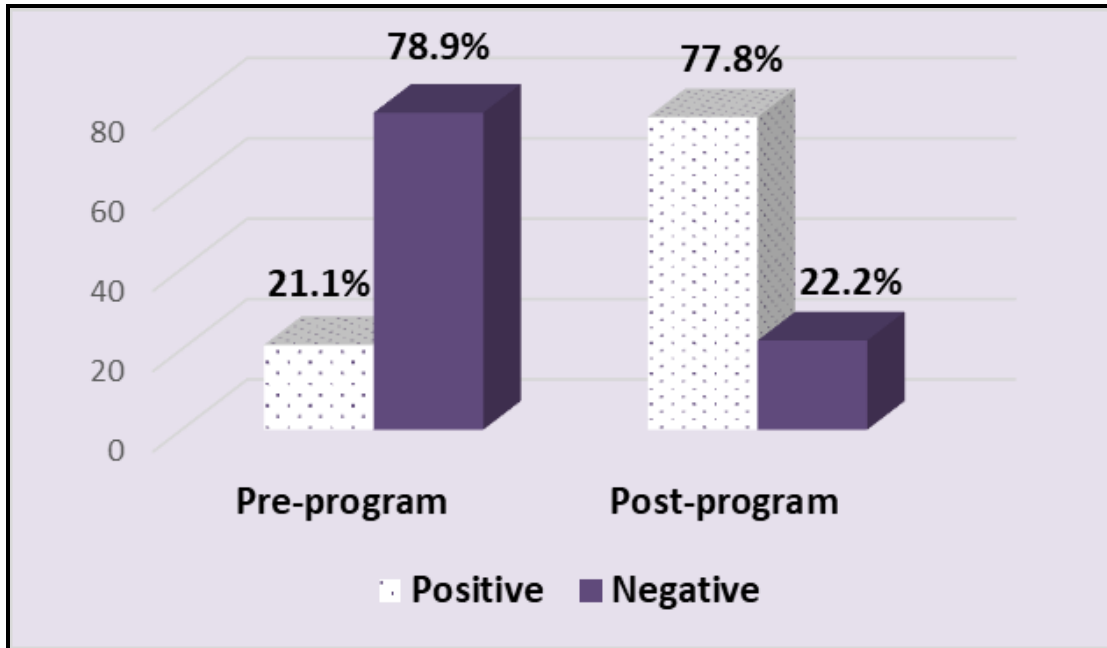


Figure (3): Distribution of the studied mothers regarding their total level of attitude about chemical substance injuries and their prevention pre and post implementation of smart phone app based preventive program (n= 90)

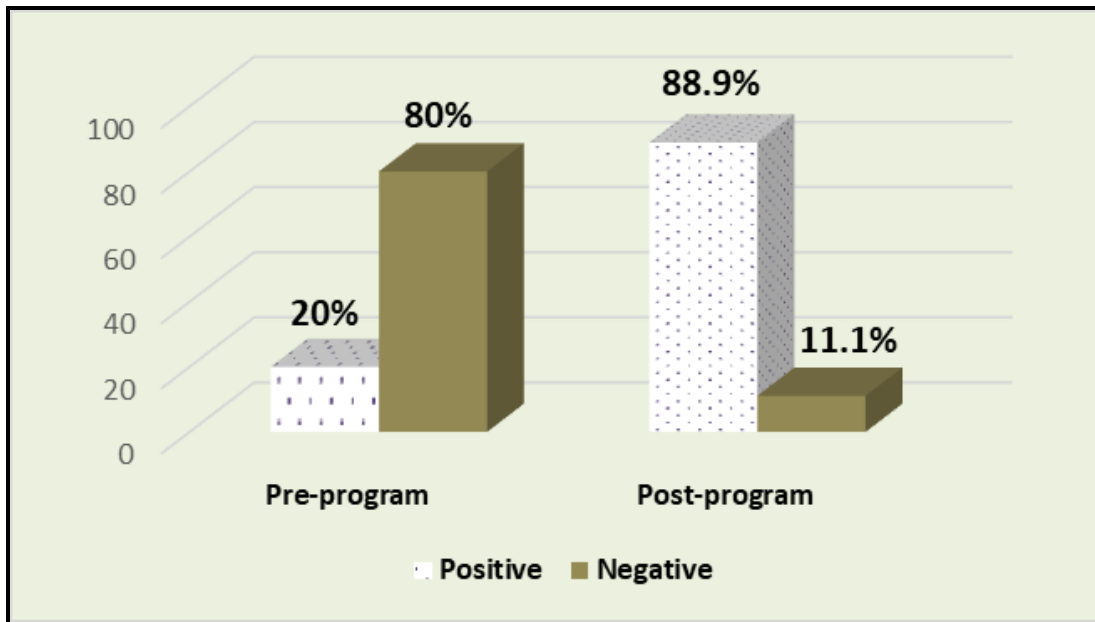


Figure (4): Distribution of the studied mothers regarding their total level of attitude about smartphone app program pre and post implementation of smart phone app based preventive program (n= 90)

Table (6): Correlation between mothers' knowledge, practices and attitudes towards chemical substances injuries and prevention of their complications (n=90)

Phases	Total		knowledge	Practices	Attitude
Pre-program	Knowledge	r	1	.769	.932
		P	--	.000**	.000**
	Practices	r	.769	1	.801
		P	.000**	----	.000**
	Attitude	r	.932	.801	1
		P	.000**	.000**	----
Post-program	Knowledge	r	1	.975	.972
		P	----	.000**	.000**
	Practices	r	.975	1	.962
		P	.000**	----	.000**
	Attitude	r	.972	.962	1
		P	.000**	.000**	----

(**) highly statistically significant ($p < 0.001$)

Table (1): Shows that 47.7% of studied mothers' age was 25 years old and more with mean 30.38 ± 5.408 years, 54.5% of them had secondary education, 75.6% of them were housewives, 56.7% of them lived in rural areas, and 44.4% of them had two children.

Table (2): Clarifies that, 65.6% of children' age was from 1-3 years old with mean age was 2.0344 ± 1.1892 years, 65.6% of them were male, 43.3% of them were the 2nd child. 26.7% of them previously exposed to chemical injuries and 70.8% of them exposed to household cleaning agents.

Table (3): Shows that mothers had higher levels of knowledge post smart phone app based preventive program than pre. Therefore, there was a highly statistical significant difference between mothers' knowledge regarding chemical substance injuries and their prevention pre and post implementation of smart phone app based preventive program.

Figure (1): Illustrates that 20.0% of studied mothers had good level of knowledge pre implementation of smart phone app based preventive program which increased to 81.1% post implementation of smart phone app based preventive program.

Table (4): Reveals that mothers had higher levels of practices post smart phone app based preventive program than pre. Therefore, there was a highly statistically significant difference in mothers' practices regarding prevention of chemical substance injuries and prevention of their complications pre and post implementation of smart phone app based preventive program.

Figure (2): Illustrates that 11.1% of the studied mothers had satisfactory practices pre implementation of smart phone app based preventive program regarding prevention of chemical substance injuries and prevention of their complications which increased to 82.2% post implementation of smart phone app based preventive program.

Table (5): Demonstrates that there was highly statistically significant difference in mothers' attitude regarding chemical substance injuries, its prevention and smartphone app-based preventive program at pre and post smart phone app based preventive program implementation.

Figure (3): Illustrates that 21.1% of studied mothers had positive attitude regarding chemical substance injuries and their prevention pre implementation of smart phone app based preventive program which increased to 77.8% post implementation of smart phone app based preventive program.

Figure (4): Shows that 20.0% of studied mothers had positive attitude regarding smartphone app-based program on pre implementation of smart phone app based preventive program compared to 88.9% post implementation of smart phone app based preventive program.

Table (6): Reveals that there were highly statistical significant positive correlations between mothers' knowledge, practices and attitude regarding chemical substances injuries and prevention of their complications pre and post implementation of smart phone app preventive program.

Discussion:

Prevention chemical injuries in children requires a multidisciplinary strategy to reduce knowledge gap and modify mothers' attitudes and behaviors. One of these strategies is using smartphone applications for mothers' education, which are widely used, interesting, and accessible at anytime and anywhere. So that, mothers can easily acquire knowledge and practices about protecting their children from chemical injuries (Behboudi et al., 2021). So, this study is essential for mothers to prevent chemical home injuries among children and learn the actions to take immediately.

The results of the present study showed that more than two thirds of studied children were exposed to household cleaning agents. This finding agreed with **Nwachukwu et al. (2019)**, who studied "risk of unintentional ingestion of harmful chemicals among under-five children in Calabar South Local Government Area of Cross River State, Nigeria, (n=120)" and reported that household cleaning agent (liquid bleach, disinfectant, liquid soap, and detergent) were the most typical dangerous chemical substance ingested by under-five children. This might be because of studied children have strong desire to learn and investigate everything orally.

The findings of the results of current study clarified that, there was a highly statistically significant improvement in mothers' knowledge regarding chemical poisoning post smart phone app based preventive program. These findings agreed with **Yaqoob et al. (2019)**, who studied "effectiveness of an educational program among mothers on household poisoning in children in the rural community", Pakistan, (n=60), and reported that there is a statistically significant difference before and after the educational intervention regarding mothers' chemical poisoning knowledge. This might be due to mothers' interest in knowing more information to protect their children from the dangers of chemical poisoning.

The result of the present study illustrated that the mean score of knowledge of mothers regarding prevention of chemical poisoning complications was low at pre smart phone app based preventive program implementation. This finding was according to **Jaber et al. (2021)** who studied "knowledge, attitude, and practices of mothers towards home accidents among children in Holy Kerbala City", (n= 368), and reported that less than one quarter of studied mothers were aware of what to do in the event of chemical poisoning.

Regarding mothers' knowledge about chemical burns, there was a very highly statistically significant improvement of mothers' knowledge post implementation of smart phone app-based preventive program. This finding was consistent with **Amin & Abd Elmnem, (2018)**, who studied "effect of home care program for mothers having children with burn injury, Egypt (n= 60)", and reported that the home care program had a significant effect on improving mothers' knowledge regarding burn. This might be due to mothers' interest in developing their knowledge about the dangers of chemicals and first aid in cases of burns.

Moreover, mothers' knowledge regarding the prevention of chemical burn complications improved post implementation of smart phone app based preventive program. This finding agreed with **Cefinkaya & Odabasi, (2021)**, who studied "the

effect of the training on parents' knowledge level regarding first aid in pediatric burns, Turkey (n=88)", and found that mothers' knowledge scores about first aid to prevent chemical burn complications increased significantly after training. This might be due to the acquired knowledge and information of mothers about prevention of chemical burn complications following the application of the smartphone app based preventive program.

Meanwhile, the result of the current study reflected that knowledge of mothers related to chemical injuries and their prevention improved post implementation of smart phone app based preventive program. This finding was like **Amini et al. (2020)**, who studied "effect of education on preventive home accident practices by mothers with toddlers: using the theory of planned behavior, Iran, (n=58)", and reported that mean score of mothers' knowledge increased after intervention.

Concerning total knowledge, the results of present research demonstrated that one fifth of studied mothers had good knowledge pre smart phone app based preventive program implementation while, majority of them had higher level of knowledge post implementation of smart phone app based preventive program. This finding was supported by **Meena, (2016)**, who studied "the effectiveness of video assisted teaching on knowledge regarding prevention of home accidents among the mothers of under five children selected hospital at Dindigul, (n=60)", and reported that after intervention most of mothers had higher level of knowledge. This might be due to the positive impact of smartphone app-based preventive program on studied mothers' knowledge.

As regards reported practices of studied mothers about first aid of chemical poisoning, there was highly statistically significant improvement in mothers reported practices post implementation of smart phone app based preventive program. This finding agreed with **BakrMoshtohry et al. (2018)**, who studied "effect of guiding program on mothers' health awareness regarding household poisoning of their children less than six years old in Rural Areas, Egypt, (n=50)", and stated that there was a clear improvement in mothers' reported practices regarding all items of first aid for household poisoning among their children less than 6 years old. This might be due to the significant positive effect of smartphone app-based preventive program on improving practices of the studied mothers.

Besides, results of the present study revealed that there was highly statistically significant improvement of mothers' practices regarding first aid of chemical burn post smart phone app based preventive program implementation. This finding was compatible with **Aly, (2020)**, who studied "education program for new

and experienced mothers around childhood accidents safety and emergency intervention, Egypt, (n=250)" and found that there was a statistically significant difference in relation to their practices related to emergency interventions for the management of burn. This might be due to the reality that knowledge is the baseline of practices, and improvement in the level of knowledge leads to improvement in the level of practices.

Regarding total practices, results of the present study reflected that more than one tenth of studied mothers had satisfactory practices about prevention of chemical substance injuries and prevention of their complications pre implementation of smart phone app based preventive program. This percentage increased to the majority of them post implementation of smart phone app based preventive program. This finding was supported by **Moridi et al. (2021)**, who stated that performance of mothers in the intervention group increased significantly, indicating the effectiveness of the educational intervention.

Also, results of the current study illustrated that there was highly statistically significant improvement of mothers' attitudes regarding first aid for prevention of chemical substance injuries complications post implementation of smart phone app based preventive program. This finding was in the same line with **El Seifi et al. (2018)**, who reported that there was statistically difference in mothers' attitudes related to first aid following implementation of a program. This difference might be due to the poor level of knowledge of studied mothers before program which affected on their attitude.

Concerning total level of the studied mothers' attitude regarding chemical substance injuries and their prevention, the findings of the present study illustrate that less than one fifth of them had positive attitude pre implementation of smart phone app based preventive program while majority of them had positive attitude post implementation of smart phone app based preventive program. This finding in accordance with **Nour et al. (2018)** in a study " knowledge, attitude and practices of mothers towards home accident among children, Makkah, (n=368)" who mentioned that majority of studied mothers had positive attitude towards the importance of attending courses related to domestic injuries and agreed on the significance of taking the appropriate safety measures to avoid home accidents. Additionally, these findings agreed with **Jaber et al. (2021)** who showed that 99.2% of mothers agreed on the importance of taking necessary precautions to prevent home accidents.

In relation to mothers' attitude towards smartphone app preventive program, the finding of the present study reflected that one fifth of them had positive attitude on pre smart phone app based preventive

program implementation compared to post program. This result on the same line with **Matin et al. (2020)** in a study " Feasibility of a mobile health tool for mothers to identify neonatal illness in rural Uganda: acceptability study, n=20" who showed that all mothers strongly agreed that the smartphones health application were easy to use and assisted them to be aware of healthy measures.

Additionally, the present study result was in accordance with **Yong et al. (2021)** who studied "Perceptions and acceptability of a smartphone app intervention (Child Safe) in Malaysia: qualitative exploratory study, (n=27)" and stated that all parents were accepting the use of the smartphone app to prevent child injury at home.

The results of the present study showed that there were highly positive statistically significant correlations between mothers' knowledge, practices and attitude regarding chemical substances injuries and prevention of their complications pre and post implementation of smart phone app based preventive program. These findings agreed with **Mohammed et al. (2021)**, who studied "mothers' perception regarding poisoning among their preschool children, Egypt, (n=130)", and reported that there were positive statistically significant correlations between total attitude, knowledge and reported practices regarding to poisoning among studied mothers. This could be due to the increase and improvement of mothers' knowledge and its reflection on their practices and attitude.

Also, these findings were consistent with **Amin & Abd Elmmem, (2018)**, who found that there was a positive correlation between total mothers' knowledge/ practices and their attitude regarding care of children with burn injuries. As well as this finding was in the same line with **Aly, (2020)**, who confirmed that there was a positive correlation between knowledge, safety behavior and emergency intervention.

Conclusion:

Smartphone app-based preventive program improved knowledge, enhanced practices, and modified attitudes of mothers regarding chemical substance injuries among their children.

Recommendations:

- Smartphone app-based preventive program should be provided to mothers to improve their knowledge and practices regarding other home injuries.
- Educational booklets and brochures related to the prevention of chemical injuries among their children should be designed for mothers.

- Mobile health applications containing all information regarding prevention of chemical substance injuries and their first aid for children should be designed for mothers.

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