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## **Telenursing use in promoting pediatric nurses' knowledge regarding COVID-19 and delta variant pandemic: Experimental cohort study**

**Awatif Elsharkawy**

Assistant Professor of Pediatric Nursing, Faculty of Nursing, Alexandria, Egypt

**Maysa Saber**

Assistant Professor of Pediatric Nursing, Faculty of Nursing, Damanhur, Egypt

**Marwa Abouheiba**

Lecturer in Pediatric Nursing, Faculty of Nursing, Alexandria, Egypt

Email: [Marwa.gad@alexu.edu.eg](mailto:Marwa.gad@alexu.edu.eg)

**Abstract**--The COVID-19 pandemic has considerably imposed extensive effects on all sectors worldwide, especially nursing education. So, the online learning has become an accessible solution to complete either the academic or other training courses. Investigate the effect of implementing telenursing in promoting pediatric nurses' knowledge regarding covid 19 and delta variant pandemic. A quasi-experimental pretest-posttest study design was used to accomplish the study. Eighty nurses from four pediatric hospitals were involved. A digital questionnaire regarding pediatric nurses' knowledge about COVID-19 and the delta variant pandemic was developed and used to test nurses' knowledge. A pretest using the digital questionnaire was done for all nurses before conducting the online educational sessions. Three online educational sessions were conducted using the Zoom platform. Two posttests using the digital questionnaire were done immediately after finishing the three educational sessions and one month later. Most nurses failed to select the correct answer in the pretest, and only 2.5% of them got a good score. In contrast, nearly 75% of nurses choose the correct answer and get excellent scores immediately after the educational sessions. There was a statistically significant difference between the nurses' total knowledge score pre and after one month of educational sessions about COVID- 19 and Delta variant pandemic with  $P=.000$ . Telenursing was an effective modality in promoting pediatric nurses' knowledge regarding basic and specific information about COVID-19 disease and its management in addition to COVID-19 disease in neonates, delta variant as well as coronavirus vaccination among children.

**Keywords**---telenursing, pediatric nurses' knowledge, covid-19, delta variant, pandemic, experimental cohort study.

## Introduction

Telenursing involves the application of telecommunications and information technology in the delivery of nursing services when there is a significant physical distance between the patient and the nurse or between any number of nurses. Telenursing can boost nurse productivity by filling nurse shortages, reducing travel time to remote areas, and allowing patients to stay in their neighborhoods or home. As a result, telenursing education benefits both nurses and patients (Nejadshafiee et al. 2022, (DIĞIN and KIZILCIK ÖZKAN 2021), Poreddi et al. 2021, Reiersen, Solli, and Bjørk 2015).

COVID-19 is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which firstly outbreaked in November 2019. On 14<sup>th</sup> of April 2022, there had been 500,186,525 confirmed cases of COVID-19 reported to WHO, with 6,190,349 deaths. A total of 11,294,502,059 vaccine doses had been administered as of 14 April 2022 (World Health Organization 2022). The virus is a member of the Coronavirus family that are zoonotic pathogens, i.e., the viruses cause and transmits illnesses between human and several animals' species such as cattle, camels, cats, and bats. The SARS-CoV-2 virus which originated in bats is like the Middle East Respiratory Syndrome coronavirus (MERS-CoV) and the severe acute respiratory syndrome Coronavirus (SARS-CoV) (Khalid et al. 2022, Tchidjou et al. 2022, Gao, Tian, and Yang 2020, Olaimat et al. 2020)

Worldwide, fewer cases of COVID-19 have been reported in children than in adults. Data from Coronavirus Disease 19–Associated Hospitalization Surveillance Network (COVID-NET) has been evaluated to explain COVID-19–associated hospitalizations among American infants and children aged 0–4 years since March 2020. Complete clinical data were available for 2,562 of 2,637 (97%) hospitalized infants and children aged 0–4 years, including 1,200 of 1,209 (99%), 790 of 841 (94%), and 572 of 587(97%) hospitalized during the pre-Delta–, Delta– and Omicron-predominant periods, respectively. Most children had COVID-19–related symptoms recorded at admission (87%) and COVID-19 as the primary reason for admission (85%) (Marks et al. 2022).

Although delta variant has been reported to increase the severity of adults, it is currently unclear whether the delta variant causes more severe COVID19 disease in children and adolescents than previous non-delta variants. A rough analysis compared current US delta-dominated waves with previous non-delta pediatric admission rates and selected time points based on weeks of similar case numbers compared to previous non-delta waves. It suggests that children during the delta wave are at high risk of hospitalization-the delta wave, which needs to be confirmed by well-designed studies (New York State Department of Health 2022, Messages 2021, Tsang et al. 2021).

Children of any age can become ill with COVID-19. While children and adults experience similar symptoms, children generally have less severe illnesses than adults. Large number of children may be asymptomatic or only have a few

symptoms. These symptoms may appear 2 to 14 days after exposure to the virus and range from very mild to severe illness. The most common symptoms are fever, cough, and tiredness. Other symptoms can include shortness of breath, chest pain or pressure, muscle or body ache, headache, loss of taste or smell, confusion, sore throat, congestion or runny nose, diarrhea, nausea and vomiting, abdominal pain, and skin rashes. In addition to these symptoms, infants may have difficulty feeding (Canoglu, Caliskan, and Sinmez 2022, AlShareef et al. 2020, Kim et al. 2020, Swann et al. 2020).

The repercussions of the outbreak of the COVID-19 presented the healthcare sector with one of its biggest challenges in the 21<sup>st</sup> century.. COVID-19 is highly contagious and is transmitted through respiratory droplets and direct contact. While providing care for patients with COVID-19, the primary goal is to minimize the risk of infection transmission between the healthcare provider and the patients. The World Health Organization (WHO) has considered infection control necessary in patients with suspected or confirmed COVID-19. As patients with COVID-19 need regular follow-up even after treatment, distance self-care education maybe the most effective approach to COVID-19 patient care. Self-care education focusing on adherence to drug treatment, drug side effects, diet, mental counseling, observance of standards of care, health care and follow-up of disease outcomes was reported to be effective (Tahir et al. 2022, Huang et al. 2020, Purabdollah and Ghasempour 2020).

Through high-speed internet access, computers, smartphones, and tablets, information, and communications technology (ICT) is now used by experts as well as non-experts. New technology applications have also entered the healthcare field and are used in care delivery and nurses' education. The COVID-19 pandemic lockdown has compelled us to employ new and existing ICT systems in communication, education, and health care. Countries' policies are responsible for reducing and eliminating virus spread by testing and treating patients and implementing strict measures such as quarantining citizens, limiting movements or activities, locking down schools, and canceling communitywide mass gatherings, sporting events, and concerts (RN MSC PhD 2020).

Pediatric nurses engaged in telenursing practice help improve quality of care, treatment efficacy, reduce cost of healthcare, reduce the need for in-person visits, increase patient and family involvement in healthcare decisions, promote careful patient monitoring, and enhance acceptance of recommended care. Difficulties in using technology such as the computers, telephones, digital assessment tools, and telemonitoring equipment due to lack of instructions, education, lack of help, and support may be a challenge for nurses and patients (Purabdollah and Ghasempour 2020, Novita et al. 2018). The rise in COVID-19 cases in Egypt presented hospitals with a severe challenge due to the shortage of nurses and the shortage of preventive, diagnostic, and therapeutic equipment. The lack of availability of adequate bedding relative to the population, and the impossibility of hospitalizing all COVID-19 patients were especially challenging (Rizk and Siam 2021).

### **Aim of the study**

The aim of this study was to: Investigate the effect of implementing telenursing on promoting pediatric nurses' knowledge regarding COVID-19 and delta variant pandemic.

### **Research hypothesis**

Pediatric nurses exhibit high knowledge score of COVID-19 and its delta variant pandemic after receiving telenursing educational sessions.

### **Operational definition**

In the current study, the telenursing used the Zoom Cloud Meetings application to conduct online educational sessions about COVID-19 and the delta variant pandemic for pediatric nurses.

### **Materials and Method**

#### **Materials**

#### **Research Design**

A quasi-experimental pretest-posttest study design was used to conduct the study.

#### **Settings**

The study was conducted at four pediatric hospitals, in Alexandria, Egypt: two university hospitals and two Ministry of Health hospitals. The two university hospitals were Alexandria University Children's Hospital at Elshatby and Smouha University Children's Hospital. The two Ministry of Health hospitals were the Elraml Children's Hospital and the Alanfoshy Children's Hospital.

#### **Subjects**

A convenient sample of 80 pediatric nurses who were working in the previously mentioned settings and fulfilled the following criteria:

- Have a smart cell phone or personal computer or Laptop.
- Have accessibility to the internet.

#### **Tools**

Two tools were used to collect the necessary data.

- Tool I: Nurses Characteristics and Informed Consent Digital Registration Form. It was developed by researchers to get nurses' characteristics and their approval to participate in the study. It included two parts:
- Part I: Nurses' characteristics including age, gender, academic qualification, mobile phone number, e-mail, name of the hospital where the nurse is

working, name of their department, years of experience, previously received training about COVID-19, previous experience in COVID-19 isolation hospitals, and previous experience interacting with COVID-19 positive cases.

- Part II: The informed consent including the research title, aim, methodology and the agreement sentence.
- Tool II: Pediatric Nurses' Knowledge about COVID-19 and Delta Variant Pandemic Digital Questionnaire
- The questionnaire was developed by the researchers after thoroughly reviewing the relevant and recent literature (Nashwan et al. 2021) (Tsang et al. 2021) (National et al. 2021)(Amer and Mohamed 2020)(Koren et al. 2021). It was used to assess the nurses' knowledge about the COVID-19 and the Delta Variant pandemic. It included 39 questions covering four categories of knowledge as follows:
  - Basic knowledge about COVID-19 as indicated by their knowledge these 13 items: causative virus, mode of transmission, common signs and symptoms, occurrence of Cytokine storm, family clustering role in disease transmission, incubation period, results of laboratory tests, the most common CT findings, effect of school closing on number of cases, the most common symptoms in hospitalized cases, common age for developing critical type of disease, medical conditions predispose to severe illness, and the most common type of coinfection.
  - Specific knowledge about management of the COVID-19 disease in children as indicated by their knowledge about these 12 items: internationally approved drug to treat the disease, the main component of supportive care, infection control strategies in health facilities, measures related to the hygiene of the respiratory system, precautions to prevent contact and droplet infection, precautions to prevent airborne infection, administrative measures related to health care workers, environmental and engineering controls for infrastructure in health facilities, good food hygiene when preparing meals for children, daily adequate amount of water, offering whole grains items and nuts to children, and offering healthy food items for children.
  - Specific knowledge about COVID-19 in neonates as indicated by these 7 items: transplacental transmission of the disease, transmission from infected mother to neonate, neonate's stay with asymptomatic mother, Coronavirus transmission through breast milk, follow-up period of neonate born to an infected mother, safe distance between an infected mother and neonate after hospital discharge.
  - Specific knowledge about Delta Variant and vaccination in children as indicated by these 7 items: the most common age affected by Delta Variant, the main problem in dealing with the Delta Variant, percentage of the Delta variant in relation to other variants, COVID-19 vaccines suitability for protection against the Delta Variant, measures to protect against the Delta Variant, appropriate age for receiving vaccines, and the WHO approved vaccine for use in children.

## Method

- Approval from the Research Ethics Committee of the Faculty of Nursing at Alexandria University was obtained before conducting the study.
- Approvals from the responsible authorities in the settings were obtained after explaining the aim and methodology of the study.
- The tools were developed and submitted to a jury of 5 experts in the field of pediatric nursing to assess content validity, and no modifications were suggested.
- Reliability of the tool was verified using the Cronbach Alfa test and  $r = 0.9$ .
- A pilot study was carried out on 10% of the sample size (8 pediatric nurses) to assess the feasibility of the study and applicability of the tool. All questions were clear, and no modification was required.
- The researchers created a WhatsApp group and sent the link to the nursing directors of the four hospitals, then they sent it to the head nurses of different units.
- The head nurses disseminated the link to their nursing staff in each unit.
- The pediatric nurses from different units who were interested in participating in the study joined the WhatsApp group. The researchers created a digital registration form and send it to all nurses participating in the WhatsApp group.
- The participating nurses filled in their characteristics and the informed consent using Tool I.
- The researchers prepared a short movie that illustrated the steps of installing the Zoom cloud meetings> software and sent it to the WhatsApp group. This movie enabled nurses to download the software to their devices (Smartphones, Laptops, and Personal computers).
- The researchers prepared educational materials that covered the four categories of knowledge that are included in Tool II.
- The educational materials were presented to the participating nurses using PowerPoint over a Zoom call.
- A pretest was performed on all participating nurses using the digital questionnaire form (Tool II).
- The researchers scheduled a Zoom meeting for each educational session and sent it to the WhatsApp group.
- Four educational sessions were accomplished over four consecutive days using Zoom platform. Each day covered a particular knowledge aspect as follows:
  - Day one: Basic knowledge about COVID-19 (Part A in Tool II).
  - Day two: Specific knowledge about management of COVID-19 disease in children (Part B in Tool II).
  - Day three: COVID-19 in neonates (Part C in Tool II).
  - Day four: Delta Variant and vaccination in children (Part D in Tool II).
- Each educational session was scheduled for 40 minutes.
- All educational sessions were recorded and sent to the participating nurses as a Zoom link on the WhatsApp group.
- Two posttests were done for all participating nurses using the digital questionnaire form (Tool II). The first posttest was performed immediately

after finishing the last educational sessions. A second posttest was done after one month of finishing the educational sessions.

- Data collection took a period of three months started from December 2021 to February 2022.
- The nurses' knowledge was evaluated using a 2-point Likert scale in which the correct answers were scored as one and the incorrect or do-not-know answers were scored as zero.
- The total score was converted into percentage to categorize the levels of nurses' knowledge as follows:
  - Fail < 60 %
  - Fair 60 < 65 %
  - Good 65 < 75 %
  - Very good 75 < 85 %
  - Excellent ≥ 85 %
- A colored booklet containing the knowledge about pediatric COVID-19 and delta variant was created, printed, and disseminated to the nursing staff in the four hospitals.

### **Ethical considerations**

- Informed digital consent was obtained from every participant after explaining the aim of the study and their right to voluntary participation and withdrawal from the study at any time.
- Nurses' privacy and anonymity were maintained through turning their video chats off during all Zoom sessions.
- Individual participant's scores were not disclosed to protect participants' confidentiality.

### **Statistical analysis**

The raw data were coded and transformed into coding sheets. The results were revised. The data was then entered into SPSS (version 20) using a personal computer. Output drafts were checked against the revised coded data for typing and spelling mistakes. Finally, analysis and interpretation of data were conducted. The following statistical measures were used:

- Descriptive statistical measures included numbers, percentages Minimum, Maximum, Arithmetic mean and Standard deviation.
- Statistical analysis tests which included Cronbach alpha and paired t test.
- The significance of the results was made at the level of 5%.

### **Results**

The pediatric nurses' characteristics are presented in

Table 1. It was found that 92.5% of the participating nurses were females. The age of 57.5% of the participating nurses was between 20 and 30 years old. As for the years of experience, 32.5 % of the participating nurses had 5 to less than 10 years of working experience. Regarding educational qualifications, 60% of them

had a nursing diploma. As regards attendance of training program about COVID-19 and working in isolation hospitals, 56.2% did not receive online or face-to-face training about COVID-19, and 57.5% did not work in an isolation hospitals. Considering working with isolated children, 88.8% of the participating nurses did not work in isolation with children suffering from COVID-19.

Table 1  
Pediatric Nurses' Characteristics (Total number of nurses= 80)

Items	No.	%
Gender:		
- Female	74	92.5
- Male	6	7.5
Age:		
- 20 < 30	46	57.5
- 30 <40	25	31.3
- 40 years and more	9	11.3
Years of experience:		
- <5 years	21	26.3
- 5 <10 years	26	32.5
- 10<15 years	13	16.3
- 15 <20 years	11	13.8
- 20 years and more	9	11.3
Educational qualifications:		
- Nursing diploma	48	60.0
- Baccalaureate degree	27	33.8
- Master's degree	5	6.3
Receiving online or face-to-face training about COVID 12:		
- No	45	56.2
- Yes	35	43.8
Working in isolation hospital:		
- No	46	57.5
- Yes	34	42.5
Actual working with isolated children in isolation hospitals:		
- No	71	88.8
- Yes	9	11.3

Table 2 shows summary of descriptive statistics of the participants responses regarding basic and specific knowledge about COVID-19 disease in children before, immediately after, and one month after the online educational sessions. The statistics show an increase in the percentage of participants who gave the correct answers before educational sessions, immediately after, and after one month for the causative factors, common symptoms, family role in transmission, results of CT, school closing, indication symptoms for hospitalization, critical illness, and age risk of developing severe illness, a common type of coinfection. There was a fluctuation in the percentage of participants who got the correct answer which increased immediately after the educational session and slightly declined again after one month. This was observed in the information regarding

cytokine storm (Pre-educational session 15%, immediately after 87.5% and 78.8%), and incubation period (pre educational session 32.5%, immediately after 85.0%, and 76.3% after one month). There was a statistically significant difference between the participants' mean total scores regarding basic and specific information about COVID-19 in pediatric cases with  $P=0.000$ .

Table 2  
Pediatric Nurses' Feedbacks Regarding Basic and Specific Knowledge about COVID-19 Disease in Children Prior to, immediately after and One Month after the Online Educational Sessions (Total number of nurses= 80)

Items	Prior to sessions		Immediately after sessions		One month after sessions	
	No.	%	No.	%	No.	%
<b>Causative Virus:</b>						
- Correct answer (SARS-CoV 2)	37	46.3	75	93.8	76	95.0
- Incorrect answer	43	53.8	5	6.3	4	5.0
<b>Mode of transmission:</b>						
- Correct answer (Respiratory droplets and contact with respiratory secretions)	15	18.8	68	85.0	65	81.3
- Incorrect answer	65	81.3	12	15.0	15	18.8
<b>Common symptoms:</b>						
- Correct answer (Cough and fever)	48	60.0	71	88.8	80	100.0
- Incorrect answer	32	40.0	9	11.3	0	0.0
<b>Occurrence of Cytokine storm:</b>						
- Correct answer (No)	12	15.0	70	87.5	63	78.8
- Incorrect answer	68	85.0	10	12.5	17	21.3
<b>Family clustering role in disease transmission:</b>						
- Correct answer (Yes)	73	91.3	80	100.0	80	100.0
- Incorrect answer	7	8.8	0	0.0	0	0.0
<b>Incubation period:</b>						
- Correct answer (3 to 7 days)	26	32.5	68	85.0	61	76.3
- Incorrect answer	54	67.5	12	15.0	19	23.8
<b>Results of laboratory tests:</b>						
- Correct answer (Increased level of liver enzymes)	9	11.3	44	55.0	48	60.0
- Incorrect answer	71	88.8	36	45.0	32	40.0
<b>The most common CT findings:</b>						
- Correct answer (The presence of ground glass opacity)	19	23.8	66	82.5	71	88.8
- Incorrect answer	61	76.3	14	17.5	9	11.3
<b>Effect of school closing on number of cases:</b>						
- Correct answer (Yes)	62	77.5	76	95.0	77	96.3
- Incorrect answer	18	22.5	4	5.0	3	3.8
<b>The most common symptoms in hospitalized cases:</b>						
- Correct answer (Severe)	23	28.8	50	62.5	60	75.0

cough)						
– Incorrect answer	57	71.3	30	37.5	20	25.0
Common age for developing critical type of disease:						
– Correct answer (less than 1 year)	22	27.5	29	36.3	72	90.0
– Incorrect answer	58	72.5	51	63.8	8	10.0
Medical conditions predispose to severe illness:						
– Correct answer (Respiratory distress)	65	81.3	77	96.3	78	97.5
– Incorrect answer	15	18.8	3	3.8	2	2.5
The most common type of coinfection:						
– Correct answer (Influenza A & B)	27	33.8	52	65.0	66	82.5
– Incorrect answer	53	66.3	28	35.0	14	17.5
Mean of all responses	5.5375				11.0250	
SD	1.84146				1.79292	
Mean/ SD (Mean of total pre score – total post score)			-5.48750- 2.51070			
T-test			-19.549- P=.000*			

T test = Paired t- test, SD: Standard deviation , \*Statistically significant at  $p \leq 0.05$

Table 3 presents a comparison of the participants' responses regarding specific information about the management of COVID-19 in pediatric cases. In general, there was an increase in the percentage of nurses who chose the correct answer to COVID-19 knowledge questions immediately after and after one month of the educational sessions. The increased scores were in the following items: internationally approved drug, supportive care, infection control strategies, respiratory system hygiene, contact, and droplet infection prevention, precaution to prevent airborne infection, environmental and engineering measures, good food hygiene, amount of water intake, and healthy food during corona pandemic. There was a slight variation between their scores immediately after the educational sessions and after one month later in other items. This was observed in the items regarding administrative measures (Score immediately after sessions was 95% and a one month later was 92.5%), adequate amount of water intake (Score immediately after sessions was 87.5% and a one month later was 86.3 %) and offering whole grains and nuts (Score immediately after sessions was 97.5% and a one month later was 96.3 %). There was a statistically significant difference

between the nurses' mean total scores regarding specific information about management of COVID-19 in pediatric age with  $P = .000$ .

Table 3  
Pediatric Nurses' Feedbacks Regarding Specific Knowledge about Management of COVID-19 Disease in Children Prior to, immediately after and One Month after the Online Educational Sessions (Total number of nurses= 80)

Items	Prior to sessions		Immediately after sessions		One month after sessions	
	No	%	No	%	No	%
<b>Internationally approved drug to treat the disease:</b>						
- Correct answer (Remdesivir)	43	53.8	71	88.8	76	95.0
- Incorrect answer	37	46.2	9	11.3	4	5.0
<b>The main component of supportive care:</b>						
- Correct answer (Complete bed rest)	70	87.5	56	70.0	64	80.0
- Incorrect answer	10	12.5	24	30.0	16	20.0
<b>Infection control strategies in health facilities:</b>						
- Correct answer (Ensure screening, early identification, and control of the source of infection)	51	63.8	74	92.5	80	100.0
- Incorrect answer	29	36.3	6	7.5	0	0.0
<b>Measures related to the hygiene of the respiratory system:</b>						
- Correct answer (Ensure that all patients cover their mouth and nose when coughing and sneezing)	21	26.3	50	62.5	68	85.0
- Incorrect answer	59	73.8	30	37.5	12	15.0
<b>Precautions to prevent contact and droplet infection:</b>						
- Correct answer (Moving patients outside their rooms or premises should be avoided if this is not necessary)	13	16.3	46	57.5	70	87.5
- Incorrect answer	67	83.8	34	42.5	10	12.5
<b>Precautions to prevent airborne infection:</b>						
- Correct answer (Wear long-sleeved gowns and clean, non-sterile gloves)	10	12.5	48	60.0	91.3	91.2
- Incorrect answer	70	87.5	32	40.0	7	8.8
<b>Administrative measures related to health care workers:</b>						
- Correct answer (Provide appropriate training for healthcare workers)	63	78.8	76	95.0	74	92.5
- Incorrect answer	17	21.3	4	5.0	6	7.5
<b>Environmental and engineering controls for infrastructure in health facilities:</b>						

- Correct answer (Ensure proper ventilation inside the rooms and halls of the building)	53	66.3	66	82.5	74	92.5
- Incorrect answer	27	33.8	14	17.5	6	7.5
Good food hygiene when preparing meals for children:						
- Correct answer (Separate raw foods from cooked ones.)	61	76.3	70	87.5	74	92.5
- Incorrect answer	19	23.8	10	12.5	6	7.5
Daily adequate amount of water:						
- Correct answer (6-7 cups)	45	56.3	70	87.5	69	86.3
- Incorrect answer	35	43.8	10	12.5	11	13.8
Offering whole grains items and nuts to children:						
- Correct answer (Oat bread, cereal and olive oil)	66	82.5	78	97.5	77	96.3
- Incorrect answer	14	17.5	2	2.5	3	3.8
Offering healthy food items for children:						
- Correct answer (Eat plenty of fruits and vegetables)	71	88.8	76	95.0	77	96.3
- Incorrect answer	9	11.3	4	5.0	3	3.8
Mean	6.4875				10.9500	
SD	1.68383				1.14627	
Mean/ SD (mean of total pre score – total post score)			-4.46250-		2.09848	
Test of significance T-test			-19.020-		P= .000*	

T test = Paired t- test , SD: Standard deviation, \*Statistically significant at  $p \leq 0.05$

Table 4 compares nurses' feedback regarding basic information about newborns and COVID-19, Delta Variant, and vaccination in the pediatric population. As for neonatal COVID-19 knowledge, there was an increase in the percentage of nurses who responded with the correct answers one month after the educational sessions. This increase was observed in the knowledge items of transplacental transmission, newborn stays with an asymptomatic mother, breast milk transmission of coronavirus, and follow up of a neonate born to an infected mother with the following percentages 92.5%, 95.0%, 100%, and 100% respectively. There was a statistically significant difference between the nurses' mean scores prior to and one month after the educational sessions with  $P=.000$ . As regards nurses' knowledge about Delta Variant and pediatric vaccination, there was an increase in the percentage of nurses who responded with the correct answers one month after the educational sessions. This increase was observed in the knowledge items regarding the most common age affected with Delta Variant, the main problem in dealing with the Delta Variant, proportion of Delta in relation to other variants, and COVID-19 vaccines suitability for protection against the Delta Variant with the following percentages 100%, 100%, 95.0%, and 97.5% respectively. There was a statistically significant difference between the nurses' mean scores prior to and one month after the educational sessions with  $P=.000$ .

Table 4  
 Pediatric Nurses' Feedbacks Regarding Basic Knowledge about COVID-19 in neonates Delta Variant and Vaccination in Children Prior to, immediately after and One Month after the Online Educational Sessions (Total number of nurses= 80)

Items	Prior to sessions		Immediately after sessions		One month after sessions	
	No	%	No	%	No	%
Transplacental transmission of the disease:						
- Correct answer (No)	49	61.3	66	82.5	74	92.5
- Incorrect answer	31	38.8	14	17.5	6	7.5
Transmission from infected mother to neonate:						
- Correct answer (Yes)	62	77.5	66	82.5	68	85.0
- Incorrect answer	18	22.5	14	17.5	12	15.0
Neonate's stay with asymptomatic mother:						
- Correct answer (Yes)	34	42.5	76	95.0	76	95.0
- Incorrect answer	46	57.5	4	5.0	4	5.0
Coronavirus transmission through breast milk:						
- Correct answer (No)	65	81.2	78	97.5	80	100
- Incorrect answer	15	18.8	2	2.5	0	0.0
Follow-up period of neonate born to an infected mother:						
- Correct answer (Fourteen days)	58	72.5	64	80.0	80	100
- Incorrect answer	22	27.5	16	20.0	0	0.0
Safe distance between an infected mother and neonate after hospital discharge:						
- Correct answer (Two meters)	41	51.3	42	52.5	80	100
- Incorrect answer	39	48.8	38	47.5	0	0.0
Mean of all items about neonatal COVID-19	4.3375				5.6875	
SD	1.31152				.60783	
Mean/ SD (Mean of total pre score – total post score)					-1.35000- 1.43289	
T-test					-8.427- P=.000*	
The most common age affected with Delta Variant:						
- Correct answer (Below 18 Years of Age)	23	28.8	56	70.0	80	100
- Incorrect answer	57	71.3	24	30.0	0	0.0
The main problem in dealing with the Delta Variant:						
- Correct answer (Spread rapidly and causing severe symptoms)	29	36.3	66	82.5	80	100
- Incorrect answer	51	63.8	14	17.5	0	0.0
Proportion of Delta in relation to other variants:						
- Correct answer (twice the other variant)	47	58.8	44	55.0	76	95.0
- Incorrect answer	33	41.3	36	45.0	4	5.0

COVID-19 vaccines suitability for protection against the Delta Variant:						
- Correct answer (provide protection against severe acute respiratory distress)	40	50.0	62	77.5	78	97.5
- Incorrect answer	40	50.0	18	22.5	2	2.5
Measures to protect against Delta Variant:						
- Correct answer (good ventilation and social distance)	72	90.0	78	97.5	78	97.5
- Incorrect answer	8	10.0	2	2.5	2	2.5
Appropriate age for receiving vaccines:						
- Correct answer (12 years)	40	50.0	67	83.8	76	95.0
- Incorrect answer	40	50.0	13	16.3	4	5.0
WHO approved vaccine for use in children:						
- Correct answer (Pfizer)	58	72.5	74	92.5	77	96.3
- Incorrect answer	22	27.5	6	7.5	3	3.8
Mean of all items about Delta Variant	3.8750				6.8500	
SD	1.32527				.35932	
Mean/ SD (mean of total pre score – total post score)			-2.97500- 1.41399			
T-test			-18.819- P=.000*			

T test = Paired t- test , SD: Standard deviation, \*Statistically significant at  $p \leq 0.05$

A comparison of nurses' total knowledge scores pre and after one month of educational sessions about Delta variant and COVID-19 is illustrated in Table 5. There was a significant decline in the percent of failed nurses prior to and one month after the educational sessions as 73% failed prior to sessions compared to only 1.3% one month later. There was a significant increase in the percent of nurses who got excellent scores prior to and one month after the educational sessions as no one scored as excellent prior to sessions compared to 73.1% one month later. There was a statistically significant difference between the nurses' total knowledge score prior to and after one month of educational sessions with  $P=.000$ .

Table 5  
Pediatric Nurses' Total Knowledge Score about COVID-19 disease and Delta Variant Infection in Children Prior to and One Month after the Online Educational Sessions (Total number of nurses= 80)

Items	Prior to educational sessions		One month after sessions	
	No.	%	No.	%
Total nurses' knowledge score:				
- Fail (< 60 %)	73	91.3	1	1.3
- Fair (60 < 65 %)	5	6.3	0	0.0

- Good (65 < 75 %)	2	2.5	4	5.0
- Very good (75 < 85 %)	0	0.0	18	22.5
- Excellent ( $\geq$ 85 %)	0	0.0	57	71.3
Mean of all nurses' scores	20.0625		35.4750	
SD	4.03887		2.83725	
Mean/ SD (mean of total pre score – total post score)	-15.41250- 5.24512			
T-test	-26.282- P=.000*			

T test = Paired t- test, SD: Standard deviation, \*Statistically significant at  $p \leq 0.05$

### Discussion

Tele-nursing aims to improve the quality of care, patient safety, and quick access to nursing care by overcoming geographical barriers. The use of telephones, mobile phones, short message services (SMS), and communication technologies are parts of telenursing. It is used for both patient and nursing staff education. The COVID-19 pandemic continues to considerably impose extensive effects on all sectors worldwide, especially nursing education. So, the online learning has become an accessible solution to complete either the academic or other training courses (Agu et al., 2021, Al Thobaity & Alshammari, 2020, Mudiyansele et al., 2020, Purabdollah & Ghasempour, 2020, RN MSC Ph.D., 2020).

Telenursing has become a required strategy in providing knowledge for patients and nursing staff remotely (DIĞIN and KIZILCIK ÖZKAN 2021). In the current study, it was found that the total knowledge score of nurses was significantly different before and after one month of the online educational sessions. The failure rate on the digital pretest exam was 91.3%, while after one month of the educational sessions this ratio changed to 1.3% with a statistically significant difference and  $P=.000$  (Table V). This high success rate might be attributed to the dissemination of the recorded materials links, which enabled nurses to revise their knowledge frequently. Similarly, Hamadneh 2021 had same conclusions. The data of her study was both qualitative and quantitative in nature. Her main conclusion was that providing an online health education program on postnatal care and infant care safe sleep infant care to medical staff in remote areas enhances their ability to share up-to-date information with parents with  $P < 0.05$  (Hamadneh 2021). Tabudlo et al., 2021 also had same conclusions. On their study they found that despite the limitations posed by the COVID-19 pandemic, telenursing offers a viable, cost-effective, and patient-centered approach in health services delivery. It had significant implications in nursing practice, education, and research (Tabudlo, Garma, and Macalintal 2021).

Nurses' basic characteristics have a significant impact in relating and correlating variables of any study findings (Chan et al. 2021). As for the current study, more than half of the nurses who participated in the study neither received any online or face-to-face training about COVID-19 nor worked in Coronavirus isolation hospitals. Furthermore, 80% of them did not work with isolated children suffering from COVID-19 (Table I). The shortage of nursing staff and the extended working

hours because of the pandemic might be the underlying cause of the inadequate attendance of COVID-19 training programs. As most isolation hospitals are set up for adult cases, and most of the COVID cases are adults, this may be the cause that nurses did not work in isolation hospitals or with isolated children. Góes et al. 2020 reached one similar and one different conclusion: about 40% of the nurses who participated in their study did not receive any training about COVID-19. On the contrary, all study participants worked in isolation hospitals with isolated children (Góes et al. 2020).

Pediatric nurses must be acquainted with basic knowledge about COVID-19 before dealing with suspected or infected cases (Nashwan et al. 2021). In the present study, pediatric nurses received low scores regarding most of the basic knowledge about COVID-19 before the educational sessions. Their scores increased after the online educational sessions in both the immediate and one month later digital assessment with a significant statistical difference and  $P=.000$  (Table II). Their high-scored knowledge retention may be explained by the availability of the audiovisual recorded materials that were sent to them as a Zoom link immediately after each educational session. Similarly, Sondakh et al. 2022 mentioned that many of their subjects did not have enough knowledge about COVID-19 in the primary assessment of participants' information (Sondakh et al. 2022). On the other hand, Rizk & Siam 2021 found different results. On their study about the effect applying a telenursing program on nurses' compliance to standard precautions during the pandemic, they found that 97.2% of the nurses had enough knowledge about coronavirus (Rizk and Siam 2021).

Specific information about COVID-19 is essential for nursing staff to provide the needed care for the affected children meticulously and precisely (Rasheed 2022). According to the current study results, it was noticeable that the studied nurses had low scores regarding the infection prevention measures as a piece of mandatory information about COVID-19 before the educational sessions. Low scores were observed in the items about respiratory hygiene, precautions to prevent contact and droplet infections, and airborne infections with the following percentage 26.3%, 16.3%, and 12.5 %, respectively. But after the educational sessions, there was an obvious increase in the scores regarding the previously mentioned items with a statistically significant difference ( $P=.000$ ) (Table III). The low pre-educational scores regarding the infection control measures might be explained by the novelty of the coronavirus and the high turnover rates of available information, which is continuously updated based on research findings. The findings of the current study were supported by Jafree et al., 2022 who showed that using a distant educational platform was an effective tool in increasing nurses' knowledge about infection prevention and control during the COVID-19 pandemic, with a statistically significant difference before and after the educational sessions in the intervention group with  $p = 0.050$  (Jafree et al. 2022). Similarly, Kim et al., 2021 found that senior nursing students' knowledge was significantly improved after the conducted online educational sessions with  $p < 0.001$  (Kim, Kim, and Lee 2021).

Knowledge of neonatal COVID-19 is controversial. The same is for the Delta-Variant infection in the pediatric population and the internationally approved vaccine for the pediatric age (Marks et al. 2022). As regards the present study,

there was a significant increase in nurses' knowledge before and after the educational sessions. This was reflected in the items that are related to the transplacental transmission of coronavirus, the feasibility of breastfeeding either for suspicious or infected mothers, in addition to the precautionary measures about Delta-Variant and the internationally approved vaccine for pediatric population with a statistically significant difference and  $P=.000$  (Table IV). The pre-educational sessions' deficient knowledge about neonatal COVID-19 could be justified by the low rate of affection and the small number of cases during the neonatal period. Anwar Abd ElAziz et al., 2021 almost have the same results, which revealed that statistically significant differences were found between nurses' knowledge categories before and after the application of the educational program with  $p<0.05$  (Anwar Abd ElAziz, Eldien Abd Elhafez, and Youssef Sayed 2021).

### **Conclusion**

Based on the findings of the present study, it can be concluded that telenursing was an effective modality in promoting pediatric nurses' knowledge regarding basic and specific information about COVID-19 disease and its management in addition to COVID-19 disease in neonates, delta variant as well as coronavirus vaccination among children.

### **Recommendations**

Based on the findings of the current study, the following recommendations are suggested:

- Telenursing educational programs should be conducted for the continuous education of the health care providers.
- Intrahospital educational committees should establish hotline telephone numbers to answer nurses' inquiries regarding COVID-19 disease and its prompt management.
- Nursing authority figures should supply the different nursing WhatsApp groups with updated knowledge about the COVID-19 pandemic.

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