Effect of Nutritional Intervention Program for Mothers on Health Parameters of Infant with Phenylketonuria

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Abstract

Background: **Phenylketonuria** is a rare inborn inherited disorder of metabolism disease due to an autosomal recessive trait. The prevalence in Egypt is one case per 7,500. When PKU untreated or delayed treatment, can lead to severe mental retardation, seizures and tremors, impaired growth and development. The present study was aimed to evaluate the effect of implementing nutritional intervention program for mothers on health parameters of their infants with phenylketonuria. **Research design**: A quasi-experimental research design was used. **Setting**: The study was conducted at pediatric outpatient clinic inherited and metabolic diseases of Tanta University Hospital. **Subjects:** A convenience sampling of 50 mothers having infants with PKU who attended the previously mentioned setting. **Two tools** were used to collect the required data: **Constructed interview questionnaire sheet**: to assess mothers' knowledge towards their infants suffering from Phenylketonuria. It consisted of **three parts**: Socio-demographic characteristics of mothers, infants, and mothers' knowledge regarding phenylketonuria, **mothers' practices sheet**: to assess mothers' practices regarding to infants' feeding. **Observational chick list** to assess outcomes of infants. **Result**: revealed that there were highly statistically significant differences between the pre-test and post-test of nutritional intervention program implementation for infants with Phenylketonuria. **Conclusion:** the present study was revealed that a significant improvement of mothers' knowledge and practice regarding phenylketonuria immediate and after one-month of program implementation, nutritional intervention program was effective on their infants' development and health parameters as increase weight . **Recommendations**: In-service training program should be conducted periodically and regularly in health care services for mothers with infants had phenylketonuria.

Key words: Health parameters-Infant- Mothers- Nutritional intervention program-Phenylketonuria.

Introduction

Phenylketonuria (PKU) is a rare inborn inherited disorder of metabolism disease due to an autosomal recessive trait in which an infant born without the ability to properly breakdown of an amino acid called phenylalanine mutation affects both males and females.[1] Babies with PKU are missing an enzyme called phenylalanine hydroxylase, which leads to an increase in its level and is harmful to the central nervous system, causing irreversible brain damage if untreated, intellectual disability, and in severe cases, it may lead to death.[2,3]

Most common clinical manifestations of PKU do not appear after birth but may be delayed by age three to six months in the form of small head size (microcephaly), stunted or slow growth, vomiting, lighter skin, hair, and eyes, delayed mental and social skills, hyperactivity-jerking movements of arms or legs, seizures, skin rash, a musty odor in urine, breath or skin that result from the excess level of phenylalanine in the body.(4)

Management of infants with PKU depends upon early diagnosis with a simple blood test in the New born Screening program, which is included in the hypothyroidism program from three to the end of seven days from birth by measuring phenylalanine (phe) level in blood spots in a filter paper.(5) Cornerstone of PKU management is low in phe, practically when infant is growing, diet must be strictly followed and outcome is expected to be improved.(6)

Nutritional interventions for infant are very important to prevent delayed growth and health problems. The major aim of the nutritional interventions is to strengthen using of guidelines, starting with nutritional assessment including; anthropometric measurements, laboratory investigations, feeding patterns, amount of infant formula, and variety of complementary foods provided. Each infant is unique in detecting nutrient requirements such as the amount of food ingested and stored, growth rates, and physical activity levels.(7,8)

Pediatric nurse is a key provider of services internationally nurses play an integral role in caring for infants with PKU in improving health outcomes of them to maintain good health status. The general principles of nursing care for these affected infants included; clinical nursing practices in the good assessment of nutritional status, early management, mother education, and follow-up.(9)

Pediatric nurse plays a crucial role in applying the recent guidelines and talent for applying the general principles of management in medical health care. In addition to maintaining safe nurses must be aware of recent nutritional intervention guidelines for infants with special nutritional disorders as phenylketonuria to make appropriate nursing decisions making.(10)

Significance of the study

The Prevalence of PKU varies worldwide. It is estimated that approximately 350 cases per million live birth about four cases per 100,000 individuals in the USA.(11) while in Egypt incidence rate was one case per 7,500 live birth.(12)The high incidence was recorded in Turkey which is one case in 2600 live births.(13)

Infants and young children are the future of the country, the healthy growth and development of them is the paramount importance for them to develop full physically and mental potentials development. Growth is the best global indicator of physical well-being and is one of a number of international goal like the World Health Organization assembly global target for 2025.(14) When pku untreated or delayed treatment, can lead to severe mental retardation or reduced IQ, seizures and tremors, difficulties in psychological and behavioral issues, social difficulties, impaired growth and development. (2,3)

Aim of the study

The study was aimed to evaluate the effect of implementing nutritional intervention program for mothers on health parameters of their infants with phenylketonuria.

Research Hypothesis

Implementing nutritional intervention program for mothers of their infants with phenylketonuria is expected to improve mothers' knowledge and practice about phenylketonuria and improve infants' physical growth as increase weight

Subjects and method

Research design: a quasi-experimental research design was used in the present study

Setting: The research was done at Pediatric outpatient clinic Inherited and metabolic diseases of Tanta University Hospital which is affiliated to Ministry of Higher Education and Scientific Research.

Subjects:

- Convenience sampling of fifty mothers and their infants were collected from the previously mentioned settings. aged ranged from 4 to 12 months within a period of six months, both sexes and Free from any congenital anomalies.

Tools of collecting data:

Tool (I): Mothers **Knowledge about phenylketonuria structure interview schedule.** It was developed by the researcher after reviewing literatures[5,15]It was consisted of three parts: .**Part (1)** **M**others' socio-demographics, as age, education, residence, occupation, family size,

b- Infants characteristics as**:** age, sex , birth order, medical history about phenylketonuria, routine laboratory investigations.

Part (II):- **Mothers' knowledge about phenylketonuria** such as definition, causes, manifestations, complication, prevention, infants' feeding patterns, infants' weaning, dietary management and food exchange list for phenylketonuria.

Scoring system of mothers' knowledge

-Correct and complete answer was scored (2).

-Correct and incomplete answer was scored (1).

- Incorrect answer or didn't know was scored (0).

Total scoring system of mothers' knowledge was c as the following:

-From 65 % and more was considered high level of knowledge.

-From 50% to less than 65 % was considered moderate level of knowledge

-Less than 50% was considered low level of knowledge

Tool (I) Part(3):Mothers' Practice regarding infants' feeding

It was adapted / by the researcher to assess **mothers'** practice about phenylketonuria care for infants with It was used three times before, immediately and one month after implementation of nutritional intervention program as the following:

It was consists of (10 marks) about number of meals, snacks, infants' feeding pattern, given their infants fruits and juice, vegetables soups, sugar , jam and honey, estimate proteins in potatoes and cheeps, in rice and cereals, given meat, fish , chicken and given milk , milk products as yogurt.

Tool II: Nutritional Assessment Sheet:

It was developed and used by the researcher to assess the effect of nutritional intervention program for mothers on health parameters of their infants with phenylketonuria after two months. . It was included:

1- **Anthropometric measurements** of infants which included: weight, length, mid-arm, head, based on World Health Organization (2010) standards of growth chart according to infants' age and sex. [16]

2- Laboratory investigations were done at the clinic as; phenylalanine, tyrosine, and phe/ tyrosine ratio.

3- **Daily dietary intake**: for 24 hours recall method to estimate daily caloric intake as carbohydrate, protein, fats, vitamins, minerals per day by asking mothers about food consumed for at least 24 hours, in portion size mild obtained of three meals (breakfast, lunch, dinner and between meals

M**ethod**

The study was accomplished through the following steps:

1- **Administrative process:** An official permission for data collection was obtained from the Dean of the Faculty of Nursing, and the directors of pediatric outpatient clinic Inherited and Metabolic Diseases of Tanta University Hospital

2- **Ethical and legal considerations**: Ethical approval to conduct the study was taken from scientific research ethical committee at the Faculty of Nursing.

-Nature of the study didn't cause any harm or pain to the entire sample. - Confidentiality and privacy regarding the data collection were taken into consideration.

3- Tools Development: Two tools were used for data collection**.**

4-Content validity: Modifications were carried out accordingly; the nominal validity of the questionnaire was calculated on the basis of expert opinion and was 99.1%.

5- Reliability of tools

Test of reliability using Cranach's alpha was 0.947 that indicates high reliability of the tools used for data collection in the current study.

6- Pilot study

A pilot study was carried out on (10%) of the studied mothers and their infants to test the tool for its clarity, applicability and feasibility. Pilot study was excluded from the total sample of the study

7- Interview schedule was translated into Arabic language by the researcher (**Tool I** and **Tool II**).

8-Phases of the study

The present research was conducted at four phases of implementing educational nutritional program including assessment, planning, implementation and evaluation.

1) Assessment phase

-The researcher conducted meeting with mothers, who participated in the research in order to explain the aim of the research, collect data about mothers and their infants to assess mothers' knowledge and practice about care provided to infants with PKU before implementing nutritional intervention program (**Tool I and II**).

2) Planning phase

Based on the results of a requirements analysis and a study of relevant literature, a training curriculum for mothers was developed. which included the following:

a- Setting specific objectives of the educational program.

b-Preparation of the content of educational program.

c- Different methods and materials for nutritional intervention program were used including interactive lectures, power point presentations, pictures, books and posters

3) Implementation phase

-The researcher interviewed with the available mothers at pediatric outpatient clinic inherited and metabolic diseases and the aim of research was explained and their approval was obtained to participate in the research prior to data collection.

-The mother performance level was assessed related to care of infants with PKU (pre- interventions implementation) by using mothers structured interviewing sheet and by using observational checklist as following the first tool was

administered to all mothers at Pediatric Outpatient Clinic Inherited and Metabolic Diseases (**Tool I**).

- The second tool was used to assessing the nutritional assessment of an infants with phenylketonuria. It was developed and used by researcher to assess effect of implementing nutritional intervention program for mothers on health parameters of their infants with phenylketonuria after two months (**Tool II**).

-There are five anthropometric measurements used to asses nutritional status as weight, length, head, upper mid arm circumference, and body mass index. Each one was measured according to standard and compared with normal standard of corresponding Egyptian for age and sex .

 - Daily dietary intake to estimate caloric intake by using 24- hour recall method. It was applied by the researcher through an interview with studied mothers at the time of interview and each follow up assessment.

- All mothers on the morning sifts were observed, mothers participated.

 I**mplementation nutritional intervention program includes**

Preparation of good media for teaching as different methods of teaching were used including; interactive lectures, power point presentations, pictures, and posters were demonstrated to facilitate mothers' understanding.

- Preparation of content which was covered reasons behind implementation of sessions.

-Intervention of nutritional program was carried out for mothers through conduction of successive sessions according to actual needs assessment of studied mothers.

-Education nutritional program was conducted in six sessions, two/per week.

Time of each session was about 30-45 minutes including periods of discussion according to mothers' progress, Mothers were divided into small groups and each group has consisted of five mothers.

- **Assessment phase**
- Interview was conducted to collect baseline data about studied mothers and their infants with phenylketonuria.
- Setting objectives of intervention educational nutritional program about phenylketonuria.
- General objectives were set ; determine effect of intervention educational nutritional program on health parameters of infants with phenylketonuria .

- **Planning phase**
- Researcher planned questionnaires sheet after review of literature built on assessment of mothers' knowledge obtained from structured questionnaire sheet (Tool 1).
- A booklet was designed and included a teaching module. It contained definition, risk factors, causes clinical manifestations, diagnosis and management , complication , prevention of phenylketonuria, type of infants' feeding, food exchanges list according to color, micronutrients.

- **Implementation Phase**
- Intervention nutritional program was carried out through conduction of successive sessions according to actual needs assessment of studied mothers.
- **Sessions covered the following topics:**
First session: Focused on definition, causes, and manifestations of phenylketonuria.

Second session: Related to management of phenylketonuria and signs of an increased level of phenylalanine in blood as vomiting, skin rashes, and hyperactivity.

Third session: Focused on importance, principles of weaning. vitamins, minerals as vegetables, fruits, water, fluids and micronutrients as vitamin D, calcium, and iron should be given to their infants.

Fourth session: Focused on infants' feeding patterns such as importance and principles of breast feeding, artificial feeding by using special formula free from phenylalanine.

Fifth session: Focused on infants' feeding in weaning by using food exchange list based on the metabolic standard of food color.

Sixth session: Focused on a schedule of blood samples in a filter paper and appropriate time intake as after two hours given of free formula and follow up schedule.

4) Evaluation phase

Mothers were observed by the researcher for the care provided to infants with PKU pre-and post-program. The mothers were evaluated before, immediately and one month after implementation of nutritional intervention program to assess their knowledge and practice about care of infants with PKU by using (**Tool I and II**).

Statistical analysis:

Collected data were organized, tabulated, and statistically analysed using SPSS software version 23, SPSS Inc. Chicago, IL, USA). For quantitative data, mean and standard deviation were calculated. For qualitative data, which describes a categorical set of data by frequency, percentage of each category, comparison were done using Chi-square test (χ^2). P value of ANOVA test was calculated. Correlation between variables was evaluated using Pearson's correlation coefficient (r). Significance was adopted at $p < 0.05$.[17]

Results

Table (1) It reveals that, nearly two fifth (38%) of mothers graduated from secondary school and more than one quarter (28%) graduated from high education. Regarding their age most (70%) of mothers were age ranged from 20 to less than 30 years , with Mean ± SD (26.520 ± 5.087). Concerning mothers' occupation, it obvious that most (72%) of them housewife, it shows more than two third (68%) of them had consanguinity between two parents.

Table (2) Shows percentage distribution of infants' regarding their socio-demographic characteristics and medical history. Nearly half (48%) of infants aged from six months mean age (6.360 ± , 0.802), it notice that , more than half (56%) of them are females but only more than two fifth (44%) of them are males. In addition, two third (66%) of infants diagnosis of PKU from 15 day to less than one month of age. Concerning past family history, it notice that more than one fifth (22%) of them had past family history of PKU. Also, more than two fifth (45.4%) from had consanguinity with their brothers or sisters. Moreover, half (50%) of infants had mild, while, more than one third (38%) had moderate.

Table (3) Demonstrates percentage distribution of mothers' regarding total scores of knowledge about phenylketonuria. It shows total score of mothers' knowledge regarding phenylketonuria, (72%) of mothers had low level of knowledge before. While, it is proved that most (86% , 82%) of them had high knowledge immediate and after one month of nutritional intervention program implementation respectively. There was statistically significant difference between before, immediate and after one month of nutritional intervention

program implementation at X2 =71.660**, P<0.001*,<0001*, 0.764 respectively.

Figure(1) Illustrate the mean score of total mothers' knowledge improved from (21.50 ± 10.10) before to (57.12 ± 10.23) immediate, and (55.50 ±11.24) after one month of nutritional intervention program with significant improvement between before , immediate , and after one month of program implementation X2 =70.670*, P<0.001*,<0.001*,0.484 respectively.

Figure(2) Shows percentage distribution mothers' practices regarding to their infants' feeding. It reveals that most (78%) of mothers had poor unsatisfactory regarding total practices of their infants' feeding before .while, most (90% and 86%) of them had good satisfactory immediately and after one month respectively. There was significant improvement between before , immediate , and after one month of nutritional intervention program implementation at X^2 = 64.235, P 0.001*,0.001*,0.764 respectively.

Table (4) Explains percentage distribution of mothers' practice regarding to their infants' feeding. It obvious that, most (90%, 86%, 92%)of mothers had unsatisfactory feeding' practices regarding given meals, snacks between meals and infants' feeding pattern before respectively. While, most (86% , 70%, 86%) of them had satisfactory immediately and after one month of program implementation. Furthermore, it obvious that all (100%) of mothers had poor unsatisfactory feeding practice regarding estimate protein in potatoes before. Compared to most (90% ,80%) of them had good satisfactory immediately and after one month. There was significant improvement between before , immediate , and after one month

of nutritional intervention program implementation at P =0.001*.

Table (5) Shows percentage distribution of infants regarding to their anthropometric measurements. It notice that, half (50%) of infants had underweight (<90%) before. But two third (60%) of them had normal weight (90%-110%) immediate. While, most (80%) of them had normal weight after two months. There was statistically significant difference between before, immediate and after two months of nutritional intervention program implementation for weight according to infants' age at X^2 =15.909*, P <0.001*.Concerning, body mass index it obvious that (60%) of infants had normal 90-110%) before. But nearly two third (64%) of them had normal range (90%-110%) immediate. Also, most (80%) of them had normal range (90%- 110%) after two months. There was statistically significant difference between before, immediate and after two months of nutritional intervention program implementation for body mass index according to infants' age at X^2 =9.333* , P <0.009*.

Table (6) Shows percentage distribution of infants regarding to their laboratory investigations. It shows that, regarding phenylalanine and tyrosine ratio in a filter paper two third (66.0%) before and immediate most (88.0%) within normal after two months. Regarding tyrosine in a filter paper , it clarifies that nearly two third (64%) normally before and immediate compared to all (100%) normally after two months. There was statistically significant difference between before, immediate and after two months of program implementation at P = 0.001*.

Table (7) Shows percentage distribution of infants regarding to their feeding, food

exchange colors and micronutrients. It shows that all (100%) of infants had given free phe formula before feeding and meals before and after two months. Regarding given vegetables soups as main meals . It clear that only 20% of infants had vegetables soups before. While, all (100%) of them had vegetables soups immediate and after two months. There was statistically significant difference between before, immediate and after two months of program implementation at $X^2= 80.0^*$, P<0.001*.

Table (8) Shows percentage distribution of infants regarding to their daily dietary intake of feeding ,vitamins and minerals . It notice that most (80%) of infants had adequate DRAs of protein and fluids before and all (100%) of them immediate. And only 30% of them had adequate DRAs of vegetables and fruits before respectively. Also reported that all (100%) of infants had not given fats before (20%) of them had adequate immediate. While, most (70%) of them had adequate DRAs of fats after two months. There was statistically significant difference between before, immediate and after two months of nutritional intervention program implementation at $X^2= 138.50^*$, P <0.001*. Unfortunately, regarding to DRAs of carbohydrate. It notice that nearly two fifth (38%) before and (60%) immediate and most (80%) after two months of infants had adequate DRAs of carbohydrate. There was statistically significant difference between before, immediate and after two months of nutritional intervention program implementation at $X^2= 91.00^*$, P <0.001.

Table (9) Shows correlation between total scores of mothers' knowledge and their reported practices regarding phenylketonuria through the program phases. There was positive statically significant correlation coefficient between total score of mothers' knowledge and their reported practices regarding phenylketonuria before, immediate and after one month of nutritional intervention program implementation at P 0.041*, 0.010*, <0.001* respectively.

Table(1):Percentage distribution of mothers' regarding to their socio-demographic characteristics.

Mothers' socio-demographic characteristics (n=50)	No.	%
Age / years		
20 −< 30	35	70.0
30 −<40	11	22.0
≥ 40	4	8.0
Mean ± SD.	26.520 ± 5.087	
Educational		
Illiterates or read and write	7	14.0
Preparatory school	10	20.0
Secondary school	19	38.0
High education	14	28.0
Occupation		
Worked	14	28.0
Housewives	36	72.0
Residence		
Urban	15	30.0
Rural	35	70.0
Mean ± SD.	6.36 ± 0.802	
Consanguinity		
- Yes	34	68.0
- No	16	32.0
Number of other child with phenylketonuria		
Yes	7	14.0
No	43	86.0

Table (2): Percentage distribution of infants' regarding to their socio-demographic characteristics and medical history.

Infants' socio- demographic characteristics	(n=50)	
	No.	**%**
Age of infants / month		
5<6	6	12.0
6<7	24	48.0
7<8	116	32.0
8<9	4	8.0
Mean ± SD.	6.360 ± .802	
Sex		
Male	22	44.0
Female	28	56.0
Birth order		
First	17	34.0
Second	14	28.0
Third	17	34.0
Fourth	2	4.0
Diagnose of phenylketonuria		
First two weeks of birth	12	24.0
From15 days to less than one month of age	33	66.0
From one to three months of age	1	2.0
After three months of age	4	8.0
Consanguinity relation with infants (n=11)		
Brother or sister	5	45.4
Uncle or aunt of mother	2	18.2
Uncle or aunt	4	36.4
Type of infants' phenylketonuria		
Classical	6	12.0
Moderate	19	38.0
Mild	25	50.0

Table (3):Percentage distribution of mothers' regarding total scores of knowledge about phenylketonuria.

Total scores of mothers' knowledge about phenylketonuria	Before (n=50)		Immediately(n=50)		After one month (n=50)		X^2	p	p₁	p₂	p₃
	No.	%	No.	%	No.	%					
Low	36	72.0	4	8.0	4	8.0	71.660^*	$<0.001^{**}$	$<0.001^*$	$<0.001^*$	0.764
Moderate	10	20.0	3	6.0	5	10.0					
High	4	8.0	43	86.0	41	82.0					
Total score	(0 – 66)						70.670^*	$<0.001^{**}$	$<0.001^*$	$<0.001^*$	0.484
Mean ± SD.	21.50 ± 10.10		57.12 ± 10.23		55.50 ± 11.24						
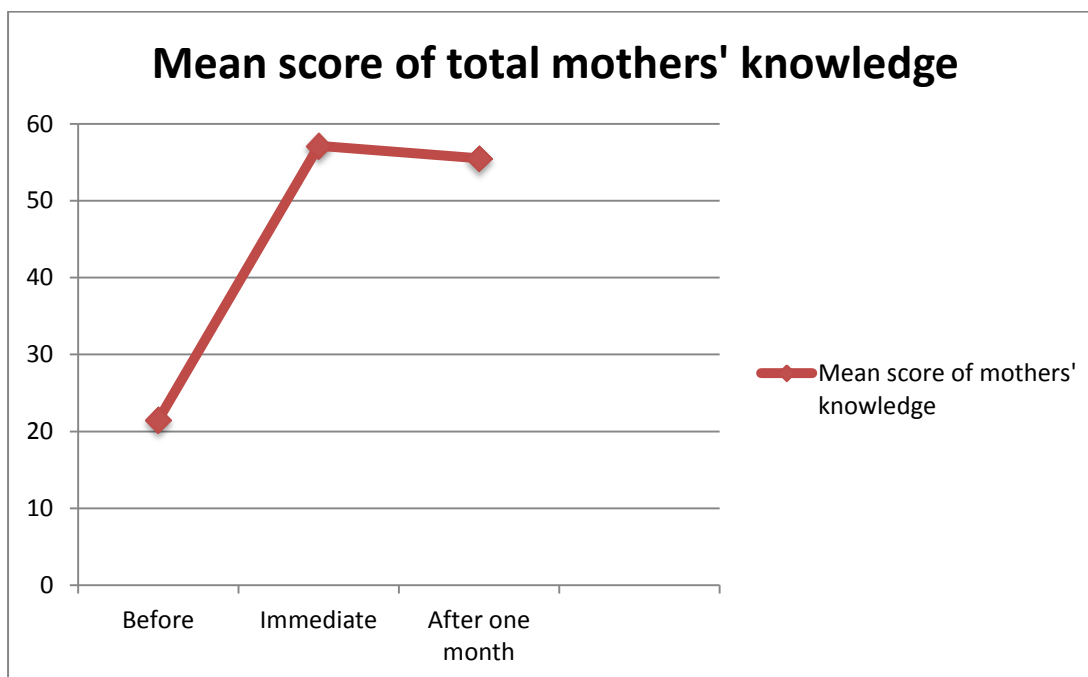
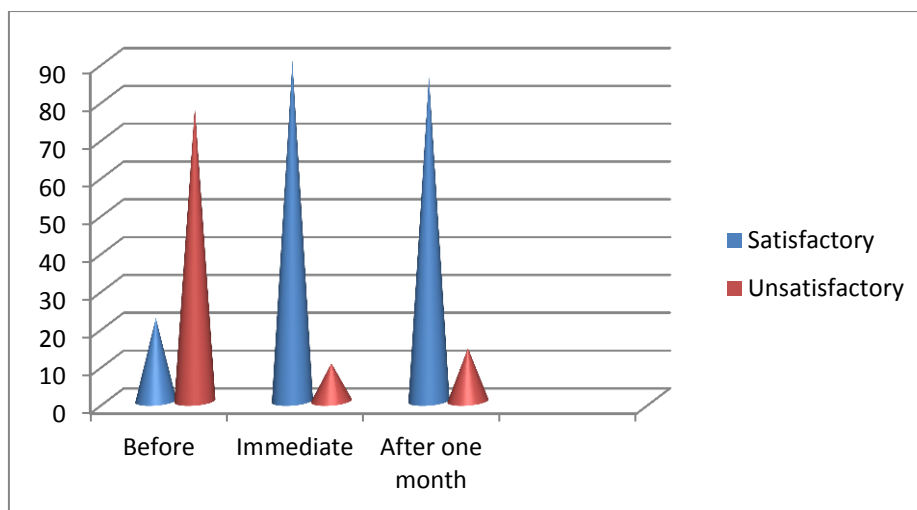**Figure (1): Mean score of total mothers' knowledge**

Figure (2) : Total mothers' practices regarding to their infants' feeding.

Table (4):Percentage distribution of mothers' practice regarding to their infants' feeding

Mothers' practice regarding infants' feeding.		Before (n = 50) No %		Immediately (n = 50) No		After one month(n = 50) No %		X2 (1)	P1	X2 (2)	P2	X2 (3)	P3
Given meals /day	Satisfactory	5	10	43	86	40	80	57.845	0.001*	49.487	0.001*	0.642	0.424
	Unsatisfactory	45	90	7	14	10	20						
given snacks /day	Satisfactory	7	14	35	70	35	70	32.182	0.001*	32.182	0.001*	0.0	1.0
	Unsatisfactory	43	86	15	30	15	30						
Type of infants' feeding pattern	Satisfactory	4	8	43	86	43	86	61.059	0.001*	61.059	0.001*	0.0	1.0
	Unsatisfactory	46	92	7	14	7	14						
Given fruits, juice	Satisfactory	19	38	35	70	35	70	10.308	0.001*	10.308	0.001*	0.0	1.0
	Unsatisfactory	31	62	15	30	15	30						
Given vegetables	Satisfactory	10	20	43	86	40	80	43.718	0.001*	36.001	0.001*	0.642	0.424
	Unsatisfactory	40	80	7	14	10	20						
Estimate proteins in potatoes	Satisfactory	0	0	45	90	44	88	81.823	0.001*	78.569	0.001*	0.102	0.749
	Unsatisfactory	50	100	5	10	6	12						
Give infants meat, fish, chicken	Satisfactory	10	20	36	72	35	70	27.213	0.001*	25.251	0.001*	0.052	0.826
	Unsatisfactory	40	80	14	28	15	30						
Give infants milk, products as; yogurt	Satisfactory	9	18	45	90	43	86	52.168	0.001*	46.312	0.001*	0.379	0.538
	Unsatisfactory	41	82	5	10	7	14						
	Unsatisfactory	41	82	5	10	7	14						

Table (5):Percentage distribution of infants regarding to their anthropometric measurements.

Infants' anthropometric measurements	Before (n=50)		Immediate (n=50)		After two months (n=50)		X2	P	P1	P2	P3
	no	%	no	%	No	%					
Weight											
Normal 90-110%	25	50	30	60	40	80	15.909*	<0.001*	0.453	0.024*	0.134
Below normal <90%	25	50	20	40	10	20					
length											
Normal 90-110%	25	50	32	64	40	80	15.364*	<0.001*	0.294	0.024*	0.230
Below normal <90%	25	50	18	36	10	20					
Head circumference											
Normal 90-110%	35	70	38	76	44	88	7.875*	0.019*	0.653	0.177	0.368
Below normal <90%	15	30	12	24	6	12					
Mid arm circumference											
Normal 90-110%	20	40	25	50	40	80	25.00*	<0.001*	0.453	0.003*	0.024*
Below normal <90%	30	60	25	50	10	20					
Weight for length= Body Mass Index											
Normal 90-110%	30	60	32	64	40	80	9.333*	0.009*	0.764	0.134	0.230
Below normal <90%	20	40	18	36	10	20					

χ^2: Chi square for Friedman test, Sig. bet. periods   *: Statistically significant at p ≤ 0.05

Table (6):Percentage distribution of infants regarding to their laboratory investigations.

laboratory investigation	Before (n = 50)		Immediately (n = 50)		After two months (n = 50)		X2 (1)	P1	X2 (2)	P2	X2 (3)	P3
	No	%	No	%	No	%						
Phenylalanine in a filter paper mg\dl Within normal	17	34	17	34	44	88	0.0	1.0	30.641	0.001*	30.641	0.001*
Above normal	33	66	33	66	6	12						
Tyrosine in a filter paper mg\dl Within normal	32	64	32	64	50	100	0.0	1.0	21.951	0.001*	21.951	0.001*
Below normal	18	36	18	36	0	0						
Phenylalanine \\Tyrosine Ratio Within normal	14	28	14	28	44	88	0.0	1.0	36.948	0.001*	36.948	0.001*
Above normal	36	72	36	72	6	12						

χ^2: Chi square for Friedman test, Sig. bet. periods   *: Statistically significant at p $\leq$ 0.05

Table (7): Percentage distribution of infants regarding their feeding, food exchange color and micronutrients

Infants' food exchange color and micronutrients	Before (n = 50)		Immediate (n = 50)		After two months (n = 50)		X2 (1)	P	P1	P2	P3
	No	%	No	%	No	%					
Given free phe formula before feeding, meals	44	88	50	100	50	100	12.00*	0.002*	0.368	0.368	1.000
Given fresh fruits, and juice at least twice daily	19	38	30	60	44	88	36.171*	<0.001*	0.016*	<0.001*	0.051
Given vegetables soups as main meals	10	20	50	100	50	100	80.0*	<0.001*	<0.001*	<0.001*	1.000
Given sugar, jam and honey	6	12	40	80	45	90	75.244*	<0.001*	<0.001*	<0.001*	0.549
Estimate proteins in Potatoes, cheeps in infants' food	0	0	29	58	44	88	79.699*	<0.001*	<0.001*	<0.001*	0.040*
Estimate protein in rice , cereals in infants' food	5	10	25	50	38	76	74.961*	<0.001*	<0.001*	<0.001*	0.134
Give infants meat, fish, chicken and eggs	15	30	10	20	5	10	19.042*	<0.001*	<0.001*	0.011*	0.294
Give infants milk and milk products as; yogurt and cheese	19	38	15	30	7	14	18.557*	<0.001*	<0.001*	0.099	0.051
Give infants artificial juices	15	30	10	20	4	8	10.706*	0.005*	0.453	0.099	0.368
Given infants Calcium	0	0	10	20	26	52	36.857*	<0.001*	0.134	<0.001*	0.016*
Given infants vitamin D	22	44	30	60	47	94	39.120*	<0.001*	0.230	<0.001*	0.011*
Given infants Iron	0	0	5	10	20	40	26.0*	<0.001*	0.453	0.003*	0.024*

χ^2: Chi square for Friedman test, Sig. bet. periods   *: Statistically significant at $p \leq 0.05$

Table (8): Percentage distribution of infants regarding to their daily dietary intake.

Infants' daily dietary intake.	Before (n = 50) No	%	Immediate (n = 50) No	%	After two months (n = 50) No	%	X2	P	P1	P2	P3
Protein : Adequate **RDAs**	30	60	50	100	40	80	23.077*	<0.001*	0.003*	0.134	0.134
Less than **RDAs**	20	40	0	0	10	20					
Carbohydrate: Adequate **RDAs**	19	38	30	60	40	80	17.892*	<0.001*	0.099	0.002*	0.134
Less than **RDAs**	31	62	20	40	10	20					
Fats :Adequate **RDAs**	0	0	10	20	35	70	54.167*	<0.001*	0.134	<0.001*	<0.001*
Less than **RDAs**	50	100	40	80	15	30					
Fruits: Adequate	15	30	42	84	35	70	40.621*	<0.001*	<0.001*	0.003*	0.294
Less than **RDAs**	35	70	8	16	15	30					
Vegetables: Adequate	15	30	40	80	42	84	43.806*	<0.001*	<0.001*	<0.001*	0.764
Less than **RDAs**	35	70	10	20	8	16					
Calcium: Adequate	0	0	10	20	26	52	39.692*	<0.001*	0.134	<0.001*	0.016*
Less than **RDAs**	50	100	40	80	24	48					
Vitamin D : Adequate	22	44	30	60	47	94	20.720*	<0.001*	0.011*	0.764	0.024*
Less than **RDAs**	28	56	20	40	3	6					
Iron: Adequate **RDAs**	0	0	5	10	20	40	72.298*	<0.001*	<0.001*	<0.001*	0.011*
Less than **RDAs**	50	100	45	90	40	80					

χ^2: Chi square for Friedman test, Sig. bet. periods   *: Statistically significant at $p \leq 0.05$

Table(9): Correlation between total scores of mothers' knowledge and their reported practices regarding phenylketonuria.

Correlation	Mothers' practices (n=50)					
	Before		immediately		After one month	
Mother's knowledge	r_s	p	r_s	p	r_s	P
	0.290*	0.041*	0.361*	0.010*	0.571*	<0.001*

**. Correlation is highly significant at the 0.01 level.

Discussion

Phenylketonuria is an autosomal recessive inheritance, consanguinity among carrier couples is risk factors that causing inborn error of phenylalanine metabolic phenylketonuria is mainly caused by decline of phenylalanine hydroxylase, enzyme that catalyse hydroxylation of phenylalanine to tyrosine.[1]This disease if untreated or undiagnosed, neurotoxic effect of high phenylalanine may due to impaired cognitive development and irreversible brain damage. In addition, which is a life threating condition and may lead to death in severe cases.[1-3]

Mothers play a vital role to deal with their infants disabilities and to gain infants' nutritional needs.[10]The problem rose due to lack of mothers' knowledge about PKU and infants' feeding pattern. Paediatric nurses could share mothers to care for their infants by giving suitable guidance and reinforcement. In addition, nurses should be assess daily dietary intake and decrease of phenylalanine.[9] Nutritional intervention programs play an integrate role in speeding and updating the mothers' knowledge, beside improving practice of mothers about infants' feeding requirements.[14]

In relation to consanguinity, the present study notice that more two third of mothers and their infants with PKU were had relative consanguineous (**Table 1**); This could be due to the scientific facts that PKU is a genetic disorder and common in relative marriage between parents .This result was agreement with **Ford et al., (2018)**[18] who stated that more half of mothers and their infants with PKU having consanguineous relationship.

Regarding infants' socio-demographic characteristics, the present study shows more half of infants were female (**Table 2**);This finding was agreement with **Fouad et Abd El-Moneem (2016)**[19] **and jurecki et al., (2017)**[20] who were find that half of PKU infants included in their studies were female. In contrast **Teruya et al., (2021)**[21]who record that more half of infants with PKU were male. In addition, the present study mentioned that half of infants moderate type of PKU and more than two third of them diagnosed of PKU from 15 days to less than one month (**Table 2**).This result in the same direction with **Teruya et al., (2021)**[21] who found that more half of sample diagnosed and early treatment of PKU within three months.

Concerning mothers' knowledge about phenylketonuria before program, the present results revealed that; the majority of mothers had low level of knowledge and minority of them had moderate level of knowledge before nutritional intervention program **Table (3);** these findings may be contributed to many factors as absence of in-services educational program at hospital from health care provider that influence mother knowledge, lack of information about PKU, mothers didn't attend nutritional intervention program and lack of health education in health care setting. These findings was in consistent with **El-Sayed et al., (2020)**[22] who was reported that more half of mothers had poor knowledge level, compared to low percentage of them had good knowledge level.

However, average knowledge constituted one third of them, that; contributed to mothers got knowledge particularly from physicians, and media. Also, **Abd El-kodoos et al., (2012)**[23]who were similar to the present findings who mentioned that most mothers and their infants with PKU had varies sources of information

about PKU as; health care staff, the internet, support groups, and organizations related to this condition**.**

Furthermore, total scores of mothers' knowledge regarding PKU the present study reported that; the mean score before nutritional intervention program implementation were improved immediately after program intervention and continues its progress after one month with statistical significant difference between before, immediate and after one month of nutritional intervention program implementation **(Figure 1)**;This may be attributed to mothers had emotional support and more than one quarter from high school and nearly two fifth of them graduated from secondary school and mothers gain information about PKU after implementing nutritional intervention program.

This results agreement with study **Abd-Elkodoos et al., (2018)**[24] who reported that there was highly statistically significance differences between the total score knowledge about phenylketonuria, pre, post and follow up 2 months of nutritional intervention program implementation among caregivers' which contributed to enormous responsibilities in providing care managing but the only barrier to develop any interventional program is educational level which the majority of mothers had low educational school level.

In respect of mothers' practices regarding infants' feeding pattern, the present finding showed most of mothers had poor unsatisfactory practice regarding infants' feeding pattern before. Compared to most of them had good satisfactory practice immediate and after one month of nutritional intervention program implementation **(Figure 2)**; This may attributed to mothers didn't aware about

infants' feeding, they had low level of knowledge before and increase their knowledge after program implementation. Moreover, knowledge is the pre-requisite to practice and practice facilitate retention of knowledge had an effect on their practice. So, improved mothers' practice about infants' feeding pattern immediate and after implementing nutritional intervention program .

These findings in the same direction with **Fouad et Abd El-Moneem (2016)**[19]who showed that, after implementation nutritional intervention program given to mothers , a highly statistically significant improvement correct knowledge scores post-test from one quarter is unsatisfactory, to nearest all enrolled in study are satisfactory practice. In addition**, Asfour (2013)**[25] continuing the previous study who was reported that mothers' practice scores and feeding pattern for their infants were much lower when scores were extremely low, and adding that nutritional knowledge is an essential component in dietary compliance and mothers' practice.

Regarding anthropometric measurements of infants, the present study showed that half of infants had underweight (<90%) before, two third of them were normal weight (90%- 110%) immediate, while, most of them were normal weight two months after nutritional intervention program implementation **(Table 5)**; These finding may be contributed to infants' born to a woman who has phenylketonuria that is not controlled with a special diet is at high risk for serious problems, this can cause low birth weight, length and growth retardation, nutritional intervention program implementation for mothers help to improve infants' growth and development. These findings agreement with **Zaghamir et**

al.,(2022)[26] who mentioned that after nutritional intervention program implementation on mothers' knowledge and practice and infants' feeding pattern and their growth. So, positive linear correlations between mothers' knowledge and their practice, and infants' development. This result confirms positive relation between them.

In contrast to the current study, **Tiele et al., (2019)**[27]who observed that the majority of new born experienced general health issues, including delayed growth as decreased weight and length. In addition, **Alena (2017)**[28] validated this conclusion by reporting that, from birth through adulthood, German infants with phenylketonuria were noticeably shorter than healthy infants. Furthermore, in this respect **Ahmad et al., (2022)**[29] They reported that; the nutritional status of the participants less than one quarter of the study sample were low length or extremely short. Also, with regards nearly half of infants were overweight.

As regard lab investigation, present study mentioned, **(Table 6)** There was statistically significant difference between phenylalanine and tyrosine ratio in a filter paper. Also, tyrosine in a filter paper improved in all infants immediate and after two months of program implementation.

Nutritional intervention programs for mothers play an important role in enhancing and updating knowledge beside improving care given to infants, and literature reports indicate that nutritional interventions program yield a long improvement in intake dietary but only a short-term improvement metabolic control.[30]

The present finding reveals that, there was statically significant correlation coefficient between total score of

mothers' knowledge and their reported practices regarding phenylketonuria before, immediate and after one month of nutritional interventions program implementation (**Table 9**) This finding the fact that increasing level of knowledge followed by increasing in practice, and increased dietary compliance for their infants with PKU. Also, the effect of nutritional intervention programs is to increase their knowledge about infants' feeding pattern.

The present findings were harmony with **Witalis et al., (2017)** [31] who reported that total caregiver knowledge scores significantly increased following educational intervention. Additionally, highly statistically significant positive correlation was discovered between total knowledge and total practice scores. The present findings were consistent with these findings. However, knowledge level improved, the amount of their practice improved. Moreover, **Mac Donald et al., (2016)**[32] are in agreement with the current results who showed a good link between mothers' practices and educational programs concerning optimal PKU management and mothers' practice.

The results of the present study show that, relation between mothers' knowledge about phenylketonuria and health parameters of infant's with PKU, following nutritional intervention program implementation. This outcome might be the consequence of an nutritional intervention programs that increased the mothers' knowledge scores and enhanced their practice since it was designed and carried out in accordance with their prior assessments of the infants' health parameters and nutritional needs. Support the necessity of on-going a nutritional intervention program to keep mothers' knowledge toward their phenylketonuria

affected infants' growth , and general health.

Conclusion

A significant improvement was observed level of mothers' knowledge regarding phenylketonuria immediate and after one-month of nutritional intervention program implementation in comparison to that in pre-program. Also, the nutritional program was effective on their infants' health parameters as; increase weight.

Recommendations

1- Health education of nutritional intervention training program should be conducted periodically and regularly in health care services for mothers with infants had phenylketonuria. and designing an education hand out about phenylketonuria and its management plan.

2 – Started with continue early detection and successful new born screening programs to early diagnose and proper management of infants with phenylketonuria to guard against cognitive impairment and growing infants and children of generally healthy.

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