Effect of Educational Intervention on Primary Health Care Nurses' Knowledge Regarding Phenylketonuria disorder and PKU test

Samia E. Khaton

Lecturer of Community Health Nursing, Faculty of Nursing, Tanta University, Egypt

Abstract

Background: Primary health care nurses are often the first line of defense and safety when it comes to educating parents and managing the entire newborn screening process to ensure healthy outcomes for families.
The aim of this study: was to assess the level of primary health care nurses' knowledge regarding Phenylketonuria (PKU) disorder and its screening test and evaluate the effect of educational intervention on their knowledge level
Methods: Quasi experimental design was used in this study. This study was conducted in the seven maternal and child health care centers at Tanta City. One hundred nurses who work at screening and follow up clinics were included in the study.
Tools of the study: questionnaire assessment sheet was used to collect data including part I; Socio-demographic data and training courses, Part II; Nurses' knowledge regarding phenylketonuria disease, Part III; Nurses' knowledge regarding phenylketonuria screening test, Part IIII; Nurses' knowledge regarding correct steps of PKU screening test procedure.
Results: There was a statistically significant difference in level of nurses' knowledge pre and post intervention. Pre intervention, only 19% of studied nurses had a good knowledge score regarding PKU disease and only 5% of them had a good knowledge score regarding PKU test. While, post intervention, all the studied nurses becomes had good knowledge score regarding the disease and its test. Pre intervention, only 16 % of studied nurses know 9-13 steps of PKU screening procedure correctly. While, post intervention this percentage increased to 95%.
Conclusions and recommendation: Educational intervention course improve nurses' level of knowledge regarding Phenylketonuria disease and its screening test. So, the study recommended that there was a dire need for continuous service training courses and health education programs for primary health care nurses especially those in well baby and screening clinics about PKU disease, its screening test and importance of early detection especially after the implementation of such screening program in Egypt.
Keywords: Phenylketonuria, Inherited, Knowledge, Nurses, Screening

I. Introduction

Phenylketonuria (PKU) is an inherited disorder of metabolism in which a chemical known as phenylalanine increased in the blood. It is one type of amino acid disorders in which a baby is born without the ability to properly break down the amino acid called phenylalanine. Phenylalanine is a building block of proteins that is obtained through the diet which is found in all proteins and in some artificial sweeteners [1,2].

In normal individuals Phenylalanine is converted in the liver to tyrosine by the activity of phenylalanine hydroxylase (PAH) enzyme. The gene for phenylalanine hydroxylase is located on chromosome 12 and contains 13 exons [3]. Phenylketonuria (PKU), the most common in born error of amino acid metabolism, results when there is a deficiency or absence of the enzyme phenylalanine hydroxylase (PAH) activity. The condition is also known as phenylalanine hydroxylase deficiency [4,5]. Amino acid disorders are inherited in an autosomal recessive manner and affect both males and females [6,7]. It is passed down through families. Both parents must pass on the defective gene in order for a baby to have the condition. This is called an autosomal recessive trait [8].

Phenylketonuria also subsumes as (Hyperphenylalaninemia) because it is resulting in the accumulation of phenylalanine and its metabolites in the blood. Which if un treated, phenylalanine can build up to harmful levels in the body, causing brain and nerve damage, intellectual disability and other serious health problems and usually first noted by sings of mental retardation in infancy [9,10]. Excess excretion of phenylalanine metabolites in the urine is also occurs. It is characterized by phenylketones in the urine giving a musty odor which is a typical feature of PKU [11]. ;the increased levels of phenylalanine in the plasma reaches (>1200 μmol/L; reference range, 35-90 μmol/L) within 2 or 3 weeks of life and the excretion of phenylpyruvic acid (approximately 1 g/d) and phenyl acetic acid in the urine was occurs [12].

Phenylketonuria prevalence and incidence varies by population. The prevalence in the general United States of America population is approximately 4 cases per 100,000 individuals. A low incidence is reported in African Americans (1/50,000). A high incidence is reported in Turkey (approximately 1 case in 2600 births), the Yemenite Jewish population (1/5300), Scotland (1:5300), Estonia (1:8090),Hungary (1/11,000), Denmark (1/12,000), France (1/13,500), the United Kingdom (1/14,300), Norway (1/14,500), China (1/17,000), Italy (1/17,000), Canada (1/20,000), Minas Gerais State in Brazil (1/20,000), and the former Yugoslavia (1/25,042).A low incidence is reported in Finland (< 1/100,000)and Japan (1/125,000) [13].

Until now, no incidence rate was reported at national level in Egypt, because screening practice for PKU does not include all neonates but sporadic studies were done. Screening for phenylketonuria among Egyptian newborns in Menoufiya governorate was conducted and revealed a prevalence of 1/3000 [14]. The national program for the early detection of disability diseases in newborns conduct two pilot study in both 2012 and 2013 to assess the prevalence of the disease by random samples from 9 governorates and the results confirmed high incidence of PKU 1/7000 [15]. Another study conducted in Pediatric Neurology Clinic, Sohag University Hospital assesses clinical laboratory profile diagnosed 24 cases with phenylketonuria PKU during the period of the study [16].

A pilot study is attempt to elicit prevalence of metabolic disorders in Egypt by tandem mass spectrometry is conducted on 16000 neonates (3-7 days) and 550 children (3 months to 15 years) in neuro-metabolic outpatient clinic, Cairo University, Children Hospitals. From 16000 screened neonates, four PKU cases were detected (1/4000) [17].

The extrapolations of prevalence and incidence statistics for phenylketonuria by countries and regions 2015,which gives only a general indication as to the actual prevalence or incidence of phenylketonuria in each region revealed that in the Middle East region, extrapolated incidence to population estimated used was 14% in Iraq; 11% in Libya; 10% in Egypt [18].

Children with untreated PKU appear normal at birth. But by age 3 to 6 months, they begin to lose interest in their surroundings. Mental retardation may develop gradually and may not be evident for the 1st few months. By age1year, children are developmentally delayed. It is usually severe and most children require institutional care if the condition remains untreated [19, 20].

Intelligence testing reveals that 50% to 70% of individuals with untreated phenylketonuria have IQs below 35 [21]. Phenylalanine plays a role in the body's production of melanin, the pigment responsible for skin and hair color. Therefore, infants with the condition often have lighter skin, hair, and eyes than brothers or sisters without the disease. Vomiting, sometimes severe enough to be misdiagnosing as pyloric stenosis, may be an early symptom [22, 23]. Behavioral, psychological (emotional) and social problems includes decreased social competence, decreased autonomy, low-self-esteem, attention problems, school problems and lower achievement motivation may also occurs [24]. Neurological symptoms may include seizures, shaking, or jerking movements in the arms and legs, hyperactivity, and epilepsy (50%) [25].

The diagnosis of Phenylketonuria in a severely mentally retarded older child with typical biochemical and physical characteristics is straight forward by determining serum phenylalanine and tyrosine levels [26]. An enzyme assay can determine if parents carry the gene for PKU. Chorionic villus sampling can be done during pregnancy to screen the unborn baby for PKU [13].

In the newborn period, phenylketonuria is diagnosed by blood test, usually as part of the routine screening tests given to a newborn within the first few days of life [27]. Diagnostic criteria for PKU are: (i) on a normal diet phenylalanine level is in excess of 20 mg/dl/24 hr on two occasions, (ii) blood tyrosine level >5mg/dl, (iii) presence of abnormal urinary metabolites of phenylalanine detected by Guthrie or ferric test [28].

Newborn screening allows early identification and early implementation of treatment. It is more economical to detect and treat a disease such as PKU early rather than provide lifelong support for an untreated child who will develop severe mental retardation [29,30]. Because the test depends on the accumulation of phenylalanine, for this reason testing would be done after the infant is 48 hours old; if the screening done before the third day of newborn's life, a higher risk of a false negative outcome is expected. The test should done after feeding protein diet (either breast feeding or bottle feeding) to reduce the possibility of false negative results. Diagnosis must be confirmed by measurement of plasma phenylalanine concentration [31].

The Egyptian Ministry of Health and Population was not conduct A National Screening Program for PKU until November 2015. Before that, a random sample was taken from only 9 governorates which have high rate of consanguinity marriages between blood relatives. This random test gives a high incidence of PKU (1/7000) newborn [16]. And so, from the beginning of November 2015, the Egyptian Ministry of Health conducts the screening program nationally in all governorates with the same time and the same filter paper of congenital hypothyroidism screening program. All 27 Governorates were covered now [32].

Dietary management or pharmacologic treatment is essential for infants with PKU. Treatment should be instituted as soon as the diagnosis is confirmed because the best results are obtained with early treatment. Infants and children with PKU are treated with a special diet that restricts phenylalanine intake as well as the use of medical foods to supplement the patient's intake of other essential amino acids and of vitamins and minerals

[33,34]. Babies with PKU are often fed a special formula e.g Lofenalac, Minafen and Albumaid XP containing high protein and low phenylalanine. It can be used throughout life as a protein source that is extremely low in phenylalanine and balanced for the remaining essential amino acids. People with PKU who are on this special diet from birth or shortly thereafter develop normally and often have no symptoms of PKU [35]. PKU patients are to eat low-protein foods such as low-protein breads, pastas and cereals. They are usually advised to eat a lot of fruits and vegetables because they contain little phenylalanine [36,37]. In the PKU diet, animal protein is avoided because it contains the highest amounts of phenylalanine for example red meat, fish, poultry and milk and milk products. Plant protein should be avoided also such as dried beans, peas and nuts as they contain high amounts of phenylalanine. The artificial sweetener aspartame such as low-fat yogurt, soft drinks, breath mints, candy, sugar-free gum, gelatin, chewable vitamins, cold medicines, pudding and hot cocoa mixes should also be avoided [38].

Nurses are often the first line of defense and safety when it comes to educating parents and managing the entire newborn screening process to ensure healthy outcomes for families. Among other responsibilities; filling pristine paper work; and following up with families, laboratories and doctors [39].

Primary health care (PHC) nurse plays an important role in primary prevention of PKU. She provides a premarital counseling about consanguineous marriage (Endogamy), an enzyme assay can determine if parents carry the gene for PKU during preconception period. Chorionic villus sampling can be done during pregnancy to screen the unborn baby for PKU [40]

PHC nurse either in maternal and child health centers or in rural health units can provide health education to the population about the disease, importance of national program for screening test, it's exact time, importance, how test result will be conveyed to parents and what to expect in the event of an abnormal result. She takes the opportunity for practicing communication skills for conveying complex information to parents and families [41].

Secondary prevention of Phenylketonuria involves early case finding which is the main role of PHC nurse in national program of screening test for all newborn specially targets populations that have risk factors in common; by taking blood sample in maternal and child health centers and rural health units for early detection of cases. She properly records the specimen and sends for analysis. Newborn screening identifies these children and proper dietary management changes the course of their lives from mental retardation to normal intelligence [42].

The nurse ensures that parents receive accurate information about screening test (e.g., purpose, meaning, risks, and advantages, their rights of enrollment depending on their locale, specimen collection and retention) prior to testing. Ensure that parents of infants with positive results are offered counseling about the interpretation and implications of their infants results [43].

After diagnosis the family may need extra support in coping with shock, anxiety or stress. The nurse coordinate and collaborate with other team members for early referral of finally diagnosed newborn to multidisciplinary teams of genetic providers, medical specialists, nurses, and nutritionists care for infants [44].

As a member of the team, the nurse assumes counseling and teaching role about proper dietary management (diet low in phenylalanine) and that all immunizations can proceed normally [45]. She can assure infant parents that the outcome is expected to be very good if the diet is closely followed, starting shortly after the child's birth. However, if treatment is delayed or the condition remains untreated, brain damage will occur. School functioning may be mildly impaired [46,47]

The nurse has also a role in the rehabilitation of the child with PKU disease. She teaches the parents to adapt with the already existing disability and use, maximize capabilities and encourage family to complete the course of treatment and maintain long term follow up to prevent the disease progression [48]. All these responsibilities required from the PHC nurses in centers and units to be acknowledge by everything about PKU disease, it's screening test, correct sampling technique and management.

Aim of the study:-
1- Assess the level of nurses' knowledge regarding Phenylketonuria disorder and PKU test in Maternal and Child Health Care Centers at Tanta City.
2- Evaluate the effect of educational intervention on nurses' level of knowledge regarding Phenylketonuria disorder and PKU test in Maternal and Child Health Care Centers at Tanta City.

Research hypothesis:-
Educational intervention will affect positively the level of nurses' knowledge regarding Phenylketonuria disorder and PKU test in Maternal and Child Health Care Centers at Tanta City.

II. Materials and Methods

Study design:
A Quasi experimental study design was used in this study.

Settings:
This study was conducted in all Maternal and Child Health Care Centers affiliated to Ministry of Health at Tanta City, El-Gharbia Governorate. There are 7 Maternal and Child Health Care Centers representing 5 districts of Tanta City in El-Gharbia governorate.

Subjects:
All nurses dealing with newborn care (conducting thyroxin test or newborn follow up) in the previous settings were included in the study. The total number was 100 nurses.

Tool of study:
Structured questionnaire assessment sheet was used to assess nurses' knowledge regarding Phenylketonuria Disorder and PKU test:-
The questionnaire was developed by the researcher based on literature review in order to collect the necessary data; it included the following four parts:

Part (1): Socio Demographic characteristics of nurse such as; name, age, educational level, experience years and training courses taken by nurses.

Part (2): Nurses knowledge regarding phenylketonuria disease which included:
Definition of phenylketonuria, Causes, Characteristics of the disease, the enzyme responsible for the occurrence of the disease, People most vulnerable, the early signs and symptoms of disease, The permanent symptoms of disease, Ways to detect the phenylketonuria, Consequences of delayed detection, Methods of treatment, The first step in the discovery of the disease, The type of food presented to affected child, When follow up needed for a child with phenylketonuria, and Factors affecting difference of nutritional management from a child to another.

Part (3): Nurses knowledge regarding phenylketonuria test which included:
Indication and importance of Phenylketonuria test, the exact time for the blood sample, Causes of taking sample at that time, is the blood sampling a prerequisite for the registration of the child, diet giving before taking sample, Phenylalanine cut off point for screening, Referral places for affected child, Place for taking recurrent blood sample for diagnosed child and the total number of recurrent sample in the first year.

Part (4) Nurses' knowledge regarding correct steps of PKU screening test procedure: in which nurses asked to rearrange the 13 steps of PKU test procedure.

Knowledge scoring system was done as follow:-
Correct answer taken (1) and incorrect answer and do not know taken (zero).

Total knowledge score (TKS) regarding PKU disease and PKU test was classified as:-
* **Good** ⟶ >75% of total knowledge score.
* **Fair** ⟶   60% ≤ 75% of total knowledge score.
* **Poor** ⟶   < 60% of total knowledge score.

Knowledge regarding steps of PKU screening test procedure was categorized as:
* **Good** ⟶ arrange 9-13 steps **correctly**
* **Fair** ⟶ arrange 6-8 steps **correctly**
* **Poor** ⟶ arrange ≤ 5steps **correctly**

III. Method

1. An official approval was obtained from the Dean of Faculty of Nursing to the director of the Health Affairs Directorate in El-Gharbia Governorate and then to the director of each selected Maternal and Child Health Care Center in order to collect the data and conduct the educational intervention.
2. Study tool was developed by the researcher based on literature review.
3. Study tool distributed to a jury of 6 professors (4 professors of Community Health and Pediatric Nursing and 2 professors of Public health Medicine before conducting the study to test its clarity and validity. Each of these experts gave an average total percentage of their acceptance of the tool; it's varied from 90-100%.
4. A pilot study carried out on 20 nurses after taking their approval to ascertain the clarity, applicability, feasibility and organization of the tool. The necessary modifications were done according to pilot study.
5. Study tool tested for its reliability using Cronbach's test, test reliability was (0.78).
6. **Ethical consideration**s: Oral consent to participate in the study was obtained from the nurses after explanation of the purpose of the study and assures them about the privacy and confidentiality of the obtained data and they have a right to withdraw from the study at any time.

Developing and implementing the educational intervention, Educational intervention was implemented by the researcher

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7. The content of **Educational Intervention** was prepared based on literature review and nurses' educational needs as determined through pre-assessment using study tool.
8. **The main objective of the educational intervention was to** acquire the studied nurses with the basic knowledge regarding phenylketonuria disease, PKU test and its procedure.
9. The meeting with studied nurses was organized in order to avoid peak of work. A schedule was done by the researcher based on the working days of each center.
10. The studied nurses were classified into seven groups; a group from each center.
11. The questionnaire sheet was distributed individually to each group of the nurses on a day before conducting the educational intervention to fill it at their morning shift after explaining the purpose of the study to assess their knowledge about PKU disease and PKU test and identify their educational needs
12. Each group of nurses was given **two sessions** ;

- **The first session** cover all items related to phenylketonuria disease: meaning, causes, characteristics of the disease, responsible enzyme, vulnerable groups, signs and symptoms of disease, consequences of delayed detection, methods of treatment, nutritional management ….etc ;
- **The second session cover all items related to PKU test and its procedure:** indication, importance, the exact time for the blood sample, phenylalanine cut off point for screening, referral places for affected child, steps of PKU procedure….etc
- The duration of each session was 2 hour.

13. Pre assessment and post assessment were done in separate days rather than the sessions' days and so each center was contacted by the researcher four times, 2 for assessment and 2 for giving an educational intervention
14. Group discussions, question-and-answer and brain storming were used as teaching methods. Power point Flip charts and pictures were used as teaching aids.
15. **Evaluation of the intervention**

Two assessments were done to the participants in order to assess their knowledge regarding PKU disease and PKU test

First time: Before implementation of the educational intervention

Second time: After the implementation of the educational intervention

16. Collection of data and conducting educational intervention were taken from middle of July 2015 to the middle of October 2015.

Statistical analysis:

The collected data were organized, tabulated and statistically analyzed using SPSS software statistical computer package version 23. For quantitative data, the range, mean and standard deviation were calculated. For qualitative data, comparison was done using Chi-square test (χ^2). Correlation between variables was evaluated using Pearson's correlation coefficient r. A significance was adopted at $P<0.05$ for interpretation of results of tests of significance.

IV. Results

Table (1): Represents the socio - demographic characteristics of the studied nurses. The results revealed that, the age of the studied nurses ranged from 25 – 55 years old with a mean age 38.42±7.224. 43% were in the age group 25- 35 years old and more than one third (39%) of them ranged from 36-55. As regards to nurses' marital status, the majority of them (85%) were married. Concerning their educational level, the majority of them (83%) had diplom, 12% had nursing bacculeruate, and only 5% had technical institute.

The table shows also that, about half (51 %) of the studied nurses had 11- 20 years of experience, about one third (34 %) of them had more than 20 years of experience with a mean18.22±7.59 years. As regard to training courses taken by nurses about phenylketonuria disease and its screening test, the table shows that more than one half of them (59 %) not taken any training courses and less than one third of them (31 %) taken less than 3 courses.

Table (1): Socio - demographic characteristics of the studied nurses

Categories		(n=100)	
		N	%
1. Age	25-35	43	43.0
	36-45	39	39.0
	46-55	18	18.0
	Mean±SD	38.42±7.224	
2. Marital status	Married	85	85.0
	Single	2	2.0
	Widow	7	7.0
	Divorced	6	6.0
3. Educational level	Diplom	83	83.0

	technical institute	5	5.0
	nursing bacculeruate	12	12.0
4. Years of experience	≤10	15	15.0
	11-20	51	51.0
	>20	34	34.0
	Mean±SD	18.22±7.59	
5. Training courses	None	59	59.0
	<3	31	31.0
	≥3	10	10.0

Table (2): Represents distribution of the studied nurses according to their knowledge regarding causes, risk group and signs and symptoms of the phenylketonuria disease pre and post educational intervention. The table illustrates that, pre intervention only one third of the studied nurses give the correct answer regarding definition of phenylketonuria, causes, characteristics, and the enzyme responsible (36%, 32%, 36% and 33% respectively). Also, only small percentage of them give the correct answer regarding people most vulnerable, the onset of sings, the early symptoms and permanent symptoms of disease (18%, 17%, 10%, 20%, respectively). This compared to nearly all of them give a correct answer regarding all these disease related issues post educational intervention.

Table (2): Distribution of the studied nurses according to their knowledge regarding causes, risk group and signs and symptoms of the phenylketonuria disease pre and post educational intervention (n=100).

Items	Incorrect				Correct				Don't know			
	pre		Post		Pre		Post		pre		post	
	N	%	N	%	N	%	N	%	N	%	N	%
1. Definition of phenylketonuria	42	42.0	0	0.0	36	36.0	100	100.0	22	22.0	0	0.0
2. Causes of disease	50	50.0	0	0.0	32	32.0	100	100.0	18	18.0	0	0.0
3. Characteristics of disease	48	48.0	0	0.0	36	36.0	100	100.0	16	16.0	0	0.0
4. The enzyme responsible for the disease	47	47.0	4	0.4	33	33.0	96	0.96	20	20.0	0	0.0
5. People most vulnerable to disease	58	58.0	0	0.0	18	18.0	100	100.0	24	24.0	0	0.0
6. The onset of sings of disease	60	60.0	5	0.5	17	17.0	95	0.95	23	23.0	0	0.0
7. The early symptoms of disease	53	53.0	0	0.0	10	10.0	100	100.0	37	37.0	0	0.0
8. Permanent symptoms of disease	58	58.0	0	0.0	20	20.0	100	100.0	22	22.0	0	0.0

Table (3): Represents distribution of the studied nurses according to their knowledge regarding case finding and management of the phenylketonuria disease The table shows that, pre intervention less than one third of the studied nurses know the correct answer regarding first step in discovering disease, consequences of delayed detection, methods of treatment (30%, 31%, 29% respectively), a few percentage know the correct answer regarding type of food introduced to affected child, factors affecting difference of nutritional management (12%,16% respectively) and one third only give the correct answer regarding child needs when follow up (35%). While, post educational intervention, 100% of them gives correct answer regarding first step in discovering disease, consequences of delayed detection, type of food introduced to affected child and child needs when follow up and most of them (93% and 94% respectively) gives correct answer regarding methods of treatment and factors affecting difference of nutritional management.

Table (3): Distribution of the studied nurses according to their knowledge regarding case finding and management of the phenylketonuria disease (n=100).

Items	Incorrect				Correct				Don't know			
	Pre		Post		Pre		Post		Pre		Post	
	N	%	N	%	N	%	N	%	N	%	N	%
1. Ways to detect phenylketonuria	42	42.0	0	0.0	41	41.0	100	100.0	17	17.0	0	0.0
2. First step in discovering disease	50	50.0	0	0.0	30	30.0	100	100.0	20	20.0	0	0.0
3. Consequences of delayed detection	50	50.0	0	0.0	31	31.0	100	100.0	19	19.0	0	0.0
4. Methods of treatment	49	49.0	7	7.0	29	29.0	93	93.0	22	22.0	0	0.0
5. Type of food to affected child	67	67.0	0	0.0	12	12.0	100	100.0	21	21.0	0	0.0
6. Factors affecting												

difference of nutritional management	60	60.0	6	6.0	16	16.0	94	94.0	24	24.0	0	0.0
7. Child Needs when follow up	49	49.0	0	0.0	35	35.0	100	100.0	16	16.0	0	0.0

Table (4): Represents distribution of the studied nurses according to the total knowledge score about phenylketonuria disease pre and post educational intervention. The table illustrates that pre intervention, nearly two thirds (63%) of the studied nurses had a poor knowledge score regarding PKU disease, 18% of them had a fair knowledge score and only 19% of them had a good knowledge score with a mean 7.87±2.6729. While, post intervention all of them had good knowledge score with a mean 14.560±0.7009. There was a statistically significant difference between total knowledge score about phenylketonuria disease pre and post educational intervention (P=0.001)

Table (4): Distribution of studied nurses according to their total knowledge score about phenylketonuria disease.

TKS about PKU disease	Pre intervention		Post intervention		P X^2
	N	%	N	%	
Poor< 60%	63	63.0	0	0	
Fair 60%-75%	18	18.0	0	0	38.066
Good >75%	19	19.0	100	100.0	0.001*
Range	4-13		13-15		
Mean±SD	7.87±2.6729		14.560±0.7009		

Table (5), Represents the distribution of the studied nurses regarding their knowledge about phenylketonuria screening test and its importance. It illustrates that, pre intervention about three quarters of studied nurses (74%) give a correct answer about the exact time for talking blood sample. However, 53% of them give incorrect answer regarding causes of taking sample at this time and 59% of them saw that blood sample is not a prerequisite for child registration. While post intervention nearly all of them (100% and 96%) becomes know the exact time for talking blood sample, causes of taking sample at this time and that blood sample is a prerequisite for child registration

Also, pre intervention only one third of the studied nurses know that the infant should take milk diet before conducting the test and only 5% know the Phenylalanine cut off point for screening. Moreover, only 22% know the referral places for affected child and 14% give correct answer regarding the total number of recurrent sample intake for the affected infant in first year. While post intervention, most of the studied nurses (100%, 93%, 100% and 95%) respectively give correct answer regarding what the infant should take before test, Phenylalanine cut off point for screening, referral places for affected child and the total number of recurrent sample intake for the affected infant in first year.

Table (5): Distribution of the studied nurses regarding their knowledge about phenylketonuria test and its importance (n=100).

Items	Incorrect				Correct				Don't know			
	Pre		Post		Pre		Post		Pre		Post	
	N	%	N	%	N	%	N	%	N	%	N	%
1. Best time for taking sample	74	74.0	0	0.0	10	10.0	100	100.0	16	16.0	0	0.0
2. Causes of taking sample at this time	53	53.0	4	4.0	34	34.0	96	96.0	13	13.0	0	0.0
3. Blood sample is a prerequisite for child registration	59	59.0	0	0.0	26	26.0	100	100.0	15	15.0	0	0.0
4. What you should make sure that new born fed before test	49	49.0	0	0.0	37	37.0	100	100.0	14	14.0	0	0.0
5. Best time to take sample after milk intake	74	74.0	0	0.0	10	10.0	100	100.0	16	16.0	0	0.0
6. Phenylalanine cut off point for screening	59	59.0	7	7.0	5	5.0	93	93.0	36	36.0	0	0.0
7. Referral places for affected newborn	54	54.0	0	0.0	22	22.0	100	100.0	24	24.0	0	0.0
8. Place for taking recurrent blood sample for diagnosed newborn	39	22.0	0	0.0	61	61.0	100	100.0	0	0	0	0.0
9. Total number of recurrent sample in first year	50	50.0	0	0.0	14	14.0	95	95.0	36	36.0	0	0.0

Table (6): Represent distribution of the studied sample regarding their total knowledge score about phenylketonuria screening test and its   importance pre and post' intervention. The result reveals that pre intervention, 59% of the studied nurses have poor knowledge score about phenylketonuria screening test, 36%

of them had a fair knowledge score and only 5% of them had a good knowledge score with a mean 3.01±1.795. While, post intervention, all the studied nurses becomes had good knowledge score with a mean 8.62±0.4878. There was a statistically significant difference between total knowledge score about phenylketonuria screening test pre and post educational intervention (P=0.0001).

Table (6): Distribution of the studied sample regarding their total knowledge score about phenylketonuria test and its importance

TKS about phenylketonuria test & its importance	Pre intervention		Post intervention		P X^2
	N	%	N	%	
Poor< 60%	59	59.0	0-	0	0.0001*
Fair 60%-75%	36	36.0	0	0	40.896
Good >75%	5	5.0	100	100.0	
Range	2-8		8-9		
Mean±SD	4.77±1.4274		8.62±0.4878		

Table (7): Represent distribution of the studied nurses according to their total knowledge score about phenylketonuria screening test procedure pre and post intervention.. The table shows that, pre intervention, more than half (57%) of nurses know only 5 or less steps of PKU screening test procedure and classified as poor level of knowledge, this is compared to one quarter of them (27%) know 6-8 steps of the procedure and classified as fair level of knowledge and only 16 % know and classified as good level of knowledge with a mean 5.64±2.7359. while post intervention, most of the nurses (95%) becomes know from 9-13 steps of the procedure and classified as good level of knowledge with a mean 12.42±1.2486. There was a statistically significant difference between total knowledge score about phenylketonuria screening test procedure spre and post educational intervention (P=0.0001).

Table (7): Distribution of the studied nurses according to their total knowledge score about phenylketonuria screening test procedure

Steps of Procedure of taking sample	Pre intervention (n=100)		Post intervention (n=100)		P X^2
	N	%	N	%	
Poor Know ≤ 5 steps	57	57.0	0	0.0	0.0001*
Fair Know 6-8 steps	27	27.0	5	5.0	177.91
Good Know 9-13 steps	16	16.0	95	95.0	
Range	3-12		7-13		
Mean±SD	5.64±2.7359		12.42±1.2486		

Table (8): Represent relationship between the total knowledge score about phenylketonuria disease and socio – demographic data among studied nurses. The table shows that, there was a statistically significant relation found between age, educational level, years of experience of the studied nurses and their total knowledge score about PKU disease (P= 0.021, 0.0001, 0.001 respectively).
On the other hand, there was no statistically significant relation found between marital status of the studied nurses and their total knowledge score about PKU disease (P= 0.274).

Table (8): Relationship between the total knowledge score about phenylketonuria disease and socio-demographic data among studied nurses

Socio-demographic Data		Total knowledge score about disease						X^2	P
		Poor		Fair		Good			
		N	%	N	%	N	%		
Age	25-35(n=43)	19	44.2	12	27.9	12	27.9	**11.527**	**0.021***
	36-45(n=39)	30	76.9	4	10.3	5	12.8		
	46-55(n=18)	14	77.8	2	11.1	2	11.1		
Marital status	Married (n=85)	50	58.8	17	20.0	18	21.2	7.542	0.274
	Single (n=2)	1	50	0	0	1	50		
	Widow (n=7)	6	85.7	1	14.3	0	0		
	Divorced (n=6)	6	100	0	0	0	0		
Educational level	Diplom (n=83)	59	71.1	14	16.9	10	12.0	**23.421**	**0.0001***
	Technical institute (n=5)	3	60	1	20	1	20		
	Nursing bachelor (n=12)	1	8.3	3	25.0	8	66.7		
Years of experience	□ 10 (n=15)	3	20.0	5	33.3	7	46.7	**18.253**	**0.001***
	11-20 (n=51)	32	62.7	9	17.6	10	19.6		
	>20 (n=34)	28	82.4	4	11.8	2	5.9		

* Significant at P<0.05.

Table (9): Represent relationship between the total knowledge score about disease and training courses taken by studied nurses. The table shows that all (100%) nurses who did not take any training courses had poor level of knowledge about the disease. About half of studied nurses (48.4%) who had < 3 courses had fair level of knowledge about the disease and 70% of those had ≥ 3courses had a good level of knowledge score. The difference between total knowledge score about PKU disease and training courses taken by nurses was statistically significant P = 0.001.

Table (9): Relationship between the total knowledge score about disease and training courses taken by studied nurses

Training courses	Total knowledge score about disease						$\square^2$	P
	Poor		Fair		Good			
	N	%	N	%	N	%		
None courses (n=59)	59	100.0	0	0.0	0	0.0	90.03	0.00*
< 3 courses (n=31)	4	12.9	15	48.4	12	38.7		
□ 3courses (n=10)	0	0	3	30	7	70		

* Significant at P<0.05.

Table (10): Represent relationship between the total knowledge score about phenylketonuria test and its importance and socio-demographic data among studied nurses. The table shows that, there was a statistically significant relation found between marital status, educational level, and years of experience of the studied nurses and their total knowledge score about PKU test and its importance (P= 0.013, 0.0001 respectively). On the other hand, the table shows also that there was no statistically significant relation found between age of studied nurses and their total knowledge score about PKU test and its importance (P= 0.05).

Table (10): Relationship between the total knowledge score about phenylketonuria test and its importance and socio-demographic data among studied nurses.

Socio-demographic Data		Total knowledge score about test						$\square^2$	P
		Poor		Fair		Good			
		N	%	N	%	N	%		
Age	25-35 (n=43)	20	46.5	18	41.9	5	11.6	9.512	0.05
	36-45 (n=39)	26	66.7	13	33.3	0	0.0		
	46-55 (n=18)	13	72.2	5	27.8	0	0.0		
Marital status	Married (n=85)	46	54.1	35	41.2	4	4.7	16.121	0.013*
	Single (n=2)	1	50	0	0	1	50		
	widow (n=7)	6	85.7	1	14.3	0	0.0		
	Divorced (n=6)	6	100	0	0	0	0.0		
Educational level	Diplom (n=83)	55	66.3	27	32.5	1	1.2	33.872	0.0001*
	technical institute (n=5)	4	80	1	20	0	0		
	Nursing bachelor (n=12)	0	0.0	8	66.7	4	33.3		
Years of experience	< 3 (n=31)	7	22.6	20	64.5	4	12.9	18.086	0.0001*
	□ 3 (n=10)	0	0	9	90	1	10		
	□ 10 (n=15)	3	20.0	9	60.0	3	20.0		
	11-20 (n=51)	30	58.8	19	37.3	2	3.9		
	>20 (n=34)	26	76.5	8	23.5	0	0.0		

* Significant at P<0.05.

Table (11): Represent relationship between the total knowledge score about phenylketonuria test and its importance take any training courses had poor knowledge score about PKU test. About two thirds of studied nurses (64.5%) who had < 3 courses had a fair level of knowledge about test. This is compared to 90% of those who had ≥ 3 training courses had a fair level of knowledge score and 10% had good level of knowledge score. The difference between total knowledge score about disease and training courses taken by nurses was statistically significant (P = 0.00).

Table (11): Relationship between the total knowledge score about phenylketonuria test and its importance and training courses taken by the studied nurses.

Training courses	Total knowledge score about test						$\square^2$	P
	Poor		Fair		Good			
	N	%	N	%	N	%		
None (n=59)	52	88.1	7	11.9	0	0.0	53.33	0.00*
< 3 (n=31)	7	22.6	20	64.5	4	12.9		
□ 3 (n=10)	0	0	9	90	1	10		

* Significant at P<0.05.

Table (12): Represents the correlation between both total knowledge scores and socio demographic data among studied nurses. The study revealed that, there was a positive correlation with a

strong significant difference between total knowledge score about PKU disease and PKU test and training courses and educational level as P value = (0.00, 0.00 respectively). On the other hand, there was a negative correlation with a strong significant difference found between total knowledge score about the disease and its test and age and years of experience of the nurses P = (0.002, 0.00 and 0.033, 0.002 respectively).

Table (12): Correlation between both total knowledge scores and socio-demographic data among studied nurses

Characteristics	Total knowledge score about disease		Total knowledge score about test and its importance	
	R	P	r	P
Age	-0.308	**0.002****	-0.213	**0.033***
Years of experience	-0.354	**0.000****	-0.309	**0.002****
Training courses	0.793	**0.000****	0.666	**0.000****
Educational level	0.352	**0.000****	0.447	**0.000****

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

V. Discussion

Community health nurse as a primary health care nurse plays an important role in prevention, early detection and referral for treatment of Phenylketonuria disease. She provides health education to the population about the disease, importance of national program of PKU screening in early detection and importance of nutritional management for affected children in order to prevent disease consequences [40,41]. The aim of this study was to assess the level of nurses' knowledge regarding Phenylketonuria disorder and PKU test and evaluate the effect of educational intervention on their knowledge level in Maternal and Child Health Care Centers.

The results of the present study illustrated that, the mean age of studied nurses was 38,42 years, the majority of them were married and having nursing school diplom, their mean years of experiences was 18,22 years and had not attend training courses about PKU disease. This results in agreement with **Abdella SH, (2015)** [49], who mentioned that the majority of subjects were having diplom degree and reported negatively related to opportunities of attending scientific meetings, seminars and attending training courses. Also, this result in the same line with **Kable RN et al., (2011)** [50], in Australia who mentioned that just one third of their studied nurses attended in service training courses which just about infection control.

Nurses in primary health care settings should be more knowledgeable about maternal and child disease and their early detection. The present study revealed that pre intervention, the majority of nurses give incorrect answer or don't know related to the definition of PKU, causes, characteristics, the responsible enzyme, people most vulnerable, the onset of sings, the early symptoms and permanent symptoms of disease. The present study in agreement with **Ayse GT et al., (2006)** [51], in Denizli, who found that; the self-reported knowledge level of primary health care midwives about some genetic abnormalities and illnesses was inadequate. Midwives reported that they did not have enough information about basic genetic topics, human genetic diseases, and prenatal diagnosis of genetic diseases, genetic screening and genetic counseling. Also, this results is in agreement with **Abdella SH, (2015)** [49], who found that the majority of nurses had no knowledge about PKU in pre education program.

On the other hands the present study disagrees with **Kiray VB et al., (2008)** [52], in Turkey who mentioned that half of subjects have knowledge about PKU disease at the first assessment. This difference could be related to different subject's characteristics. Also the result of the present study may be related to lack of training courses or education about this disease from the health administration authorities and at the time of data collection, the PKU screening test is not applied yet in Egypt.

Regarding total knowledge score about PKU disease, the present study reported that, pre educational intervention about two thirds of nurses found to have poor total knowledge score while post intervention all of them reported good knowledge score. **Abdella SH, (2015)** [49], mentioned also that, pre assessment all (99%) nurses have poor knowledge score about the disease. This reflects lack of training courses and professional development programs among primary health care nurses in many governorates in Egypt and the in need for conducting massive educational training courses from Ministry of Health and Health Administrators to maintain sustainable knowledge and practice of nurses work in MCH centers and rural health units.

As regards nurses' knowledge about causes of taking blood sample at a definite time for early detection and prevention of complication which could be irreversible mental retardation, the present study showed that about two thirds of nurses give incorrect answer or don't know regarding importance of taking blood sample at a definite time. This result is in agreement with **Abdella SH, (2015)** [49], who mentioned that the majority of nurses give incorrect answer regarding importance of early detection of PKU disease. Also the present study in agreement with **waisbren SE et al., (2007)** [53], in United Sates of America who reported that PKU is typically diagnosed at birth through newborn screening programs. However, if it is not caught and treated, the patient will

become significantly mentally challenged for a lifetime. **Castro S et al., (2012)** [54], in Portugal suggested also that neonatal screening demands constant reassessment of its own results.

The screening test help in early detection of PKU disease and prevention of its complication, the nurse should be aware of importance of early detection, dietary management and factor affecting it. In the present study, pre intervention, only less than one third of the studied nurses oriented by consequences of delayed detection, methods of treatment, food introduced for affected child and factors affecting nutritional management. This means that mothers who will contacted by those nurses especially after the implementation of the PKU screening in Egypt at November 2015, may becomes have no knowledge about early management and its importance in   preventing consequences which can in turn in increasing morbidity and health costs of affected children. This supported by **Kleine, s (2010)** [55], in Iraq who reported that the goal of screening and monitoring is to support early detection of dangers and prevention of complications of the disease. This could mean that the preventive characteristic of screening and monitoring could lead to a decrease of the mortality rate as well as a decrease in morbidity and health costs for disabled children.

This agrees with **Michals K, (2008)** [56], who illustrated that, there is a need for more shared education and communication about PKU with respect to all elements of management based on broad consensus guidelines. These findings could be because an increased knowledge would facilitate better prevention for children within the resources available. Also this result is in agreement with **Hatem et.al, (2010)** [57], in Iran who reported that early diagnosis and treatment of hereditary metabolic disorders are of great importance in preventing or delaying the onset of the disease. Moreover, screening at birth reduces mortality, diseases and social burden accompanied by irreversible effects of the diseases among the population. The annual cost of taking care of a phenylketonuria patient was for more than the cost of caring for a screened individual.   Also, National Institute of Health reported that blood phenyl hydroxylase enzyme (Phe) control is achieved by intense and continuing education, regular frequent blood testing, recording of food intake, maintenance of highly restrictive diet and regular and frequent visits to PKU clinic.

PKU screening test is essential procedure for early detection of the disease. The present study reported also that pre intervention, about nearly two thirds of studied nurses had poor total knowledge score about PKU screening test and its importance for early detection and prevention of consequences while most of them becomes having good score after educational intervention. This result in the same line with **Abdella's SH result, (2015)** [49], who showed that the majority of participant nurses pre application of the capacity building program do not know that the protective measures for problems caused by PKU was to conduct newborn screening for the PKU disease. In addition to special care and consideration if the child has a positive result and needs to actually start nutritional therapy and all this was changed positively after building capacity of the nurses.

This also agrees with **Hoffman K, (2007)** [58], who reported that a significant number of participants indicated that they are unaware of existing of such a screening program. Also **Read C et al., (2004)** [59], who documented that their results reflected lack of community awareness regarding early detection of PKU. These results aggravate presence of more efforts from responsible authorities toward continuous education courses for primary health care nurses. Moreover, the present study reported also that two thirds of the studied nurses found to have poor level knowledge score regarding correct steps of screening test procedure pre intervention. This results can be also related to lack of regular training courses given to nurses included in well baby and screening clinic and this supported also by **Mandour I et al., (2012)** [19], who mentioned that the rejection rate for blood spots encountered (30%), calls for the necessity of training personnel on proper sample collection from newborns.

As regards to relationship between the total knowledge score about PKU disease and its screening test and training courses taken by studied nurses, the present study showed that all nurses who had not training courses had poor knowledge score. This result in the same line with **Abd El- Hamid A, (2011)** [60], who mentioned that none of the nurses attended training courses in mental disability and mental retardation and all of them gained none satisfactory scores in their total knowledge score. All of this supports the focus view on that the nurses should receive periodical refreshing in service training courses to keep them up to date to have the ability of giving health teaching to families of the affected children.

This supported also by **Abd - Elkodoos R et al., (2012)** [61], who found that one quarter of family care givers had unsatisfactory total knowledge scores regarding their PKU children and the majority of family had poor level of practices regarding their PKU children. Also this is in agreement with **Ali N,(2008)** [62], who showed that when family care givers are provided with the basic knowledge about their children condition, developmental prognosis and various treatment approaches, they practiced new and healthy behaviors and / or can change unhealthy behavior. Also **Ozel H et al., (2008)** [63], found that caregiver's practice scores and dietary compliance was much lower when knowledge scores were particularly low.

Educational courses may be different in their content and nature between nursing diplom, nursing institute or baccalaureate of nursing and this may affect on nurses qualifications. The present study reported presence of a significant relationship between the studied nurses total knowledge score about PKU disease and

their educational level. The result is similar to **Abdella SH, (2015)** [49], who found that there was statistical significant relation between nurses qualifications and their total knowledge score.

The Present study showed that there is a negative correlation between total knowledge score of the nurses about the disease & its screening test and their age and years of experience. This may be related to that older nurses not have the initiation to explore knowledge and the majority of them express that training courses or any knowledge must given to younger nurses. This result gives an importance for the capacity building of all nurses about their field of practice. This view is supported also by **Abdella SH, (2015)** [49], who found that all subjects in the independent stage showed that application of nursing capacity building was very important. Also **Alleyne J et al., (2007)** [64], reported that management and leadership interventions and approaches have significantly influenced the participant's capacity to improve the quality of services provided to the patients. All of these emphasize the importance of continuous education and training to nurses as a health care provider in order to transfer to family care providers.

IV. Conclusion

Based on the finding of the present study, it can be concluded that

- The majority of nurses dealing with infants in screening and follow up clinic in MCH centers, Tanta city have poor total knowledge score regarding PKU disease and its screening test.
- Educational intervention and training has a positive effect on improving knowledge level of primary health care nurses about Phenylketonuria disease and PKU test & its importance as it refreshes and improve their old knowledge
- There was a positive correlation with a strong significant difference between total knowledge score about PKU disease and PKU test and training courses and educational level of the studied nurses.

V. Recommendations

Based on the results of the present study the following recommendations are suggested:-

1. There was a dire need for continuous service training courses and health education programs for primary health care nurses especially those in well baby and screening clinics about PKU disease, its screening test and importance of early detection especially after the implementation of PKU screening program in Egypt.
2. Education and training to primary health care nurses should be done at regular base and target all categories especially old nurses.
3. More emphasis should be placed on curriculum taught in undergraduate nursing education especially diplom degree targeting genetic diseases such PKU and its management.
4. Further researches are needed to measure the prevalence of PKU in Egypt.

Acknowledgement

References

[1]. Green E. Learning About Phenylketonuria -National Human Genome Research Institute. Last Updated: August 21, 2014.Available at: https://www.genome.gov/25020037.
[2]. Genetics Home Reference. (2012). Phenylketonuria. Retrieved June 22, 2012, Available at: http://ghr.nlm.nih.gov/condition= phenylketonuria.
[3]. Cockburn F, Carachi R, Goel K and Young D. Children's Medicine and Surgery.3rd ed. Great Britain: Arnold co., 2009; 391-396.
[4]. Englert CH. U.S. National Library of Medicine 8600 Rockville Pike, Bethesda, MD 20894 U.S. Department of Health and Human Services National Institutes of Health. Page last updated: 09 September 2015. Phenylketonuria: Medline Plus Medical Encyclopedia https://www.nlm.nih.gov/medlineplus/ency/article/001166.htm
[5]. Screening, Technology And Research in Genetics (STAR-G) Project for more information on classic phenylketonuria .Available at: http://www.newbornscreening.info/Parents/aminoaciddisorders/PKU.html#13.
[6]. Gaur S and Razia R. Textbook of Child Health Nursing.1st ed. London: Jypee brother com, 2016; 96-97.
[7]. John J , Yannis J and Charles S. Phenylalanine hydroxylase deficiency. Genetics in Medicine, 2011;V13/ N8: 697–707
[8]. Phenylketonuria. Anti Essays. Retrieved January 25, 2016, from Available at: http://www.antiessays.com/free-essays/Phenylketonuria-233635.html.
[9]. Vockley J, Andersson HC, and Antshel KM. Phenylalanine hydroxylase deficiency : diagnosis and management guideline. Genetics in Medicine 2014; 16: 188-220.
[10]. Camp Camp KM, Parisi MA, and Acosta PB. Phenylketonuria Scientific Review conference state of the science and future research needs. Mol Genet Metab, 2014; 112:87.
[11]. Charissa A. Pathophysiology of phenylketonuria. Mental Retardation and Developmental Disabilities Research Reviews,2009; Volume 5, (2): pages 104–112.
[12]. Peter J, AndersonV. White matter pathology in phenylketonuria. Molecular Genetics and Metabolism, 2010; Volume 99, Supplement: Pages 3–9.
[13]. Patel S, Zieve D, Black B, Slon S, and Wang N. The New York Times Company 2013. Phenylketonuria - Symptoms, Diagnosis, Treatment. available at: www.nytimes.com/health/guides/disease/phenylketonuria/overview.html.

[14]. Arnold G, Steiner R and Rophena L. phenylketonuria. Medscape. Last updated: Apr 28,2014. Available at:Emedicine.medscape.com/ article/ 947781.

[15]. El Araby H, Fateen E and Gouda A. Screening for phenylketonuria and galactosemia among Egyptian newborns in Menoufiya governorate. Egyptian Journal of Medical Human Genetics, NO2009; Vol10, No 2 : Pages164-176.

[16]. الشامل للمسح يوريا كيتون الفينيل مرض اضافة بروتوكول , الولادة حديثي في الإعاقة لأمراض المبكر الكشف برنامج للمواليد 2015. Egyptian Neonatal Screening Program for phenylketonuria2015.

[17]. Sadek A, Emam A and Alhaggag M. Clinico laboratory profile of phenylketonuria (PKU) in Sohag University Hospital-Upper Egypt. Egyptian Journal of Medical Human Genetics, July 2013;Volume 14, Issue 3: Pages 293–298.

[18]. Statistics by Country for Phenylketonuria –Right Diagnosis.com ,Last updated on April 17,2015. Available at: http://www.rightdiagnosis.com/p/phenylketonuria/stats-country.htm.

[19]. Mandour I, Hassan F, Elmougy F, Abdelhady S, Selm L, Abdel Atty S, Morgan M, Salem F, Oraby A, Mehaney D, Abdel Monem M, Elnekhely I and Moharam N. Preliminary Results of Egypt Experience for use of Tandem Mass Spectrometry for Expanded Metabolic screening. Journal of Applied Sciences Research, 2009; 5(10): 14425-1435.

[20]. US Department of Health and Human Services | National Institutes of Health. What are common symptoms of phenylketonuria. Last Reviewed: 08/23/2013. Available at: https://www.nichd.nih.gov/health/topics/pku/conditioninfo/Pages /symptoms.aspx

[21]. Easy Pediatrics Company. Clinical manifestations of classic Phenylketonuria Available at: http://easypediatrics.com/clinical-manifestations-of-classic-phenylketonuria-pku.

[22]. Harding C. Phenylketonuria Clinical manifestations. Available at: http://www.medmerits.com/index.php/article/phenylketonuria/P2.

[23]. United States National Library of Medicine. Phenylketonuria last updated: 13 January 2016. Available at: https://www.nlm.nih.gov/medlineplus/ency/article/001166.htm.

[24]. Marinus D, Carlo D. Physician's Guide to the Diagnosis, Treatment, and Follow-Up of Inherited Metabolic Diseases. Available at: http://link.springer.com/book/10.1007/.

[25]. Zeljko P M .Dermatologic Manifestations of Phenylketonuria. Available at: http://misc.medscape.com/pi/android/ medscapeapp/html/ A1115450-business.html.

[26]. Gibson M. Phenylketonuria classification. Available at: http://www.wikidoc.org/index.php/Phenylketonuria_classification.

[27]. Hay w, Levin M, Sondheimer J and Deterding R. Current Diagnosis and Treatment Pediatrics. Twentieth Edition. United States of America: Mc Graw-Hill Companies,2011;1001-1003.

[28]. Kugler M. Phenylketonuria PKU disease: An inherited metabolic disorder. Available at:http://rarediseases.about.com/od/ metabolicdisorders/a/phenylketonuria.htm.

[29]. Lundy K and Janes Sh. Community Health Nursing Caring for the Public's Health. 3rd Edition. United States of America: Jones & Bartelett learning company, 2016; 832-833.

[30]. Kennedy A, Shelton H and Susan L. Maternal- Child Nursing Care with the Women's Health Companion. 2nd Edition. United States of America: Davis company, 2016; 740-741.

[31]. Lissauer T and Clayden G. Illustrated Text book of Pediatrics.4th Edition. China: Elsevier company, 2012; 446-447.

[32]. The Egyptian Ministry of Health and Population. Availableat:https://www.egypt.gov.eg/services/servicelist.aspx?ID=1296& section=serviceproviders

[33]. Burns C, Dunn A, Brady M, Barber N, Blosser C, andGarzon D. Pediatric Primary Care.5THed. United States of America: Elsevier co, 2013;552-553.

[34]. Kinuthia E.   Updated: Jan 10, 2014.   Foods to Avoid on A phenylketonuria Diet/Live strong Com. Available at: http://www.livestrong.com/article/290094-foods-to-avoid-on-a-phenylketonuria-diet/.

[35]. Cleary M. Phenylketonuria. Pediatrics and Child Health, 2010;vo 21, issue 2: 61-64.

[36]. Poustie V and Wildgoose J. Cochrane Library. Dietary interventions for phenylketonuria. 20 January 2010. Available at http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD001304.pub2/full.

[37]. Macleod E and Ney D. Nutritional management of Phenylketonuria. Annales Nestle, 2010;68(2), 58-69.

[38]. Singh RH, Rohr F, Frazier D, Cunningham A, Mofidi S, Ogata B, Splett PL, Moseley K, Huntington K, Acosta PB, Vockley J and Van Calcar SC. Recommendations for the nutrition management of phenylalanine hydroxylase deficiency. Genet Med, 2014; 16(2):121-131.

[39]. Michelle H. Newborn Screening, July 2, 2012.Available at: http://nursing.advanceweb.com/Archives/Article-Archives / Newborn-Screening.aspx

[40]. Steele S. Phenylketonuria: counseling and teaching functions of the nurse on an interdisciplinary team. Available at: www.ncbi.nlm.nih.gov/pubmed/2632503.

[41]. Savage C and Kub J. Public health and nursing: a natural partenership. International Journal of Environmental Research and Public health, 2009; 6(11): 2843- 2848.

[42]. Deluca J. Kemper A. Implications of Newborn Screening for Nurses & Nursing Faculty. Available at: www.genome.gov/Multimedia/Slides/JNS/NewbornScreening_JNS_03_20_13.pdf.

[43]. Phyllis M. Phenylketonuria (PKU). American Journal of Nursing, January 2009; Volume 109, p 19.

[44]. National Health and Nutrition Examination Survey. NHANES 2014. Available at: [http://wwwn.cdc.gov/nchs/nhanes/search/ datapage.aspx?Component=Examination&CycleBeginYear=2007].

[45]. Patel S. The New York Times. Phenylketonuria - Symptoms, Diagnosis, Treatment. Review Date: 6/9/2013 Available at: http://www.nytimes.com/health/guides/disease/phenylketonuria/overview.html.

[46]. Samour P, King K. Essentials of Pediatric Nutrition. United States of America: Jenes &Bartlett Learning com, 2013;119-132.

[47]. Harkness G and Demarco R. Community and Public Health Nursing Evidence for Practice.2nd ed. China: Lippincott Williams & Wilkins co, 2016;75-85.

[48]. The National Institutes of Health (NIH) Consensus Development Conference Statement. Phenylketonuria: Screening and Management Available at: Consnsus.nih.gov/2000/2000phenylketonuria113html.htm

[49]. Abdella Sh. Capacity building of primary health care nurses regarding early detection of phenylketonuria disease. Master degree. Faculty of nursing, Menoufia University, Egypt, 2015.

[50]. Kable RN, Ashley K, Maya G and Mcleod M. Organizational risk management and nurses' perception of workplace risk associated with sharps including needle stick injuries in nurses in New South Wales, Australia. Journal of advanced nursing, 2011;68 (9):1933-1943.

[51]. Ayşe G, Aysun O, Hülya C, Huriye D and Beyza A. Midwives' Approach to Genetic Diseases and Genetic Counseling in Denizli, Turkey. Journal of Genetic Counseling, June 2006;Volume 15, Issue 3: 191-198.

[52]. Kiray VB, Tomatir AG, Kuzi KN and Taspinar A. Nursing Students' Self Reported Knowledge of Genetics and Genetic education. Inherit metabolic disease journal, 2009; vol12, no4: 225-232.

[53]. Waisbren S, NoelK, Fahrbach K, Cella C,Frame D, Doren A and Harvey L. Phenylalanine blood levels and clinical outcomes in phenylketonuria: a systematic literature review and meta- analysis. Molecular genetics and metabolism, 2007; vol 98, issue 1-2: 63-70.
[54]. Casto S, Borges J, Chagas H, Tiburcio J, Starling A and Marcos J. Relationships between phenylalanine levels, intelligence and socioeconomic status of patients with phenylketonuira. Journal of pediatrics, 2012; vol 88, issue 4: 353-360.
[55]. Kleine S (2010). Capacity building for the future primary health care mothers and children in Iraq. Available at http://purl.utwente.nl/essays/60028.
[56]. Michals K. Sapropterin dihydrochloride, 6-R-L-erythro-5,6,7,8-tetrahydrobiopterin, in the treatment of phenylketonuria. Expert Opinion on Investigational Drugs,2008; Volume 17, Issue 2: 245-251.
[57]. Hatem N, javanbakht M, Shirvani S, Askarian M and Rastegar M. Investigate the cost- effectiveness of the neonatal screening program University of Medical Sciences, Shiraz, Iran. Iranian Journal of Pediatrics. 2010; vol 23, issue 5: 493-500.
[58]. Hoffman K. Assessing the attitudes and beliefs of African- Americans toward newborn screening and sickle cell disease. Journal of Genetic counseling, 2007, vol 16, issue 6:674.
[59]. Read C and William F. Using the Impact of Event Scale to Evaluate Psychological Response to Being a Phenylketonuria Gene Carrier. Journal of Genetic Counseling, June 2004; Volume 13, Issue 3, pp 207–219.
[60]. Abdel-Hamid A. Development of the Skill of Primary Health Care Nurses in early Detection of Mental Retardation During Childhood. Doctoral Degree Faculty of Nursing, Ain Shams University, Egypt,2011.
[61]. Abd- Elkodoos R, Bader-Eldein S and Ismail G. Family Caregiver's Knowledge and practices of Children With Phenylketonuria at AboElreesh Hospital. Medical Journal of Cairo University, 2012; vol 80, no2:61-69.
[62]. Ali N. Needs of the physically handicapped adults in the vocational rehabilitation centers. Masrter degree. Faculty of Nursing, Alexandria University, Egypt, 2008.
[63]. Ozel H, Kucukkasap T, Koksal G, Kanoglu S, Dursun A, Tokatli A and CosKun T. Does maternal knowledge impact blood phenylalanine concentration in Turkish children with phenylketonuria? Journal of Inherited Metabolic Disease. 2008; 31,2: 213-217.
[64]. Alleyne J. Building the capacity for evidence- based clinical nursing leadership: the role of executive co- coaching and group clinical supervision for quality patient services. Journal of nursing management. 15 (2): 230-243.