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## The knowledge level of the healthcare professionals responsible for newborns' heel prick tests



Rabia Bayrak<sup>a,\*</sup>, Ayla Ünsal<sup>b</sup>, Ali Güneş<sup>c</sup>

<sup>a</sup> Kırşehir Ahi Evran University Health Services Vocational, Kırşehir, Turkey

<sup>b</sup> Kırşehir Ahi Evran University Faculty of Science Health, Department of Nursing, Kırşehir, Turkey

<sup>c</sup> Kırşehir Ahi Evran University Faculty of Medicine, Department of Pediatric, Kırşehir, Turkey

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## ABSTRACT

**Purpose:** This study was conducted to determine the level of knowledge of healthcare professionals involved in newborn heel prick tests.

**Methods:** The study was conducted between 10.02.2021–10.03.2021 with 147 healthcare workers working in heel prick screening in health institutions where heel prick blood samples were collected in a province and districts in the Central Anatolia region of Turkey. As a data collection tool, a questionnaire prepared by the researcher in line with the literature was used. The data were evaluated by number, percentage, mean and standard deviation analysis and chi-square analysis was performed in IBM SPSS for Windows 29.0v programme. **Results:** The majority of healthcare professionals gave correct answers to the questions regarding the collection, storage and transfer of heel prick. It has been observed that healthcare professionals do not have sufficient information regarding the definition of Congenital Metabolic Diseases, their findings and where to refer patients whose results are suspicious. The most significance was found in the distribution of answers regarding the symptoms of the screened diseases according to occupational groups.

**Conclusion:** In diseases that can be controlled with treatment and nutrition if detected early, errors in the collection, storage and transport of the sample can affect the test result and delay the diagnosis. Healthcare professionals have important responsibilities issues from genetic counseling before marriage, taking heel blood, from informing the family to caring for the diagnosed baby.

**Practice implications:** This study will provide valuable information to health professionals involved in newborn screening and to future studies in this field.

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## Introduction

The pathological picture resulting from defects in the synthesis or catabolism of proteins, carbohydrates and fatty acids is called Congenital Metabolic Disease (CMD). In metabolic disorders, pathology occurs due to the absence or inadequacy of the products of the enzyme that cannot occur or cannot perform its function sufficiently due to faulty genetic information (Erdöl & Sağlam, 2016; Navarrete et al., 2019). Metabolic diseases can occur from the intrauterine period to adulthood and involve almost every organ (Saudubray & Charpentier, 2001).

Although CMD are rare, their importance increases when a large number of metabolic diseases are considered. The incidence varies between 1 in 1500 and 3000 (Friedman et al., 2017; Mihçı, 2020). Autosomal recessive inheritance increases the likelihood of the diseases in our country where consanguineous marriages are common. Even in

the absence of consanguineous marriage, having parents from the same village is an important history for CMD (Coşkun & Yurdakök, 2014; Erdöl & Sağlam, 2016; T.C. Ministry of Health General Directorate of Public Health, 2018). According to the data of the Turkish Statistical Institute, the population of the province located in the Central Anatolia region of Turkey, where this study was conducted, was determined as 243 thousand 42 in 2020 (Turkish Statistical Institute, 2021a). Again, according to the data of the Turkish Statistical Institute, 3.8% of the official marriages in 2020 were consanguineous marriages (Turkish Statistical Institute, 2021b). In line with this data, it is essential to conduct screenings to detect diseases early.

Screening is the process in which physical examination, laboratory and radiologic examinations are performed for symptomless diseases with the aim of early diagnosis and timely initiation of effective treatment before irreversible damage (Association of Women's Health, Obstetric and Neonatal Nurses, 2016; Dilmen, 2010; Friedman et al., 2017; Karakaya et al., 2020; Powell, 2019). In order to detect CMD, some tests are performed from heel blood within the scope of the

\* Corresponding author.

E-mail address: [rabia.bayrak@ahievran.edu.tr](mailto:rabia.bayrak@ahievran.edu.tr) (R. Bayrak).

screening program in the world and in our country. Screenings performed in the first 24 h in newborns are very important because they help to recognize some important problems. Screening of newborns with anamnesis and physical examination allows early diagnosis and initiation of treatment of life-threatening diseases (Altunhan & Yılmaz, 2018; American Academy of Pediatrics Newborn Screening Authoring Committee, 2008; Joseph et al., 2016; Van Karnebeek & Stockler, 2012). Various screening programs planned for newborns to lead a healthy life are used in our country as in the whole world. The diseases to be screened are determined according to the conditions of the countries and common diseases (Içke & Ekti Genç, 2017; Wright et al., 2017). In Turkey, a total of six diseases are screened: Phenylketonuria, Congenital Hypothyroidism, Biotinidase Deficiency, Cystic Fibrosis, Congenital Adrenal Hyperplasia and Spinal Muscular Atrophy. Tests applied to newborns can be divided into two groups: General Screening Tests and Selective Metabolic Screening Tests. General screening tests are divided into the Newborn Metabolic Screening Program and Expanded Newborn Screening. Within the scope of Newborn Metabolic Screening Program, all live-born babies can be screened without any symptoms, while Expanded Newborn Screening is an application where >30 diseases can be screened from a drop of blood with Tandem Mass Spectrometry (Tandem MS/MS). Selective Metabolic Screening Tests, on the other hand, are tests applied to newborns with family history or clinical findings (Uslu et al., 2015).

Healthcare workers, especially nurses, have important responsibilities in the collection of heel prick blood sample with the correct technique, follow-up, informing and educating the family for these tests. Errors made in the collection, storage and transportation of the blood sample may cause the test to give incorrect results and to be repeated. Repetition of the test causes delays in the detection and diagnosis of the disease (Bayrak & Ünsal, 2022; Zengin et al., 2023). However, time is of the essence in the prevention and treatment of CMD. It will be possible to prevent errors by determining the level of knowledge of healthcare professionals on the subject and planning trainings if deemed necessary. In the literature, it was observed that there were no national and international studies including all healthcare workers such as physicians, nurses and midwives on the subject and similar studies were limited in number (Beyzadeoğlu et al., 2002; Tunç, 2006; Yıldız et al., 2006). Studies reported that 2217 babies were screened for heel blood in this province in 2020. It was requested to repeat the heel prick screening of 59 of the screened babies and 4 of them were diagnosed with CMD (Bayrak et al., 2023).

In every society, children are seen as valuable individuals and future adults, and their needs are met with the highest level of opportunities. Every parent wants to have a healthy child, but sometimes conditions such as illness prevent the family from meeting this expectation. CMDs, which can negatively affect the quality of life of the child and the family, have been encountered more frequently in recent years (Balk, 2007). In the Convention on the Rights of the Child, the principle of “special care and protection should be provided to the child and his/her mother before and after birth in order for the child to grow up in a healthy way” is included. In addition, the declaration of the rights of the newborn includes the principles that “every newborn has the right to life” and “every newborn has the right to receive health, social and emotional care that will ensure maximum physical, mental, spiritual, moral and social development in later life” (Aguilar Cordero et al., 2014). Having a sick child affects not only parents but also all family members psychologically and socially (Heel prick procedure for newborn blood spot screening, 2021). Starting from newborn screening, which is a preventive service, nurses have important responsibilities in many areas such as physical, social, psychological, etc. in every aspect of the lives of babies and their families who are diagnosed as a result of screening. Nurses have a great role in informing the family about the disease, providing supportive care, taking family history, keeping records, ensuring compliance with treatment, and ensuring that parents accept the strengths and weaknesses of the child (Balk, 2007). In this

direction, nurses should fulfill their roles of caregiver, educator, researcher, decision maker, manager, patient advocate, communicator, comforting, therapeutic, career developer and counselor in the best way. The aim of this study, which was prepared in line with these thoughts and data, is to investigate the level of knowledge of healthcare workers involved in newborn heel prick screening and to raise awareness about the importance of the subject.

## Methods

### Design and participants

The data of this descriptive study were collected from two hospitals and 19 Family Health Centers (FHCs), including one hospital, 12 FHCs, one district hospital and seven FHCs in the districts a city center located in the Central Anatolia region of Turkey. The population of the study consisted of a total of 190 physicians, nurses and midwives, including 80 physicians and 80 nurses/midwives working in primary health care institutions and 6 physicians and 24 nurses/midwives working in secondary health care institutions, who were involved in newborn heel prick screening.

### Sample and setting

In this study, the sample selection method was not used and a total of 147 health workers (77.3%) who met the conditions for participation in the study, volunteered to participate in the study and were not on leave on the day of data collection were included in the study. The sample size was calculated according to the sampling formula with known population (Trost, 1986). The sample size required for the study was determined as a minimum of 127 health personnel at 95% power and 0.05 error margin, and the study was completed with 147 people. Random sampling method was preferred as the sampling method.

### Data collection tools

In the study, a questionnaire form consisting of 38 questions prepared by the researchers in line with the literature (Altunhan & Yılmaz, 2018; Er, 2006; Kurtipek, 2017; Kim et al., 2003; Family Medicine Practice Regulation, 2013; Balk, 2007) was used as a data collection tool. The form was developed by the researcher and submitted to the opinions of professors, associate professors and doctoral faculty members who are experts in their fields for content validity. Necessary corrections were made in the form in line with the suggestions from the experts. The questionnaire form consists of three sections: descriptive characteristics, the steps of the procedure before, during and after heel prick blood collection and CMD. The first part of the introductory information form included questions about age, gender, occupation, length of service in the profession, educational status, whether there was any training on congenital metabolic diseases and heel prick screening, and whether there were any children diagnosed with CMD followed up in the unit. The second part of the form consists of 13 questions about the procedural steps before taking heel prick blood, five questions about what to pay attention to while taking the sample, and five questions about what to pay attention to after taking the sample until it is sent to the relevant unit. In the last section, there are a total of 15 questions about the definition of diseases related to CMDs, their symptoms and where they should be directed according to the results.

### Data collection

After the purpose of the study was explained to the healthcare workers by the researcher and verbal consent was obtained from the participants, the questionnaire form was given to them and they were asked to fill it out. It took approximately 10–15 min for the participants to complete the questionnaire.

### Data analysis

The data were evaluated by number, percentage, mean and standard deviation analysis and chi-square analysis was performed in IBM SPSS for Windows 29.0v programme.

### Place and time of the research

The study was conducted between 10.02.2021 and 10.03.2021 in primary care (PHC) and secondary care (Hospital) health institutions, including one hospital and 12 Family Health Centers (FHC) in a city center and one hospital and seven FHCs in six districts.

### Ethics committee permission

The study was conducted in accordance with the approval of the Clinical Research Ethics Committee of a university dated 26.01.2021 and decision number 2021–02/11 and the institutional permission of the Scientific Study Commission of the Provincial Health Directorate of the region numbered E-42884709–020. Before data collection, the purpose of the study was explained to the participants and it was stated that participation was voluntary. Verbal consent was obtained from those who wanted to participate and it was explained that the data obtained would be published anonymously for scientific purposes. The study was conducted in accordance with ethical, conscientious and medical rules according to the provisions of the Declaration of Helsinki.

### Results

Among the healthcare workers who participated in the study, 40.1% were physicians, 34.7% were nurses and 25.2% were midwives. Regarding their educational status, 10.9% were health vocational high school graduates, 7.5% were associate degree graduates, 38.8% were bachelor's degree graduates, 38.8% were master's degree graduates, 37.4% were general practitioners and 5.4% were specialist physicians. It was observed that the majority (45.6%) of the healthcare workers were 41 years of age or older. It was found that 83.7% of the participants had >8 years of service. Among the healthcare workers, 55.1% had participated in a training program on CMD, while 44.9% had not. When the total correct answers given by healthcare professionals regarding the time of heel prick were examined; physicians were found to be 75.3%, nurses 76.1%, midwives 77.3%. Although the percentages of all professional groups were close to each other, midwives gave the highest number of correct answers. Among the procedural steps before heel prick blood collection, the questions related to filling out the specimen paper were the ones with the most correct answers. Correct answers according to occupational groups are as follows: physicians 92.5%, nurses 99.2%, midwives 98.4%. Nurses were determined as the group with the highest number of correct answers. The correct answers given to the questions related to the applications for the region to be sampled from the pre-procedure steps are as follows; physicians 84.2%, nurses 88.9%, midwives 91%. It was observed that midwives gave more correct answers than other professional groups. The first blood sample is taken from each newborn baby 48 h after oral feeding following birth.' Significance was determined among the answers given to the question. The significance stems from the fact that at least the physicians answered "wrong" for this application (p: 0.034). 'To assess prematurity and low birth weight, gestational week and infant birth weight must be recorded.' Significance was determined among the answers given to the question. The significance stems from the fact that mostly physicians answered "I have no idea" for this application (p: 0.027). 'The baby's heel is cleaned with 70% isopropyl alcohol and the heel is dried with a dry sterile gauze pad to prevent the alcohol remaining on the skin from diluting the sample.' Significance was determined among the answers given to the question. The significance stems from the fact that

mostly physicians answered "I have no idea" for this practice (p: 0.041) (Table 1).

The correct answers given by healthcare workers to the steps of the procedure during heel prick blood collection were as follows: physicians 96.3%, nurses 96.5%, midwives 98.4%. Midwives were determined as the group giving the most correct answers (Table 2). The correct answers given by healthcare workers to all procedure steps were as follows: physicians 92.9%, nurses 96.9%, midwives 98.4%. It was observed that midwives were the health workers who gave the most correct answers to the steps (Table 3). The rate of correct knowledge of the definitions of the diseases screened within the scope of the Neonatal screening program by the occupational groups was 76.3% for physicians, 51.4% for nurses and 52.4% for midwives. It was observed that the group with the highest number of correct answers was physicians. A significance was found between the distribution of responses regarding disease definitions screened in NTP according to professional groups. The significance for PKU stems mostly from the fact that nurses answered "I have no idea" (p: 0.007). The significance for CH is mostly due to the fact that the midwives gave the "wrong" answer (p: 0.014). The significance for BD comes at least from the fact that physicians answered "I have no idea" (p: <0.001). The significance for CAH is due to the fact that the most physicians and the least nurses answered "right" (p: <0.001) (Table 4).

It was observed that 70.2% of physicians, 41.6% of nurses and 54.1% of midwives knew the symptoms of the diseases screened within the scope of Neonatal screening program correctly. It was found that physicians gave the most correct answers. A significance was found between the distribution of responses regarding the symptoms of screened diseases according to professional groups. The significance for PKU stems mostly from the fact that nurses answered "I have no idea" (p: 0.020). The significance for CH comes from the fact that physicians answered "right" the most and "I have no idea" the least (p: <0.001). The significance for BD stems from the fact that physicians responded the least with "no idea" and the nurses responded with "no idea" the most (p: 0.002). The significance for CF stems from the fact that physicians responded the least with "no idea" and the nurses responded with "no idea" the most (p:0.026). The significance for CAH comes from the fact that physicians responded at least "no idea" (p: 0.012) (Table 5).

It was determined that 52.2% of physicians, 47.8% of nurses and 36.7% of midwives knew correctly where to refer the patient according to the result. Here, physicians gave the most correct answers. According to the screening results, a significance was found between the distribution of the answers regarding the clinic to which the patients would be directed according to professional groups. The significance for CH is at least due to the fact that physicians answered "I have no idea" (p: 0.021). The significance for CF comes from the fact that midwives answered "I have no idea" (p: 0.037). The significance for CAH stems mostly from the fact that midwives answered "I have no idea" (p: <0.001) (Table 6).

### Discussion

One of the most important elements that show the level of development of a society is the promotion of health. A healthy society consists of healthy individuals. The aims of the services provided by health institutions in order to maximize the health welfare of societies include protecting the individual against diseases with preventive health services, taking the necessary precautions and ensuring the initiation of appropriate treatment (Sünter, 2019).

Newborn screenings are one of the preventive health services carried out by healthcare professionals. Screening for CMDs is of great importance for early detection and initiation of treatment. CMDs are diseases caused by gene variants that lead to abnormalities in the synthesis, metabolism, transport and storage of biochemical substances, with defects in the functioning of enzymes, receptors and transporters,

**Table 1**  
Distribution of responses regarding the procedural steps before heel blood collection according to occupational groups.

Profession	Right		Wrong		No Opinion		X <sup>2</sup> p-value
	n	%*	n	%*	n	%*	
<b>TIME FOR HEEL PRICK BLOOD COLLECTION</b>							
The first blood sample is taken from each newborn baby 48 h after oral feeding following birth.							
Physician	48	<b>81.4</b>	7	11.9	4	6.7	9.267
Nurse	35	68.6	16	31.4	0.0	0.0	<b>0.034</b>
Midwife	26	70.3	9	24.3	2	5.4	
Babies in neonatal intensive care units should have their first blood sample collected within the first 48 h for screening.							
Physician	49	83.1	6	10.2	4	6.7	7.210
Nurse	49	<b>96.0</b>	1	2.0	1	2.0	0.136
Midwife	29	78.4	4	10.8	4	10.8	
In order to reach every baby, the first blood sample should be taken at the last moment when babies born in health facilities leave the health facility.							
Physician	33	55.9	20	33.9	6	10.2	6.677
Nurse	31	60.8	16	31.4	4	7.8	0.154
Midwife	25	<b>67.6</b>	5	13.5	7	18.9	
Within the first week, a repeat blood sample should be taken at the family doctor's office or migrant health center.							
Physician	55	93.2	0.0	0.0	4	6.8	5.316
Nurse	48	94.1	2	3.9	1	2.0	0.109
Midwife	37	<b>100.0</b>	0.0	0.0	0.0	0.0	
A second blood sample should be taken from sick infants who are hospitalized in neonatal wards 48 h after they are switched to oral feeding.							
Physician	37	62.7	9	15.3	13	22.0	8.048
Nurse	31	60.8	16	31.4	4	7.8	0.090
Midwife	26	<b>70.3</b>	7	18.9	4	10.8	
<b>FILLING IN THE SAMPLE SHEET</b>							
Each page of the specimen sheet must be filled in properly and completely by hand, legibly and in ballpoint pen.							
Physician	55	93.2	2	3.4	2	3.4	3.129
Nurse	50	98.0	0.0	0.0	1	2.0	0.673
Midwife	37	<b>100.0</b>	0.0	0.0	0.0	0.0	
Care should be taken to ensure that all mandatory fields for accessing the baby, especially the mother's TR Identity Number, are filled in completely and correctly.							
Physician	56	94.9	0.0	0.0	3	5.1	3.059
Nurse	51	<b>100.0</b>	0.0	0.0	0.0	0.0	0.136
Midwife	37	<b>100.0</b>	0.0	0.0	0.0	0.0	
For multiple babies (twins, triplets, etc.), the number of babies should be written on the form.							
Physician	53	89.8	3	5.1	3	5.1	5.655
Nurse	51	<b>100.0</b>	0.0	0.0	0.0	0.0	0.129
Midwife	36	97.3	0.0	0.0	1	2.7	
To assess prematurity and low birth weight, gestational week and infant birth weight must be recorded.							
Physician	54	91.5	0.0	0.0	5	8.5	5.865
Nurse	51	<b>100.0</b>	0.0	0.0	0.0	0.0	<b>0.027</b>
Midwife	37	<b>100.0</b>	0.0	0.0	0.0	0.0	
The parental consent declaration section must be filled out for each baby whose blood was taken and for each baby whose blood was not taken, and the parents must sign it.							
Physician	55	93.2	0.0	0.0	4	6.8	3.973
Nurse	50	98.0	0.0	0.0	1	2.0	0.347
Midwife	35	<b>94.6</b>	1	2.7	1	2.7	
<b>APPLICATIONS FOR THE REGION TO BE SAMPLED</b>							
The baby's foot can be warmed with a warm towel for 3 min to increase blood flow in the area where the blood will be taken.							
Physician	48	<b>81.4</b>	2	3.4	9	15.3	0.965
Nurse	39	76.5	3	5.9	9	17.6	0.959
Midwife	30	81.1	2	5.4	5	13.5	
It is better to keep the baby's foot below the level of the heart to increase venous pressure.							
Physician	50	84.7	4	6.8	5	8.5	3.379
Nurse	47	92.2	1	2.0	3	5.9	0.490
Midwife	35	<b>94.6</b>	0.0	0.0	2	5.4	
The baby's heel is cleaned with 70% isopropyl alcohol and the heel is dried with a dry sterile gauze pad to prevent the alcohol remaining on the skin from diluting the sample.							
Physician	51	86.4	2	3.4	6	10.2	7.162
Nurse	50	<b>98.0</b>	1	2.0	0.0	0.0	<b>0.041</b>
Midwife	36	97.3	0.0	0.0	1	2.7	

\*Row percentage is taken; X<sup>2</sup>: pearson chi-square test.

with severe mental/physical symptoms and even death if left untreated (Guo et al., 2024). Health professionals, including pediatricians, family physicians, nurses and midwives, who take part in newborn screenings, must understand the importance of screenings and assume the responsibilities required by their roles. They should be responsible for coordinating the newborn screening process, starting from initial screening through diagnosis and treatment. The knowledge and awareness of healthcare professionals on the subject is critical for appropriate screening (American Academy of Pediatrics, 2000).

In this study, more than half of the participants (55.1%) stated that they had attended a training on CMDs and heel prick screening. Yıldız et al. (Yıldız et al., 2006) reported that 89.3% of the participants and Tunc reported that 64.3% (Tunc, 2006) did not receive training on this

subject. When compared with the literature, it is seen that although in-service training was found to be higher in this study, it was not sufficient. In-service training can be defined as teaching the knowledge, skills and behaviors necessary for employees to fulfill their duties efficiently and effectively. As in every institution, organizing in-service trainings in line with the needs of employees in health institutions provides benefits in many areas such as increasing productivity, reducing errors, gaining a sense of professional confidence, etc. (Buğdaylı & Akyürek, 2017). Organizing in-service trainings for healthcare workers at certain intervals in line with the service they provide and then evaluating the effectiveness of the training will ensure that the knowledge of healthcare workers on the subject remains more up-to-date and fresh and will help to increase the quality of the service provided.

**Table 2**  
Distribution of Responses Regarding the Procedural Steps During Heel Blood Collection According to Occupational Groups.

Profession	Right		Wrong		No Opinion		X <sup>2</sup> p-value
	n	%*	n	%*	n	%*	
The infant's heel is punctured with a sterile lancet at the medial and lateral outer edges of the heel with a depth of no >2.5 mm.							
Physician	57	96.6	1	1.7	1	1.7	3.050
Nurse	51	<b>100.0</b>	0.0	0.0	0.0	0.0	0.999
Midwife	37	<b>100.0</b>	0.0	0.0	0.0	0.0	
The first blood drop sample is wiped with sterile gauze as it may contain tissue fluid.							
Physician	57	<b>96.6</b>	1	1.7	1	1.7	3.885
Nurse	47	92.2	4	7.8	0.0	0.0	0.395
Midwife	35	94.6	1	2.7	1	2.7	
Squeeze the area very lightly and wait for the next drop to form spontaneously with free blood flow.							
Physician	57	96.6	1	1.7	1	1.7	1.738
Nurse	49	96.1	1	2.0	1	2.0	0.999
Midwife	37	<b>100.0</b>	0.0	0.0	0.0	0.0	
The resulting blood droplet is touched to the center of the ring on the filter paper, allowing the paper to absorb the appropriate amount of blood droplet.							
Physician	58	<b>98.3</b>	0.0	0.0	1	1.7	3.280
Nurse	50	98.0	1	2.0	0.0	0.0	0.701
Midwife	36	97.3	1	2.7	0.0	0.0	
Make sure that the drop of blood passes to the back of the paper.							
Physician	55	93.2	3	5.1	1	1.7	4.420
Nurse	49	96.1	0.0	0.0	2	3.1	0.279
Midwife	37	<b>100.0</b>	0.0	0.0	0.0	0.0	

\*Row percentage is taken, X<sup>2</sup>: pearson chi-square test.

The aim of newborn screening is to early diagnose intoxication-type metabolic diseases as a result of the pathological metabolites formed due to the disorder in the metabolic pathway reaching a level that can be detected in the body. For this reason, it is important that the heel blood sample is taken at the right time (48 h after oral feeding) in order to detect diseases. However, in some special cases, the sample collection time may be earlier and may need to be repeated later (Uslu et al., 2015).

In the study, physicians were the group with the highest percentage of correct answers (81.4%) that the first blood sample should be taken 48 h after oral feeding. The correct answer percentages of nurses and midwives were 68.6% and 70.3%, respectively. Tunç reported that 83.5% of nurses and midwives and Yıldız et al. reported that 70.7% of all participants knew the correct time of the first blood sample collection (Tunç, 2006; Yıldız et al., 2006). Although the study was similar to the literature in this regard, the majority of the participants knew the correct time of the first blood sample collection. In his study, Tunç found a significant relationship between the educational level of the

participants and the answers they gave and reported that the percentage of correct answers increased with increasing educational level (Tunç, 2006). Therefore, it may be considered that those who gave incorrect answers in this study may be those who did not receive CMD education.

The questions about the time of collection of the second blood sample and the time of collection in some special cases were mostly answered correctly by midwives. In the literature, Tunç reported that the time of collection of the second blood sample was known correctly with 91.2% and the time of collection in special cases was known correctly with 52.2% (Tunç, 2006). In the study by Yıldız et al. it was reported that the time of blood sampling in special cases was generally unknown (Yıldız et al., 2006). In this context, it is seen that the study supports the literature. The reason for the higher level of correct responses of midwives may be due to the fact that midwives have more knowledge about maternal and infant health due to their education.

Screening cards should be filled in completely and legibly, and the accuracy of the information should be confirmed with the family after

**Table 3**  
Distribution of the Responses Regarding the Procedural Steps After Heel Blood Collection According to Occupational Groups.

Profession	Right		Wrong		No Opinion		X <sup>2</sup> p-value
	n	%*	n	%*	n	%*	
Care must be taken not to place the blood in the envelope when it is wet.							
Physician	56	94.9	2	3.4	1	1.7	3.545
Nurse	51	<b>100.0</b>	0.0	0.0	0.0	0.0	0.524
Midwife	37	<b>100.0</b>	0.0	0.0	0.0	0.0	
The blood should be dried in a horizontal position at room temperature for at least 20.03 h.							
Physician	50	84.7	5	8.5	4	6.8	5.088
Nurse	47	92.2	1	2.0	3	5.9	0.272
Midwife	36	<b>97.3</b>	1	2.7	0.0	0.0	
Direct contact of the blood drop with heat and light should be avoided.							
Physician	56	94.9	0.0	0.0	3	5.1	2.197
Nurse	48	94.1	1	2.0	2	3.9	0.918
Midwife	36	<b>97.3</b>	0.0	0.0	1	2.7	
After the sample has dried, it should be placed in a moistureproof envelope and kept in the refrigerator until it is delivered to the provincial health directorate.							
Physician	56	94.9	1	1.7	2	3.4	5.020
Nurse	50	<b>98.0</b>	0.0	0.0	1	2.0	0.612
Midwife	36	97.3	0.0	0.0	1	2.7	
The personnel who transport the samples to the provincial health directorate should be informed that they should be protected from heat, light and moisture.							
Physician	56	94.9	0.0	0.0	3	5.1	3.059
Nurse	51	<b>100.0</b>	0.0	0.0	0.0	0.0	0.102
Midwife	37	<b>100.0</b>	0.0	0.0	0.0	0.0	

**Table 4**  
Distribution of Responses Regarding the Definitions of Diseases Screened in the NTP by Occupational Groups.

Profession	Right		Wrong		No Opinion		X <sup>2</sup> p-value
	n	%*	n	%*	n	%*	
<b>PKU</b>							
Physician	46	<b>78.0</b>	12	20.3	1	1.7	15.206
Nurse	23	45.1	23	45.1	5	9.8	<b>0.007</b>
Midwife	23	62.2	14	37.8	0.0	0.0	
<b>CH</b>							
Physician	55	<b>93.2</b>	4	6.8	0.0	0.0	9.322
Nurse	44	86.3	4	7.8	3	5.9	<b>0.014</b>
Midwife	27	73.0	8	21.6	2	5.4	
<b>BD</b>							
Physician	44	<b>74.6</b>	14	23.7	1	1.7	19.578
Nurse	25	49.0	15	29.4	11	21.6	<b>&lt;0.001</b>
Midwife	15	40.5	17	45.9	5	13.5	
<b>CF</b>							
Physician	42	<b>71.2</b>	15	25.4	2	3.4	6.084
Nurse	29	56.9	15	29.4	7	13.7	0.204
Midwife	20	54.1	12	32.4	5	13.5	
<b>CAH</b>							
Physician	38	<b>64.4</b>	17	28.8	4	6.8	26.669
Nurse	10	19.6	26	51.0	15	29.4	<b>&lt;0.001</b>
Midwife	12	32.4	15	40.5	10	27.0	

\*Row percentage is taken, X<sup>2</sup>: pearson chi-square test.  
PKU: Phenylketonuria, CH: Congenital Hypothyroidism, BD: Biotinidase Deficiency, CF: Cystic Fibrosis, CAH: Congenital Adrenal Hyperplasia.

completion. Accuracy of the mother's TR identity number and telephone number is important to be able to contact the family when necessary (Kim et al., 2003; Newborn screening sample collection guidelines, 2021). Writing the gestational week and birth weight is necessary to determine prematurity and low birth weight. In multiple babies, the number of babies should be specified to prevent confusion (Balk, 2007).

>90% of the healthcare workers who participated in the study answered the questions regarding the proper filling of the specimen sheet correctly. The occupational groups that gave correct answers were nurses (99.2%), midwives (98.4%) and physicians (92.5%), respectively. Beyzadeoğlu et al. reported that nurses/midwives (87.3%) gave more correct answers than physicians (67.6%) in filling out the sample sheet (Beyzadeoğlu et al., 2002). Yıldız et al. reported that 88% of the

**Table 5**  
Distribution of Responses Regarding the Symptoms of Screened Diseases by Occupational Groups.

Profession	Right		Wrong		No Opinion		X <sup>2</sup> p-value
	n	%*	n	%*	n	%*	
<b>PKU</b>							
Physician	42	<b>71.2</b>	17	28.8	0.0	0.0	12.596
Nurse	25	49.0	18	35.3	8	15.7	<b>0.020</b>
Midwife	24	64.9	11	29.7	2	5.4	
<b>CH</b>							
Physician	50	<b>84.7</b>	8	13.6	1	1.7	33.437
Nurse	19	37.3	19	37.3	13	25.5	<b>&lt;0.001</b>
Midwife	19	51.4	6	16.2	12	32.4	
<b>BD</b>							
Physician	35	<b>59.3</b>	23	39.0	1	1.7	17.460
Nurse	15	29.4	24	47.1	12	23.5	<b>0.002</b>
Midwife	20	54.1	12	32.4	5	13.5	
<b>CF</b>							
Physician	49	<b>83.1</b>	7	11.9	3	5.1	11.012
Nurse	30	58.8	7	13.7	14	27.5	<b>0.026</b>
Midwife	25	67.6	5	13.5	7	18.9	
<b>CAH</b>							
Physician	31	<b>52.5</b>	23	39.0	5	8.5	12.890
Nurse	17	33.3	18	35.3	16	31.4	<b>0.012</b>
Midwife	12	32.4	12	32.4	13	35.1	

\*Row percentage is taken, X<sup>2</sup>: pearson chi-square test.  
PKU: Phenylketonuria, CH: Congenital Hypothyroidism, BD: Biotinidase Deficiency, CF: Cystic Fibrosis, CAH: Congenital Adrenal Hyperplasia.

**Table 6**  
Distribution of the Responses Regarding the Clinic to Which the Patients will be Referred According to the Screening Results by Occupational Groups.

Profession	Right		Wrong		No Opinion		X <sup>2</sup> p-value
	n	%*	n	%*	n	%*	
<b>PKU</b>							
Physician	34	57.6	24	40.7	1	1.7	8.232
Nurse	31	<b>60.8</b>	15	29.4	5	9.8	0.061
Midwife	15	40.5	18	48.6	4	10.8	
<b>CH</b>							
Physician	42	<b>71.2</b>	15	25.4	2	3.4	11.594
Nurse	28	54.9	11	21.6	12	23.5	<b>0.021</b>
Midwife	22	59.5	6	16.2	9	24.3	
<b>BD</b>							
Physician	30	<b>50.8</b>	28	47.5	1	1.7	5.264
Nurse	20	39.2	25	49.0	6	11.8	0.333
Midwife	17	45.9	17	45.9	3	8.1	
<b>CF</b>							
Physician	18	30.5	24	40.7	17	28.8	10.237
Nurse	17	<b>33.3</b>	17	33.3	17	33.3	<b>0.037</b>
Midwife	7	18.9	8	21.6	22	59.5	
<b>CAH</b>							
Physician	30	50.8	24	40.7	5	8.5	19.233
Nurse	26	<b>51.0</b>	15	29.4	10	19.6	<b>&lt;0.001</b>
Midwife	7	18.9	15	40.5	15	40.5	

\*Row percentage is taken, X<sup>2</sup>: pearson chi-square test.  
PKU: Phenylketonuria, CH: Congenital Hypothyroidism, BD: Biotinidase Deficiency, CF: Cystic Fibrosis, CAH: Congenital Adrenal Hyperplasia.

participants and Tunç (Tunç, 2006) reported that 40.7% of the participants filled the specimen sheet completely. The findings of this study are similar to those of Yıldız et al. (Yıldız et al., 2006). The reason why nurses and midwives have a better command of filling out the specimen sheet than physicians may be due to the fact that physicians are in the background in this regard compared to nurses and midwives and that nurses and midwives perform these procedures.

The correct practices are warming the heel, keeping the foot below the level of the heart, using 70% isopropyl alcohol to clean the area where blood will be taken and drying the excess of the alcohol used (Aguilar Cordero et al., 2014; Heel prick procedure for newborn blood spot screening, 2021).

In this study, physicians (81.4%) responded that warming the baby's foot was a correct practice to accelerate blood flow, midwives (94.6%) responded that keeping the foot below the heart level would increase venous pressure, and nurses (98%) responded correctly about cleaning the area where blood would be taken. In the study by Yıldız et al. it was reported that 38.7% of the participants warmed the baby's foot, 56% positioned it, and 66.7% used the correct solution for cleaning the area where blood would be drawn (Yıldız et al., 2006). Beyzadeoğlu et al. reported that 26.5% of physicians and 82.3% of nurses/midwives reported that the knowledge of the participants about the appropriate area for blood sampling was correct (Beyzadeoğlu et al., 2002). Tunç, on the other hand, reported that all of the participants used alcohol for cleaning and 89.6% of them left the excess alcohol used for cleaning to dry (Tunç, 2006). When the study is compared with the literature, it is seen that the correct practices for the blood collection site are high. This may be due to the fact that the studies were conducted long before this study and the awareness of the importance of newborn screening has increased during this time, information updates, and developments in science and technology.

Nurses and midwives do not lack knowledge about the area where blood will be drawn and the material to be used. Tunç (Tunç, 2006) reported the level of knowledge of this subject as 91.2% and Yıldız et al. reported it as 76% (Yıldız et al., 2006). Although a serious lack of knowledge was not observed in the studies compared in the literature, there was almost no lack of knowledge about the subject mentioned in this study. The continuity of the practices may be considered as the reason for this.

It is known by >90% of the participants that the first bloodstain should be erased. Tunç (Tunç, 2006) reported the level of correct

application of this subject as 64.8% and Yıldız et al. (Yıldız et al., 2006) reported it as 57.3%. Compared to other studies, the knowledge level of the participants in this study was higher.

Not squeezing the heel too much is correctly known by physicians (96.6%), nurses (96.1%) and midwives (100%). Tunç (Tunç, 2006) and Yıldız (Yıldız et al., 2006) reported that the percentages of knowledge on the subject were 41.8% and 40.7%, respectively. Compared to the literature, the level of knowledge in this study is almost more adequate. This may be thought to be due to the development of technology and the easier access to accurate information.

Most of the participants gave correct answers to the questions that the blood drop should be impregnated on the paper in such a way that the appropriate amount of rings are filled (physicians 98.3%, nurses 98%, midwives 97.3%) and the blood sample taken should pass to the back side of the paper (physicians 93.2%, nurses 96.1%, midwives 100%). Tunç (Tunç, 2006) reported 94.5%, Yıldız et al. (Yıldız et al., 2006) reported 99.3%, and 90.7% of the participants correctly knew that the blood sample should pass to the back of the paper and that the blood sample should pass to the back of the paper. The finding is similar to the findings in other studies.

As healthcare professionals, having accurate and adequate knowledge about CMDs, which are rare diseases, is important in terms of detection, treatment and follow-up of the disease, as well as informing and raising awareness of families and society (Aktuğlu Zeybek, 2003). When the participants were asked about the definitions of the diseases screened in this study; for Phenylketonuria (PKU), physicians 78%, nurses 45.1%, midwives 62.2%, for Congenital Hypothyroidism (CH), physicians 93.2%, nurses 86.3%, midwives 73%, for Biotinidase Deficiency (BD), physicians 74.6%, nurses 49%, midwives 40.5%, physicians 71.2%, nurses 56.9%, midwives 54.1% for Cystic Fibrosis (CF), physicians 64.4%, nurses 19.9%, midwives 32.4% for Congenital Adrenal Hyperplasia (CAH). The mean percentages of correct knowledge of the definitions of the diseases screened in the literature are as follows: Tunç (Tunç, 2006), 33% for PKU, Demirtaş et al. (Demirtaş et al., 2019) 89.6% for CF, Beyzadeoğlu et al. (Beyzadeoğlu et al., 2002) 86% for physicians and 60% for nurses/midwives. The study is similar to the literature. However, although PKU is the first disease to be screened, the percentage of correct knowledge is not at the level it should be. It is seen that nurses and midwives have more knowledge gaps than physicians. The fact that physicians have more knowledge in this field may be thought to be the reason why physicians have more knowledge in this field, since physician education primarily focuses on preventive medicine and diagnosis of health problems, and nursing and midwifery education primarily focuses on preventive services and practices to improve health.

Regarding the symptoms of the diseases screened within the scope of the newborn screening program; for PKU, physicians 71.2%, nurses 49%, midwives 64.9%; for CH, physicians 84.7%, nurses 37.3%, midwives 51.4%; for BD, physicians 59.3%, nurses 29.4%, midwives 54.1%; for CF, physicians 83.1%, nurses 58.8%, midwives 67.6%; for CAH, physicians 52.5%, nurses 33.3%, midwives 32.4% gave correct answers. In Tunç's study, approximately 52% of the participants knew the symptoms of PKU correctly. In the study of Demirtaş et al. (Demirtaş et al., 2019), the percentage of correct knowledge of CF symptoms was approximately 85%. The study is similar to the literature in terms of knowing the main symptoms of the diseases. It was found that healthcare workers, especially nurses and midwives, had a knowledge gap on this subject.

Babies with suspicious results after screening are referred to the relevant clinics. The Ministry informs the Provincial Directorate of Health and then the family physicians that the result is suspicious and they should be referred to the relevant clinic immediately. In the study, the percentage of correct knowledge of the clinic to be referred according to the screening result was as follows: For PKU, physicians 57.6%, nurses 60.8%, midwives 40.5%; for CH, physicians 71.2%, nurses 54.9%, midwives 59.5%; for BD, physicians 50.8%, nurses 39.2%, midwives 45.9%;

for CF, physicians 30.5%, nurses 33.3%, midwives 18.9%; for CAH, physicians 50.8%, nurses 51%, midwives 18.9%. In the literature, Demirtaş et al. (Demirtaş et al., 2019) reported that referral for CF was known correctly by 62.2%. It is seen that there is a knowledge gap among healthcare workers regarding referral.

In this study, it was found that the participants did not have sufficient knowledge about the diseases, although the percentage of correct answers to questions about heel prick screening was high. The reason for this may be that the number of infants diagnosed with CMD in the last six years in the province where the study was conducted was 23, there were no infants diagnosed with CF and CAH screening had not started to be performed yet; therefore, not many sick infants were encountered and the lack of information was not felt.

### Strengths

One of the strengths of this study is that the province where the study was conducted is small and therefore the results of the study can be easily evaluated with the participants. Sharing the results of the study with the provincial health directorate enables the organisation of trainings for healthcare workers on the necessary issues. Again, awareness has been created in the healthcare professionals participating in the study and the majority of the participants requested that the results of the study be reported to their parties. With the survey questions used in the study, it was tried to emphasise the importance of every stage of screening, starting from genetic counseling to the care of the baby diagnosed with CMD and the education of the family. Thus, it is aimed to prevent problems in early diagnosis and treatment. In addition, the lack of sufficient studies on the subject in our country and the fact that the study will contribute to the literature can be considered among the strengths.

### Study limitations

This study was conducted within a limited period of time because it is a master's thesis. The results can only be generalized to healthcare professionals who received heel prick screening within the borders of the province where the research was conducted. In addition, the limitations of the study include being in the pandemic process at the time of the study, having healthcare workers on leave on the day of data collection, and the unwillingness of some healthcare workers to participate in the study.

### Implications to practice

Genetic diseases are more common in our country where consanguineous marriages are common. With the role of educator, which is among the modern roles of nursing, it is possible to raise awareness of the society on this issue and to inform about diseases, main symptoms of diseases, treatment and care. With the role of researcher, it is ensured that knowledge accumulation is increased by conducting research on issues specific to the profession (Altay, 2018; Aydemir Gedük, 2018; Taylan et al., 2012). Today, since midwives work in the same position and field as nurses, the duties, responsibilities and roles of nurses are also valid for midwives. Physicians, on the other hand, are responsible for following the developments in issues related to diseases and improving themselves due to their profession and the education they receive. However, today, it is seen that the importance given to practices in addition to basic medical education in physician education and to basic medical education in addition to practices in nursing and midwifery education has increased.

### Conclusion

When the percentages of correct answers to the questions posed to the health workers are analyzed, it is found that the questions regarding

the steps before, during and after the collection of heel prick blood sample are answered correctly by the majority of the participants. However, almost half of the participants did not know that if the baby leaves the hospital before completing 48 h, the first blood sample should be taken at the last moment of departure and when to take a duplicate sample from babies followed up in neonatal wards. In addition, it is seen that all participants, especially nurses and midwives, have knowledge gaps in the definitions of the diseases screened, their findings and referral according to the results. In line with the results obtained from the study, it is important to plan in-service trainings for health workers on the subjects where lack of information is determined, to encourage and ensure that health workers provide information to the public in order to ensure the permanence of the information provided through training, to establish a consultancy unit on the subject in primary and secondary health care institutions and to assign health workers, to open certified training programmes on the subject.

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## Compliance with ethical standards

The study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was obtained from the University Clinical Research Ethics Committee and written permission was obtained from Kırşehir Provincial Health Directorate. Participation in the study was voluntary, and verbal and written consent was obtained from the health professionals included in the study after they were informed about their rights to study, confidentiality, confidentiality and withdrawal from the study.

## CRediT authorship contribution statement

**Rabia Bayrak:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Ayla Ünsal:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Ali Güneş:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

## Declaration of competing interest

The authors have any personal and financial conflicts of interest or disclosures to report.

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