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Quality Analysis of Congenital Hypothyroidism Screening (CHS) Implementation in Newborns by Independent Midwives: A Review of Sample Collection Time, Specimen Quality, and Speed of Follow-up Results

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A B S T R A C T

This descriptive analytical cross-sectional study assessed the quality of Congenital Hypothyroidism Screening (CHS) implementation by Independent Midwives, a vital program for preventing intellectual developmental delay caused by congenital hypothyroidism (CH). The study involved 60 newborns at BPM Kustini, Lamongan (January-June 2025). Quality was evaluated across three critical points: timeliness of sample collection, quality of Dried Blood Spot (DBS) specimens, and speed of follow-up on results. The findings indicated that 66.67% of samples were collected on time (48-72 hours), 75% of DBS specimens were of good quality, and 83.33% of follow-up results were conducted quickly (≤ 10 days). Bivariate analysis using the Chi-Square test revealed significant correlations between the timeliness of sampling and the quality of DBS specimens (p=0.002) and between specimen quality and the speed of follow-up results (p=0.003). Overall, the quality of CHS in independent midwifery practices was promising. Timeliness of sample collection was found to be key to producing high-quality DBS specimens, which, in turn, affected the speed of result follow-up. The study recommends improving midwives' technical competence and family education, and strengthening the referral system to reinforce CHS's success in community services.

Introduction

Every baby has the right to start life with the opportunity to grow and develop optimally. However, in some babies, the risk of developmental disorders can arise from the moment they first open their eyes (Noflidaputri & Meilinda, 2020). One such disorder is congenital hypothyroidism (CH), a condition in which the thyroid gland does not function properly from birth. Without early detection and treatment, this disorder can cause developmental delays, intellectual impairment, and permanent disability, even though such damage can be prevented if detected and treated early in life (Noflidaputri & Meilinda, 2020; Andarwulan et al., 2020; Rosyida, 2023).

Congenital Hypothyroidism Screening (CHS) is the first step in determining the future of thousands of babies every year. Through a single drop of blood from the baby's heel (dried blood spot/DBS), healthcare professionals can assess TSH levels and detect early signs of thyroid dysfunction. International studies indicate that screening conducted 48–72 hours after birth provides the highest

accuracy and reduces false positives, as neonatal TSH levels are more stable within this timeframe (Peters et al., 2016).

Congenital hypothyroidism (CH) represents a major, yet preventable, cause of intellectual developmental delay. As a relatively common neonatal endocrine disorder, CH can significantly impair future physical growth and cognitive development. Consequently, numerous nations have instituted neonatal thyroid screening programs as a crucial early detection strategy to ensure prompt therapeutic intervention (Peters et al., 2016). Congenital hypothyroidism is typically a sporadic disorder with an estimated global incidence of approximately 1 in 3,000 to 4,000 live births. However, regional data reveal significant variability. Prevalence rates in Singapore (1:3,000-3,500), Malaysia (1:3,026), and the Philippines (1:3,460) align closely with global estimates. Hongkong reports a slightly higher frequency of 1:2,404. In contrast, studies indicate the highest incidence rates in India (1:1,700) and Bangladesh (1:2,000), whereas markedly lower rates are observed in Korea (1:4,300), Vietnam (1:5,502), and Japan (1:7,600) (Khan et al., 2024). Critically, the majority of affected newborns are asymptomatic and appear clinically healthy at birth, underscoring the necessity of systematic screening to identify cases during the neonatal period before the condition progresses and causes irreversible neurodevelopmental damage (Bowden & Goldis, 2023).

In Indonesia, many babies are born in community health facilities, and independent midwifery services play an important role in implementing CHS. According to data from the Indonesian Health Survey, only 16,4% of newborns currently undergo screening for congenital hypothyroidism at birth (Kemenkes RI, 2023). Midwives play a pivotal role in addressing this gap, as they are positioned at the forefront of maternal care. By serving as the primary point of contact and maintaining frequent, early engagement with mothers, midwives act as trusted figures for families. However, implementing CHS in the field remains challenging. Several studies highlight three critical points that greatly determine the quality of screening: the timeliness of sample collection, specimen quality, and the speed of follow-up on positive results (Holder et. al., 2021; Moat et al., 2024).

Results from screening programmes in 11 provinces in Indonesia found an incidence of HK of approximately 1:2,736 live births, suggesting that this condition occurs more frequently than in developed countries (Setyaningsih & Wulandari, 2022). On the other hand, there are reports of a rate of 1:12,724 live births, but this figure is believed not to reflect the actual prevalence, but rather the result of insufficient screening coverage that has not reached all newborns (Fernandes et al., 2024).

The objectives of this study are 1) to analyse the timeliness of CHS sampling in newborns conducted by independent midwives; 2) to assess the quality of dried blood spot (DBS) specimens produced by independent midwives in the implementation of CHS; 3) to evaluate the speed of follow-up of CHS results by independent midwives; 4) to analyse the relationship between the quality of DBS specimens and the speed of follow-up of CHS results; 5) to analyse the relationship between the timeliness of sampling and the quality of DBS specimens.

Previous studies at the Bengkuang Community Health Center demonstrated that screening implementation is affected by factors including technical skills, logistical support, family consent, and

regulatory policy (Nuraini, 2020; Setyaningsih et al., 2022; Sonia et al., 2025). Furthermore, research at the Tebing Syahbandar Community Health Center identified the availability of medical consumables, health worker competence, and techniques for parental education as critical determinants (Iswati & Rosyida, 2020; Nasution et al., 2025)—efforts to improve the involved resources as required to optimize the effectiveness of the screening program.

The gap in this research is that although congenital hypothyroidism screening programmes (CHSP) have been implemented in various facilities in Indonesia, most previous studies have focused more on screening coverage, laboratory method accuracy, or policy reviews at the national and hospital levels. Very few studies have specifically examined the quality of CHSP implementation at the primary care level, particularly in independent midwifery practices.

In practice, three critical points greatly determine the success of CHS but have not been comprehensively evaluated, namely 1) the timing of sample collection, where babies are often too young, causing midwives to face a dilemma in collecting samples; 2) The quality of DBS specimens, where simple errors in specimen collection and handling (blood too thick, not completely dry, mixed with lotion/cream, or examination paper) can occur; 3) The speed of follow-up results, where delays in recall confirmatory tests and therapy before day 14 can have an impact on permanent neurological damage (Pulungan et al., 2024; Octavius et al., 2023).

Prior studies highlight critical hurdles in sample collection due to neonates being discharged within 24 hours and a 38.3% prevalence in facilities, resulting in diagnostic delays (Pulungan et al., 2024). Additionally, midwives' proficiency is a pivotal determinant; however, technical gaps in the screening process remain evident. This underscores the urgent need for targeted training programs for healthcare workers (Sonia et al., 2025). The novelty of this study lies in its focus on evaluating the quality of Congenital Hypothyroidism Screening (CHS) implementation at the level of independent midwives, rather than at hospitals or the policy level, by assessing three critical points that greatly determine the success of screening, namely the timeliness of sample collection, the quality of dried blood spot (DBS) specimens, and the speed of follow-up on results.

This approach has not been widely researched, particularly in the context of community services in Indonesia, as most previous studies have only highlighted programme coverage, laboratory test accuracy, or national policy flows. By combining technical analysis and social communication factors among midwives, families, and referral systems, this study offers a new, more comprehensive perspective on the quality of CHS, while also opening up opportunities for realistic, applicable field-based intervention recommendations.

Methods

This study employed a quantitative, descriptive-analytical design using a cross-sectional approach to assess the quality of Congenital Hypothyroidism Screening (CHS) implementation by Independent Midwives over a single observation period, without conducting long-term follow-ups. This approach was chosen to obtain an overview of the relationship between the timeliness of sample

collection, the quality of dried blood specimens, and the speed of follow-up on CHS results at a single measurement point.

This research was conducted at Kustini's Independent Midwifery Practice, SST, M.Kes Lamongan, from January to June 2025. The research population consisted of all newborns who underwent CHS sampling at the midwifery practice in the research area. Sampling was conducted using a total sampling technique, where the entire population served as the research sample, comprising 60 newborns.

The variables in this study were the independent variables of sampling time and dry blood specimen quality, and the dependent variable of follow-up speed. Data collection in this study was conducted through observation checklists, specimen audit forms, and follow-up time records. Data analysis uses univariate analysis to display the frequency distributions of timeliness, specimen quality, and follow-up speed, and bivariate analysis using the Chi-square test to examine relationships between variables.

The ethics of this research were ensured through the provision and signing of informed consent forms by all participants. It is used as a form of informed consent, in which participants agree to participate after receiving a clear explanation of the research. Researchers first provide information on the research's purpose, data collection procedures, benefits, and potential discomforts. Information is conveyed honestly and openly, using language that is easy to understand. Ethical clearance was obtained from the Research Ethics Committee of Universitas Dr. Soetomo Surabaya under certificate number OU.176.E/VII/2025.

Results

Table 1. Characteristics of Variables

Variable	Frequency n = 60	%
Sampling Time		
On Time (48-72 hours)	40	66.67
Inaccurate (>72 hours)	20	33.3
Quality of Dried Blood Specimens (DBS)		
Good (homogeneous, full spot, no layering, no contamination)	45	75
Poor (small spots, layering, double spots, not dry)	15	25
Speed of Follow-up on CHS Results		
Fast (≤10 days)	50	83.3
Slow (≥10 days)	10	16.67

Table 1 presents the descriptive characteristics for the assessment of Congenital Hypothyroidism Screening (CHS) implementation quality, based on a total sample of 60 newborns. The data indicate that the majority of samples were collected on time (48-72 hours), accounting for 66.67% (n=40) of the cases. Conversely, 33.3% (n=20) were classified as inaccurate because collection occurred after 72 hours. In terms of specimen quality, good specimens constituted a significant majority at 75% (n=45). The remaining 25% (n=15) were categorized as poor quality. The follow-up process demonstrated high efficiency, with fast execution (≤ 10 days) observed for 83.3% (n=50) of the results. Only 16.67% (n=10) of the follow-ups were classified as slow (≥ 10 days).

Table 2. Relationship Between The Timeliness of Sample Collection and The Quality of DBS Specimens

Sampling Time	Good	Poor	Total	p-value
On Time (48-72 hours)	35	5	40	
Inaccurate (> 72 hours)	10	10	20	0.002
Total	45	15	60	

Based on Table 2, the p-value is 0.002, less than the significance level of 0.05 ($p<0.05$). So it can be concluded that there is a significant relationship between the timeliness of sample collection and the quality of DBS specimens. Samples collected within 48-72 hours are more likely to produce good-quality specimens, while late collection (>72 hours) tends to produce poorer-quality specimens.

Table 3. Relationship Between DBS Specimen Quality and Speed of Follow-up on CHS Results

Specimen Quality	Fast Follow-up	Slow Follow-up	Total	p-value
Good	42	3	45	
Poor	8	7	15	0.003
Total	50	10	60	

Based on the table, the p-value of 0.003 is less than the significance level of 0.05 ($p<0.05$). So it can be concluded that there is a significant relationship between the quality of DBS specimens and the speed of follow-up on CHS results. In specimens of good quality, most follow-ups were conducted promptly (42 out of 45), whereas in specimens of poorer quality, the proportion of delayed follow-ups was higher (7 out of 15).

Discussion

Timeliness of CHS sampling in newborns conducted by independent midwives

The results of the study show that most congenital hypothyroidism screening samples were taken within 48-72 hours after birth. Sampling at this time is in line with international recommendations, as this period is considered the most stable phase for assessing neonatal thyroid hormone levels. During the first 24 hours, the infant's TSH levels undergo a physiological surge as the infant adapts to the environment outside the womb, so sampling too early risks yielding biased or questionable results (van Trotsenburg et al., 2021).

Conversely, if sampling is performed too late, the risk of delayed diagnosis increases, especially in cases of congenital hypothyroidism that require immediate treatment to prevent neurological damage. Ideally, testing should be performed within 48-72 hours to maintain test accuracy and accelerate early detection (van Trotsenburg et al., 2021). In addition to physiological factors, the timing of collection is also closely related to the quality of the dried blood spot (DBS) specimen. When midwives collect samples at the right time, capillary blood flow is more optimal, making it easier to obtain a homogeneous, full blood spot that does not layer (Majid et al., 2024).

The quality of DBS is greatly influenced by the technique and timing of collection, with appropriate timing helping reduce the risk of specimens being declared unfit for analysis or requiring repeat testing. This aligns with (Majid et al., 2024), which emphasises that timing, technique, drying, and specimen handling are crucial to the success of DBS-based screening. Implementation in the field, particularly in midwife-led practices, is often influenced by social dynamics and community customs (Hindrati et al., 2024; Mudlikah, 2024). Ideally, collection should be performed on the second to third

day postpartum; however, in practice, some mothers are discharged earlier, or neonatal follow-up does not proceed as scheduled. This situation requires midwives not only to master technical skills but also to strengthen communication, family education, and the scheduling of follow-up visits so that appointment timing remains in line with standards. (van Trotsenburg et al., 2021) explain that the success of neonatal screening is primarily determined by coordination between health workers, families, and the follow-up system.

Overall, the results of this study confirm that specimen collection is not merely a clinical procedure but rather an integral part of the CHS screening quality system. When collection times can be maintained in accordance with standards, specimen quality improves, laboratory analysis processes become more efficient, and follow-up on results can be carried out more quickly, ultimately increasing the chances of babies with congenital hypothyroidism being detected and treated at the right time.

Quality of Dried Blood Spot (DBS) Specimens Produced by Independent Midwives in the Implementation of CHS

The results of the study indicate that the dried blood specimens obtained were in adequate condition for Congenital Hypothyroidism Screening (CHS). The quality of the blood spots, which were homogeneous, evenly distributed, and uncontaminated, was an important factor in obtaining accurate TSH analysis results. When blood completely covers the surface of the filter paper and does not form layers, the absorption process and laboratory analysis are more optimal. This is in line with the findings (Chace et al., 2014), which confirm that the quality of Dried Blood Spots (DBS) is highly dependent on the puncture technique, puncture depth, and sample handling from initial collection through delivery to the laboratory.

In addition to the drip technique, the competence of health workers also plays a significant role in determining specimen quality. (Victor R. De Jesus, 2021) states that trained screening personnel will be better able to produce samples ready for analysis because they understand basic principles such as the single-drip point, avoiding direct contact with the filter medium, and ensuring adequate drying at a suitable room temperature. Conversely, uneven or pooled blood spots typically result from improper needle pressure, repeated drops at the same spot, or rushing through the collection procedure.

The quality of DBS is also greatly determined by the drying and storage processes. (Grüner et al., 2015) emphasise that specimens packaged before they are scorched are at risk of changes in blood structure, which can subsequently lead to misinterpretation of TSH values. Therefore, simple steps such as waiting for the sample to dry completely before packaging, keeping it away from damp surfaces, and avoiding surface contamination are non-negotiable quality standards in neonatal screening programmes.

These findings confirm that the quality of DBS specimens depends not only on the equipment or media, but primarily on the accuracy of clinical procedures and the competence of health workers. By ensuring correct techniques, sufficient drying time, and proper handling procedures, independent midwives can play a strategic role in improving the success of CHS programmes and preventing delays in the diagnosis of congenital hypothyroidism from the first days of life.

Speed of Follow-up on CHS Results by Independent Midwives

The results of the study show that most follow-up actions on CHS results can be completed within the appropriate time frame. The speed of following up on laboratory results is a key component because delays in identifying congenital hypothyroidism can potentially cause long-term effects on a baby's growth and development. The screening programme is designed so that babies suspected of being positive can receive a confirmed diagnosis and treatment immediately, ensuring their brain development remains on an optimal track in the early stages of life.

These findings show that independent midwives can play an effective role as the front line of the early detection system (Baska et al., 2025). This is possible because midwives have direct access to parents and make repeated contact after delivery, either through home visits or practice services. According to Rose et al. (2023), follow-up CHS should ideally be carried out within 7-10 days of life to prevent delays in levothyroxine therapy.

Meanwhile, a small number of cases with slow follow-up have been found. These obstacles can arise from two sources: technical and communication factors (Setyowati et al., 2020). From a technical perspective, delays often occur because of the time required to distribute information from the laboratory to primary health facilities. From a communication perspective, obstacles can arise when family contact numbers are difficult to reach or when parents do not understand the urgency of CHS, causing them to delay their response. (Chace et al., 2014) emphasise that a tiered communication system and consistent education for families greatly influence the success of CHS follow-up.

The above findings indicate that maintaining follow-up speed requires a more systematic, coordinated approach. Independent midwives are on the right track, but they need additional support through a digital reminder system, stronger cross-facility coordination, and repeated socialisation with families about the impact of delayed treatment. With these steps, follow-up on CHS cases can be fast, equitable, and continuous so that the main objective of screening, which is to prevent developmental delays due to congenital hypothyroidism, can be fully achieved.

The Relationship between DBS Specimen Quality and the Speed of Follow-up on CHS Results

The results of this study indicate a significant relationship between the time of sampling (48-72 hours vs. >72 hours) and the quality of dried blood spot (DBS) specimens. Specifically, samples collected within the ideal 48-72 hour window were much more likely to yield high-quality specimens than those collected later (<72 hours). These findings are of significant importance in the context of congenital hypothyroidism screening at the primary care level.

Physiologically, sampling too early or too late can affect the condition being sampled, for example, capillary blood volume that is not yet ideal, capillary pressure that is still changing, or neonatal metabolism that is not yet stable (Rose et al., 2023). Conversely, sampling at the appropriate time (48-72 hours) allows the baby's condition to stabilise and capillary blood flow to become more optimal. This has implications for the quality of the blood spot on the filter paper, which should be complete, homogeneous, free from other fluids, and completely dry.

According to Majid et al. (2024), "The quality of dried blood spot (DBS) specimens impacts

newborn screening results, hence proper training is crucial for DBS specimen collection." (APHL, 2014) asserts that specimen collection within the recommended time frame is essential: "initial newborn screening specimens should be collected at 24 to 48 hours of life. Although the range in this study was 48-72 hours, these findings are consistent with the general principle that the closer to the ideal time, the better the collection quality.

The sampling process carried out by independent midwives often faces real challenges in terms of timing: babies are discharged early, facilities may be limited, or family education may be inadequate. If midwives collect samples too early because the baby is being discharged, the risk of suboptimal specimens increases, leading to insufficiently full, mixed, or not-dry-enough spots. Conversely, delaying sampling until ideal conditions are met without guaranteeing the infant's return also carries risks, as it may yield poor-quality specimens or result in no sample being collected.

The findings of this study confirm that the success of the CHS programme is not only determined by the availability of laboratory facilities and national policies, but mainly by the quality of implementation at the front line, namely the services provided by independent midwives. The timeliness of sample collection, the quality of dried blood specimens, and the speed of follow-up on results are integral to a process that cannot be separated. When all three are carried out well and consistently, the chances of babies receiving early diagnosis and timely treatment increase, while also preventing permanent developmental disorders.

CHS is not just about laboratory testing, but about saving a child's quality of life from the very first days of birth. Every timely action taken by midwives during this period is a long-term investment in the future of the next generation (Hastatiarni et al., 2023). Therefore, continuous improvement, system support, and strengthening midwives' capacity are key to ensuring that no baby is denied the opportunity to grow and develop optimally.

The Relationship Between the Timeliness of Sample Collection and the Quality of DBS Specimens

The results of the study indicate that the quality of dried blood spots (DBS) tends to be better in groups whose samples were collected within the recommended time frame. Timeliness has been shown to play a role in producing homogeneous, easy-to-analyse specimens that do not suffer blood structure damage. Conversely, delays in sampling can lead to technical problems such as uneven spots, layering, or suboptimal absorption on filter paper, thereby increasing the likelihood that specimens will be declared unfit for testing. This aligns with the opinion (Moat et al., 2024) that DBS quality is influenced by blood hormone stability and the baby's physiological condition in the first hours of life.

These findings reinforce the basic principle of congenital hypothyroidism screening, emphasising the importance of the time window as a key determinant of the programme's success. During the appropriate period, TSH levels in the circulation tend to be stable for analysis, enabling laboratories to produce more accurate interpretations. Conversely, delaying sample collection risks producing questionable results or requiring retesting. This is not only detrimental from a technical standpoint, but also places an additional psychological burden on families who must undergo further procedures (APHL, 2014). Delayed sample collection increases the likelihood of delayed diagnosis, as reduced

specimen quality reduces diagnostic accuracy.

Statistical tests show a significant relationship between timeliness and specimen quality, indicating that DBS quality is determined not only by sampling skills but also by timely decisions during its implementation. These results illustrate that procedural accuracy in the early days of a baby's life is a clinical investment. When specimens are of good quality, the laboratory follow-up process runs quickly, and the risk of reconfirmation can be minimised. Thus, midwives, as the primary screeners, play a central role in maintaining service quality.

Overall, the relationship between sampling time and DBS specimen quality confirms that successful screening relies not only on the availability of equipment and technical training, but also on adherence to the time standards set by national and international protocols. Timeliness is the starting point of an effective diagnostic chain, and it is from there that early diagnosis can be achieved to prevent the long-term effects of congenital hypothyroidism on child growth and development.

Conclusions

This study concludes that the implementation of Congenital Hypothyroidism Screening by independent midwives generally demonstrates satisfactory performance, evidenced by a 66.67% rate of timely and ample collection, 75% prevalence of good-quality specimens, and 83.33% achievement in rapid result follow-up. Statistical analysis confirms a significant correlation between the timeliness of sample collection and Dried Blood Spot (DBS) specimen quality ($p=0.002$), as well as between specimen quality and the speed of result follow-up ($p=0.003$). These findings underscore that midwife adherence to the standard sampling window (48-72 hours) is a primary determinant of specimen quality, which, in turn, accelerates the diagnostic process and mitigates the long-term sequelae of congenital hypothyroidism in newborns.

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