

NEONATAL HEARING SCREENING BY CHILD HEALTH SERVICES IN THE NETHERLANDS

The neonatal hearing screening consists of a three-round screening. The OAE (OtoAcoustic Emission) method is used in rounds 1 and 2, and the AABR (Automated Auditory Brainstem Response) method in round 3. When adequate hearing is not demonstrated after these three rounds of screening, referral to an audiological center (AC) follows. A small proportion of children follows a different screening protocol (e.g., AABR-AABR).

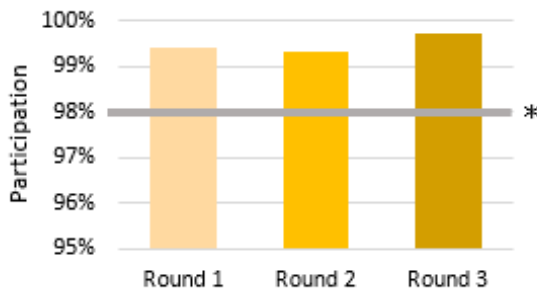
SCREENING BY CHS

164.415 children eligible

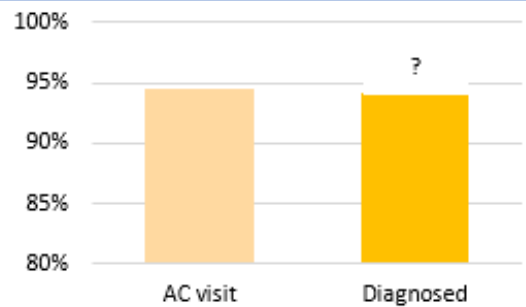
DIAGNOSIS AT THE AC

680 children referred

Participation

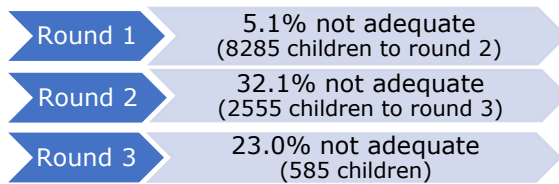


- Screening participation rates are high.

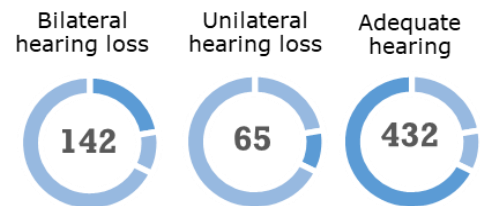


- Between 94,2% and 98,5% of the referred children received a diagnosis.

Referral / findings

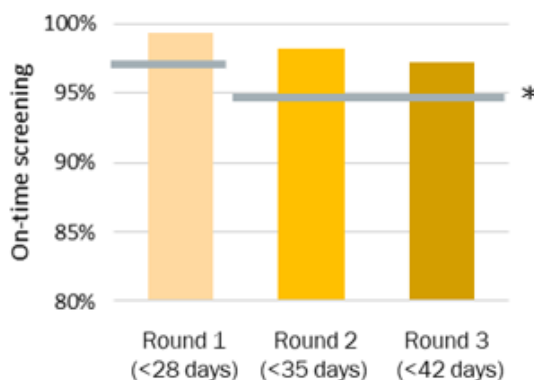


- The number of referrals to the AC by the standard three-round screening (i.e., OAE-OAE-AABR) is low (0.37%), but higher than for 2021 and earlier ($\leq 0.32\%$).
- Another 93 children were referred through other screening routes (mainly OAE-AABR).
- A total of 680 children were referred to the AC (0.41%).

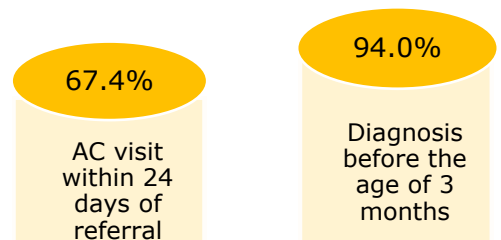


- 207 children with hearing loss ≥ 40 dB were identified.
- 32% of the 639 children with a known diagnosis have hearing loss.

Timeliness



- The signal values for timely screening were met.



- The diagnosis should be made within 3 months in $\geq 95\%$. As in previous years, this condition was not satisfied.

*Signal value: minimum target value

Diagnosis refers to (not) having permanent hearing loss of at least 40dB in one or both ears.

NEONATAL HEARING SCREENING

The neonatal hearing screening (NHS) is a nationwide population screening offered to every newborn in The Netherlands by Child Health Services (CHS). The NHS is financed by municipalities.

The aim of the NHS is on-time identification of children with permanent hearing loss of at least 40dB in one or both ears, so that suitable intervention can be started in children with bilateral hearing loss before the age of six months.

The Center for Population Screening of the Dutch National Institute for Public Health and the Environment (RIVM) coordinates a number of national tasks for the NHS, including the annual monitoring of implementation quality. The Centre for Population Screening commissions an independent party to do this. This monitor serves as its report.

Children who are admitted to a Neonatal Intensive Care Unit (NICU) receive the hearing screening as part of their care there. This is not covered by this monitor.

THREE-ROUND SCREENING

The neonatal hearing screening consists of a three-round screening. The OAE (OtoAcoustic Emission) method is used in rounds 1 and 2, and the AABR (Automated Auditory Brainstem Response) method in round 3. When adequate hearing is not demonstrated after these three rounds of screening, referral to an audiological center (AC) follows. Children who are at risk for auditory neuropathy are exclusively screened with the AABR in two rounds. More information about this and the neonatal hearing screening program can be found in the neonatal hearing screening scripts of CHS (<https://www.pns.nl/draaiboek-gehoorscreening>).

MONITOR FOR 2022

This monitor reports the results of the neonatal hearing screening program of children born in 2022. The indicators established for this purpose were used (see [the set of indicators](#) of the neonatal hearing screening scripts of CHS).

DIFFERENCE WITH THE PREVIOUS MONITOR CHANGES AT CHS ORGANIZATIONS

In 2022, organization 51 merged into organisation 39, and organisation 71 was added to organization 32 mid-year. Furthermore, organization 31 was also added to organization 32 and they now perform the hearing screening at the same time as the heel prick screening.

CHANGES AT AUDIOLOGICAL CENTERS (ACs)

As in 2021, data were provided by 25 ACs in 2022. No children were referred to AC 6 this year, but, unlike previous year, children were referred to AC 5. The number of referred children per AC can strongly fluctuate across years.

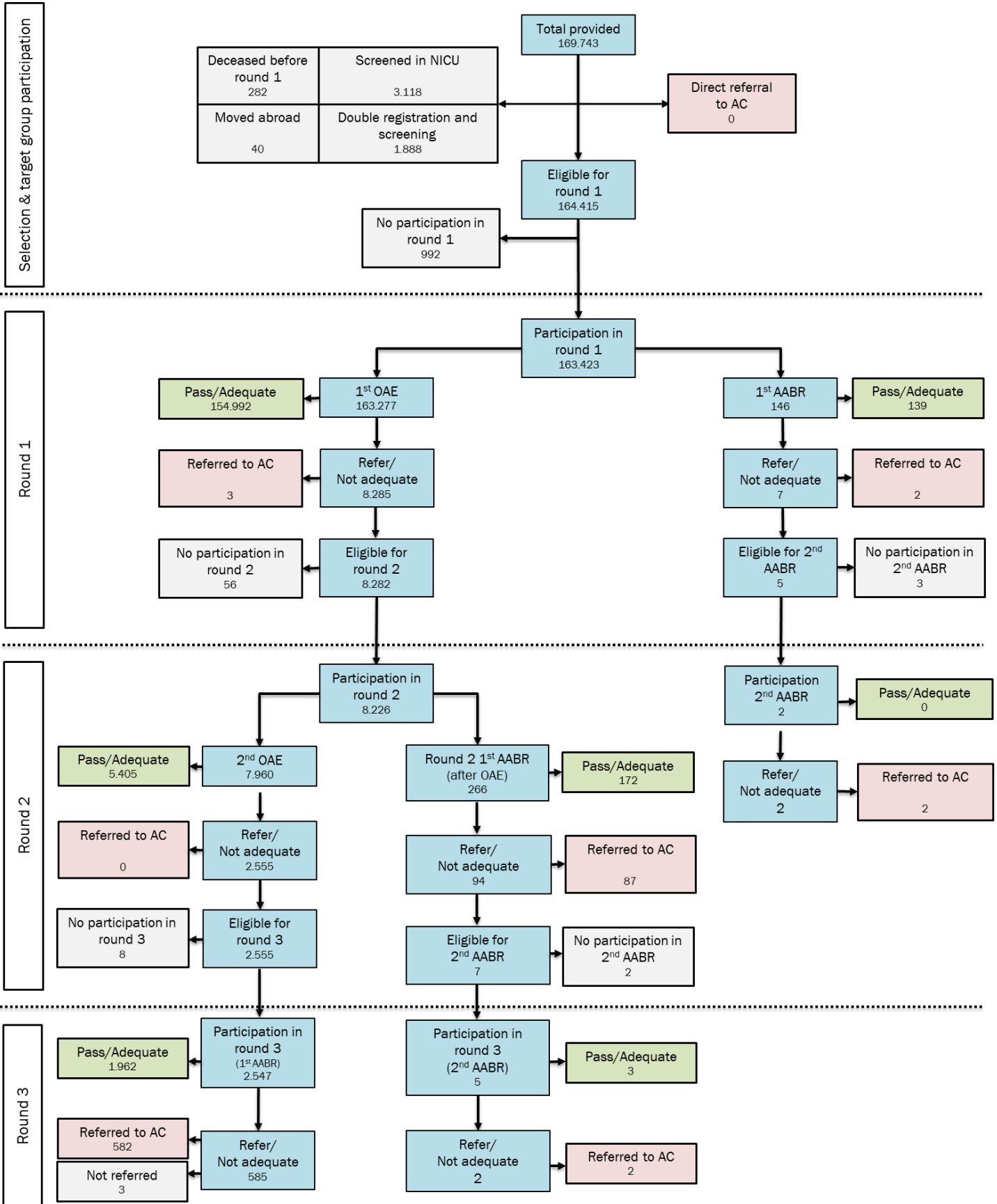
METHOD

Screening and diagnostic data were obtained from the neonatal hearing screening information system (NIS). Using a reporting tool, the Dutch Foundation for the Deaf and Hard of Hearing Child (NSDSK) supplies the number of children per indicator of the screening and diagnostics, nationwide, per CHS organization and per AC.

TNO compares the supplied totals with those of previous years and interprets the results.

RESULTS OF THE SCREENING PROGRAM IN 2022

Figure 1: Flowchart neonatal hearing creening of 2022



PARTICIPATION

PARTICIPATION AT NATIONAL LEVEL

In 2022, 164,415 children were eligible for neonatal hearing screening by CHS (Figure 1).

The percentage of children who were offered the hearing screening at home in combination with the heel prick screening (78.6%) is higher than in previous years (75 to 77%; see Figure 2 and Appendix A).

Table 1 shows that the signal values for participation ($\geq 98\%$ per round) were surpassed in all three rounds of screening. A total of 992 children did not participate in round 1, 56 in round 2, and 8 in round 3.

For 546 of the 992 children who did not participate, the parents did not give consent for the screening. This equals 0.33% of the children who were eligible for the screening and is higher than in previous years (Figure 2c, see Appendix A for the numbers). Due to the increasing number of parents who refuse the screening, investigation into the reasons for refusal of the screening could be considered. Furthermore, 41 children did not participate because they could not be traced. This number is higher than in 2021 and in 2016-2019 (32 and 20-25), and is comparable to 2020 (42), when the hearing screening was suspended for 6 weeks due to the outbreak of the COVID-19 virus. Other reasons were screening outside of The Netherlands (164), too old (67), meningitis (23), double no-show without notification (116), and other (35).

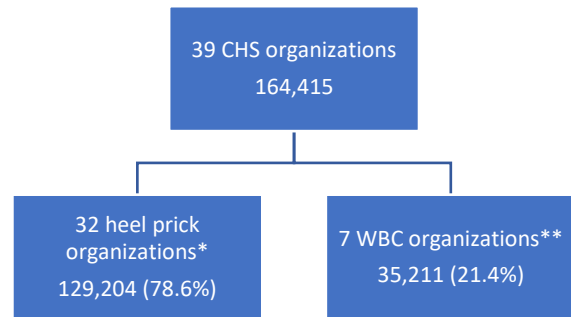
The reason for not participating in round 2 or 3 often was refusal by parents or no-show, and in round 2 the reason often also was 'other'. 66% (37/56) of the children who did not participate in round 2 obtained an adequate result in

one ear. Among non-participants in round 3 this percentage was 50% (4/8).

As in previous years, the participation rate in 2022 was lower among well-baby clinic (WBC) organizations than among heel prick organizations for round 1 and especially round 2 of screening (Table 1, Appendix A).

For children who have not yet obtained adequate results in both ears, participation in the follow-up process is especially important. In 2022, there were 28 children who did not participate further despite not having adequate results in either ear (21 in 2021).

Figure 2: Number of children screened per performing organization



* Heel prick organizations offer combined hearing and neonatal blood spot screening at the child's home.

** In WBC organizations blood collection through the heel prick is done by midwives, while hearing screening is offered at the well baby clinic when the child is several weeks of age.

Table 1: Participation per round of screening by heel prick and WBC organizations in 2022

	Signal value	Heel prick org. number (denom.)	% participation 2022 (2021)	WBC org. number (denom.)	% participation 2022 (2021)	Total number (denom.)	% participation 2022 (2021)
Round 1 (OAE or AABR)	$\geq 98\%$	129,204	99.5% (99.6%)	35,211	99.2% (99.3%)	164,415	99.4% (99.5%)
Round 2 (OAE/AABR after OAE)	$\geq 98\%$	6,237	99.6% (99.7%)	2,045	98.6% (98.9%)	8,282	99.3% (99.5%)
Round 3 (AABR after 2xOAE)	$\geq 98\%$	1,695	99.6% (99.8%)	860	99.9% (99.3%)	2,555	99.7% (99.6%)
Multiplication of round 1-3			98.6% (99.1%)		97.7% (97.4%)		98.4% (98.6%)

Figure 2b: Percentage of children who are offered the hearing screening in combination with the heel prick screening.

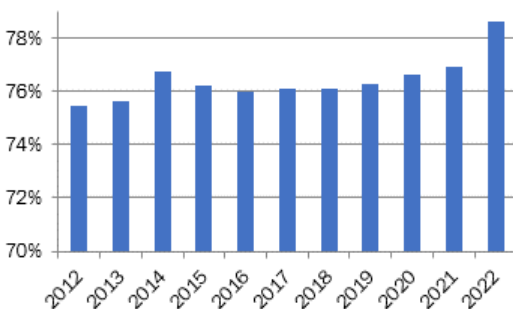
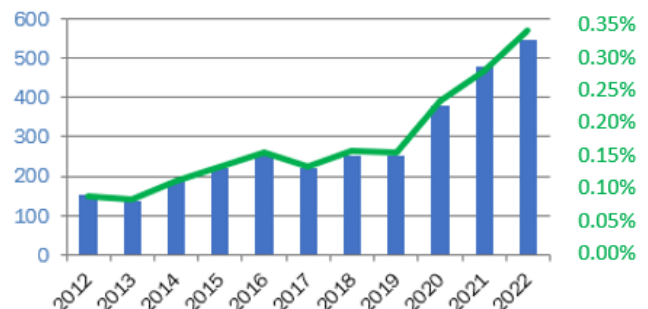


Figure 2c: Number of parents who did not consent with screening (blue) and percentage of number eligible (green).

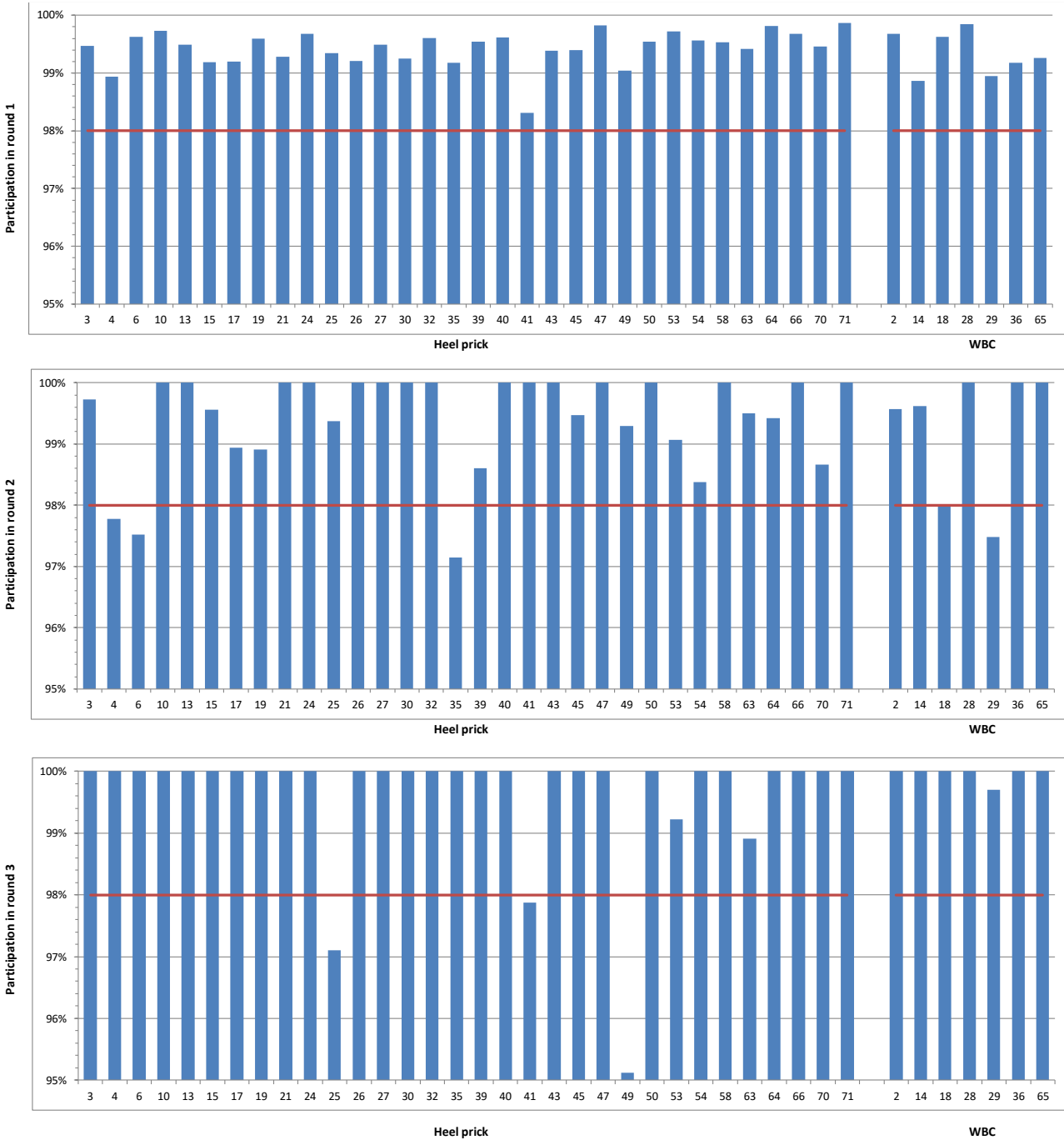


PARTICIPATION AT ORGANIZATIONAL LEVEL

Figure 3 shows that all CHS organizations met the signal value of at least 98% for screening round 1. Four organizations (4, 6, 35 and 29) failed to meet the signal value for screening round 2. Of these organizations,

only organization 29 also failed to meet the signal value in 2021. Three organizations (25, 41, and 49) failed to meet the signal value for round 3, but per organization only 1-2 children did not participate.

Figure 3: Participation per screening round by CHS organizations, plotted against the signal value (red line)



TIMELINESS

TIMELINESS AT NATIONAL LEVEL

The screening process should be completed within 6 weeks after birth for at least 95% of the children in the neonatal hearing screening program. When a child is born prematurely (i.e., after a pregnancy period of less than 37 weeks), this process is allowed to take longer: the due date is then used instead of the birth date.

Table 2 and Appendix A show that in 2022 the signal value of 95% was almost always met. Only the timeliness of the screening by WBC organizations in round 3 fails to meet the signal value of 95%.

TIMELINESS AT ORGANIZATIONAL LEVEL

Figure 4 shows which CHS organizations completed the screening on time for at least 97% (round 1) or 95% (rounds 2 and 3) of the children. In round 1, all CHS organizations screened the children on time. In round 2, WBC organizations 36 and 65 failed to meet the signal value of 95%, and in round 3, organizations 41, 58, 36 and 65 failed to meet the signal value of 95%.

As in 2021, this is due to a large number of children screened too late in organization 65 (i.e., 15 in round 3; at the national level 72 children were screened too late). Although actions have been undertaken, the timeliness has not yet improved sufficiently.

Table 2: Timeliness per screening round by heel prick and WBC organizations in 2022.

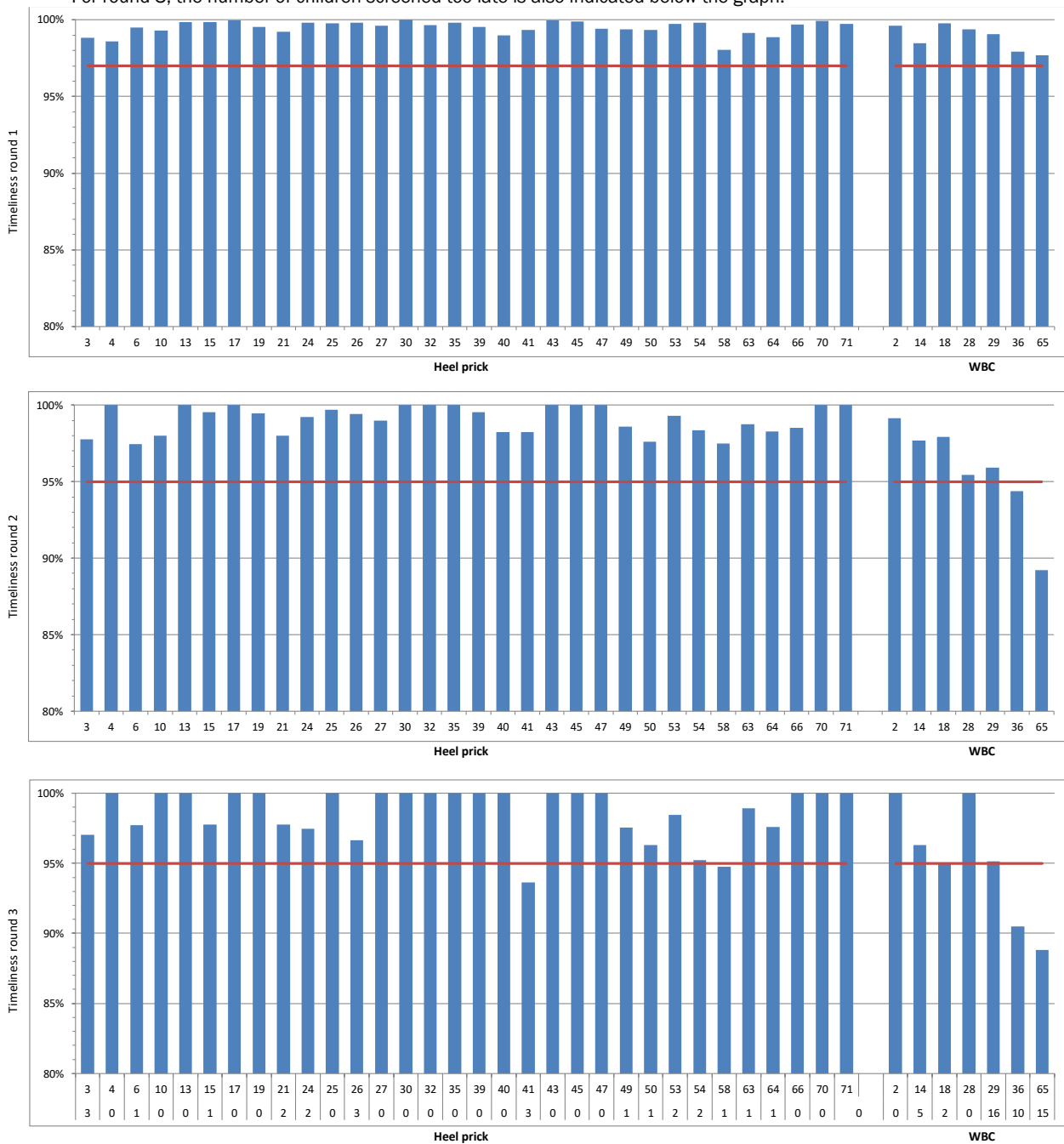
	Signal value	Heel prick org. number (denom.)	% timely screened 2022 (2021)	WBC org. number (denom.)	% timely scrfeened 2022 (2021)	Total number (denom.)	% timely screened 2022 (2021)
Round 1 (OAE+AABR)	≥97% before day 28	128,502	99.5% (99.5%)	34,921	98.8% (98.3%)	163,423	99.4% (99.2%)
Round 2 (OAE+AABR*)	≥95% before day 35	6,209	99.0% (98.7%)	2,017	95.6% (95.2%)	8,226	98.2% (97.8%)
Round 3 (AABR*)	≥95% before day 42	1,688	98.6% (98.1%)	859	94.4% (94.8%)	2,547	97.2% (97.0%)

Bold numbers indicate that the quality norm was not met.

* In the numbers for round 2, the 2 children with an AABR in round 1 and 2 are not included. In the numbers for round 3, only the AABR screenings of the standard protocol (2x OAE and 1x AABR) were included.

Figure 4: Timeliness per screening round by CHS organizations, plotted against the signal value (red line).

For round 3, the number of children screened too late is also indicated below the graph.



REFERS AND REFERRAL RATES

The word *refer* is used to indicate inadequate screening results in one or both ears. A refer in rounds 1 or 2 results in another screening round, and in round 3 this results in a referral. The word *referral* is used to indicate that a child is referred to an AC.

REFER RATES AT NATIONAL LEVEL

At the national level, the refer rate has strongly increased for screenings with OAE compared to 2021 and previous years (Table 3 and Appendix A). More and more CHS organizations are using the Echoscreen III (ESIII), which gives a higher refer rate than the ESIII. The signal value for round 1 ($\leq 7\%$) is still met, but collectively the WBC organizations, as in previous years, failed to meet the signal value of the refer rate for round 2 (43.7% instead of $\leq 40\%$). The referral rate after 3 rounds was 0.37% in 2022. As in previous years, this is well below the signal value of 0.5% (see Appendix A for the numbers per year). However, there is an increase compared to 2021 and previous years, and collectively the WBC organizations failed to meet the signal value (0.57%). *Investigation into the cause of the rising referral rate is advisable, also because in 2022 the signal value for specificity was not met (see "Validity of the screening program in 2022").*

Children screened at the WBC are several weeks older than children screened at home. This may contribute to the higher refer rates at rounds 1 and 2, and the higher referral rate at round 3: it is presumed that there are slightly more respiratory infections and the child is also awake more often (Van der Ploeg et al., 2007; Neonatale gehoorscreening: rol van de leeftijd op de testuitkomst. Tijdschrift JGZ 2007(2): 27-29; in Dutch).

A total of 678 children (including those with alternative and hospital protocols) were referred to the AC (0.41%, red boxes in Figure 1).

SCREENING WITH AABR IN ROUND 1 OR 2

There were 146 children (0.09%) screened exclusively with the AABR method because they had increased risk of auditory neuropathy or were hospitalized for a long period of time. This number is comparable to 2021 (154) and lower than in 2017-2020 (between 188 and 248). Children mainly follow this protocol because of meningitis (33x) or long hospital stay (28x), but in 73 cases the reason is unclear ('other reason').

Of these 146 children, 4 children ultimately received a referral (see Figure 1). The referral rate for this protocol is high (2.7%, Table 4). Three children with an inadequate first AABR test did not participate in a second AABR test. These three children have an increased risk of hearing loss because the first AABR test was inadequate in both ears.

Exclusive screening with the AABR happened approximately equally frequent at WBC organizations as at heel prick organizations in 2022 (respectively 0.09% and 0.11%). At organizations 36 and 41, the hospital protocol is used relatively frequently (respectively 0.35% and 0.65%).

A total of 266 children received a screening with OAE in round 1 and AABR in round 2. This number is comparable to 2016-2019 (253-288) and 2021 (273). Only in 2020, this number was much higher (357), presumably due to COVID-19. As in previous years, the referral rate in these children was high (33.5%, see Table 4 and Figure 1). This alternative protocol is only applied sometimes, for example in case of schisis (70x), hearing loss in the family (76x) or a syndrome (32x). The reason is also sometimes 'other' (65x) or unknown (18x).

Table 3: Refer rates per screening round by heel prick and WBC organizations in 2022.

	Norm or signal value	Heel prick org. number (denom.)	% refer 2022 (2021)	WBC org. number (denom.)	% refer 2022 (2021)	Total number (denom.)	% refer 2022 (2021)
Round 1 (OAE)	$\leq 7\%$	128,393	4.9% (4.5%)	34,884	5.9% (5.0%)	163,277	5.1% (4.6%)
Round 2 (OAE)	$\leq 40\%$	5,990	28.3% (27.7%)	1,970	43.7% (42.1%)	7,960	32.1% (31.3%)
To round 3 (at 100% participation for rounds 1 and 2)			1.4% (1.2%)		2.6% (2.1%)		1.6% (1.4%)
Round 3 (AABR)	*	1,688	23.4% (23.6%)	859	22.1% (20.0%)	2,547	23.0% (22.4%)
Referral to AC (at 100% participation for rounds 1-3)	$< 0.5\%$		0.32% (0.29%)		0.57% (0.42%)		0.37% (0.32%)

Bold numbers indicate that the quality norm or signal value was not met. For rounds 1 and 2 only the OAE results are reported, Table 4 shows the referrals for use of the AABR in rounds 1 and 2.

* Because the results of rounds 1 and 2 affect the expectation for round 3, no signal value was set for round 3.

Table 4: Referrals to the AC after exclusive screening with the ABR method (hospital protocol) and in children screened first with the OAE and subsequently with the ABR.

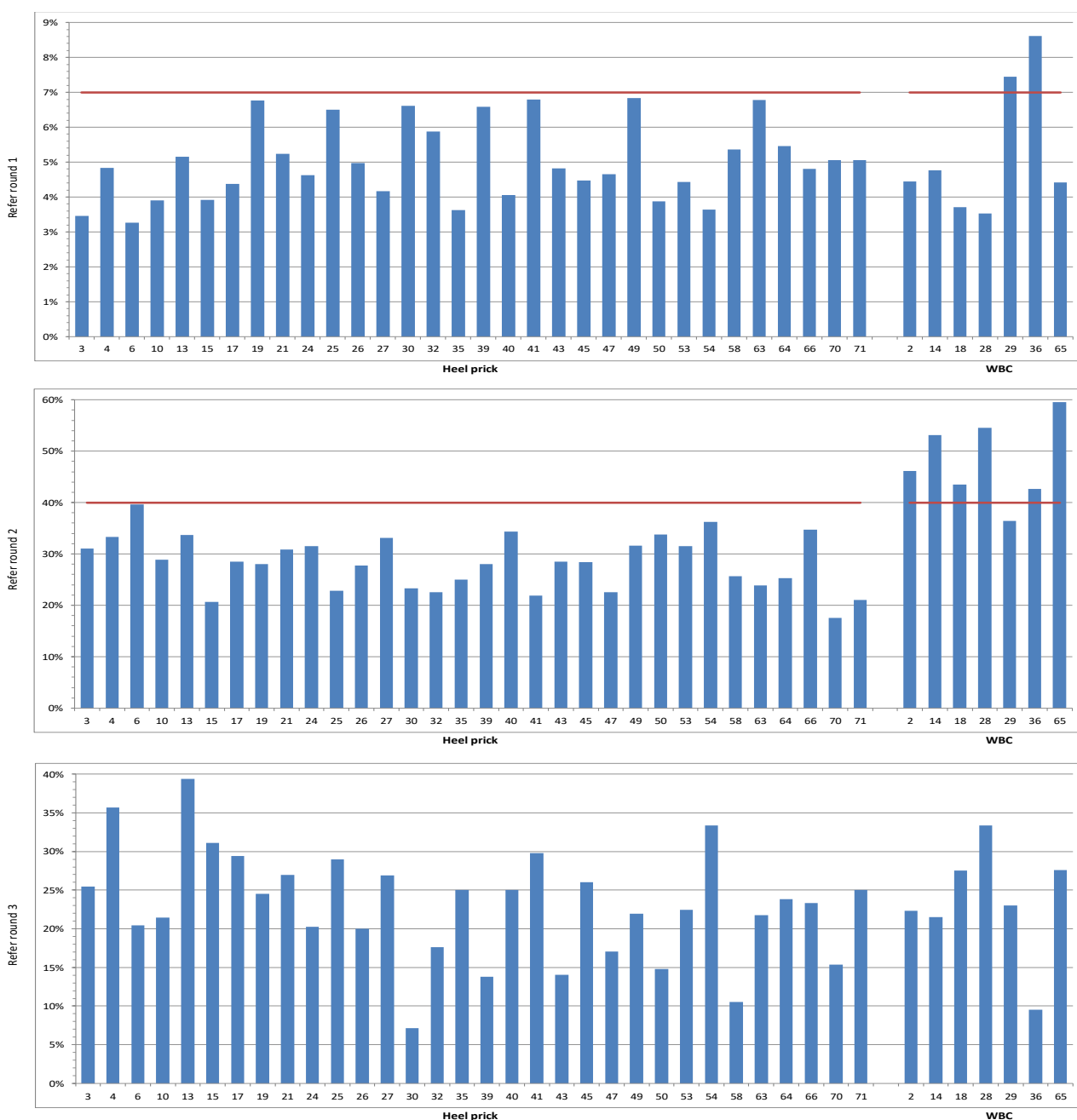
	Heel prick org. number	Referred number (%)	WBC org. number	Referred number (%)	Total number	Referred number (%)
Exclusive screening with ABR (in round 1 and possibly round 2)	109	2 (1.8%)	37	2 (5.4%)	146	4 (2.7%)
AABR in round 2 (following OAE)	219	72 (32.9%)	47	17 (36.1%)	266	89 (33.5%)

REFER RATES AT ORGANIZATIONAL LEVEL

Figure 5a shows that in screening round 1 almost all CHS organizations met the norm of at most 7% refers in 2022. Only CHS 29 and 36 failed to meet the norm. At round 2, the signal value of $\leq 40\%$ was met by all heel prick organizations, but only by 1 WBC organization.

Heel prick organization 39 had a relatively high refer rate at round 1 for years, but is now below the norm in 2022 (6.6%).

Figure 5a: Refer rates per screening round per CHS organization, plotted against the norm value (red line).



REFERRAL RATES

Six CHS organizations fail to meet the norm value (<0.5%) for referral after 3 rounds (4, 13, 14, 28, 29 and 65, Figure 5b). Organization 14 fails to meet this norm for the last 4 years.

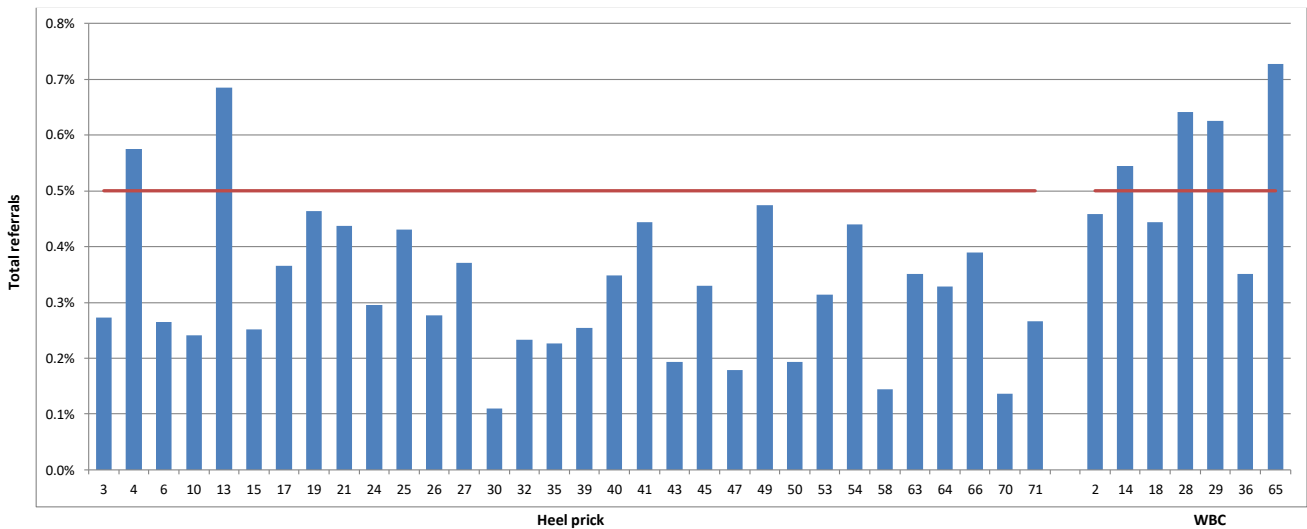
NATIONAL LEVEL

Of the children born in 2022, 678 children were referred to an AC (Figure 1). This sets the total referral rate to 0.41%. When we only look at children screened according to the standard protocol (i.e., three-round screening with 2x OAE and 1x ABR), the referral rate after 3 rounds is 0.37%. There are 582 referrals according to the standard

protocol. Three children who followed the standard screening protocol received a refer at every round, but were nevertheless not referred and therefore are not counted. Potential reasons for this can be that the parents refuse the referral or no-show without cancellation. The child may also be deceased.

Of the 412 children who followed a special protocol (266 with 1x OAE and 1-2x AABR, and 146 with 2x AABR), 93 (22.6%) received a referral. Three children with an inadequate AABR at round 1 (the hospital protocol) were not screened further, and two children were not further screened despite an inadequate OAE and AABR. All five had a bilateral refer at the screening.

Figure 5b: Referral rate to the AC after three screening rounds per CHS organization, plotted against the norm value (red line).



RESULTS DIAGNOSTIC PROCESS 2022

This section of the monitor deals with the execution of the diagnostic process after the neonatal hearing screening in 2022.

Besides the 678 referred children mentioned above, an additional 2 children were referred: 1 child who was erroneously removed from the screening database and 1 child who was referred after an adequate hearing screening. Thus, a total of 680 children were referred.

PARTICIPATION

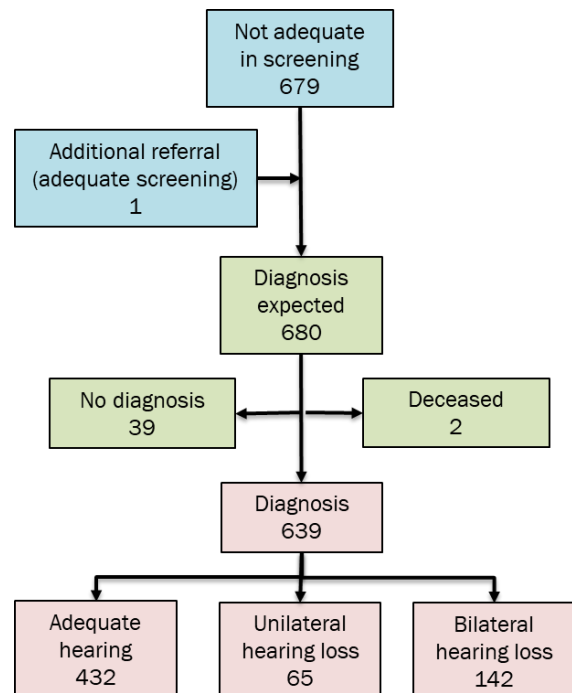
Of the 680 referred children (Figure 6), at least 643 children (94.6%) visited the AC at least once. For 639 of these 643 (99.4%) a diagnosis was provided. A diagnosis indicates: (no) permanent hearing loss of at least 40dB in one or both ears. The signal values of these quality indicators (100%) were not met.

For 41 of the referred children (6%) no diagnosis was provided. This limits the insight into the diagnostic outcomes. Reasons for the lack of diagnosis included no consent for reporting, no participation in follow-up examination (10x), death (2x) or hospitalization.

When the 2 deceased children are excluded, participation in diagnostics are at least 94.2% (639 with known diagnosis divided by 678). A maximum of 98.5% received

a diagnosis, since 10 children did not participate in (follow-up) examination with certainty.

Figure 6: Diagnostic examination of children of 2022



TIMELINESS

REFERRAL INTERVAL

The aim is that at least 95% of the referred children visits the AC within 24 days following the final screening. This target value was not met in 2022: 67.4% of the 638 children of whom both dates are known visited the AC in time (Table 5). As in previous years, the target value was not met, but the value was higher than in 2021.

There is a difference between uni- and bilateral refer: children with a bilateral refer more often visit the AC within 24 days (Table 5). As in previous years, there was a large difference between heel prick and WBC organizations (74.7% vs. 50.8%, see Appendix A) in 2022.

TIMELINESS COMPLETING DIAGNOSIS NATIONWIDE

For 638 children with a diagnosis it was possible to determine whether this diagnosis was made at the AC within the first three months of life (<92 days, after correction for premature birth). In 94.0%, this was successful (target value: 95%), but in 38 children this was not the case. Children with a unilateral referral had a lower on-time diagnosis rate than children with a bilateral referral (Table 5), but whether the diagnosis is made timely for uni- or bilateral referral varies over the years.

The target value of 95% is structurally not met. However, with 94.0% it was almost realized for 2022. Since 2019,

the percentage of children with an on-time diagnosis has improved compared with the years before 2019 (83-86%, see Appendix A). This is likely due to the extra attention paid by the ACs to timely completion of diagnosis. In 2020, the result (82.6%) was poorer due to the temporary suspension of the screening due to COVID-19.

TIMELINESS COMPLETING DIAGNOSIS PER AC

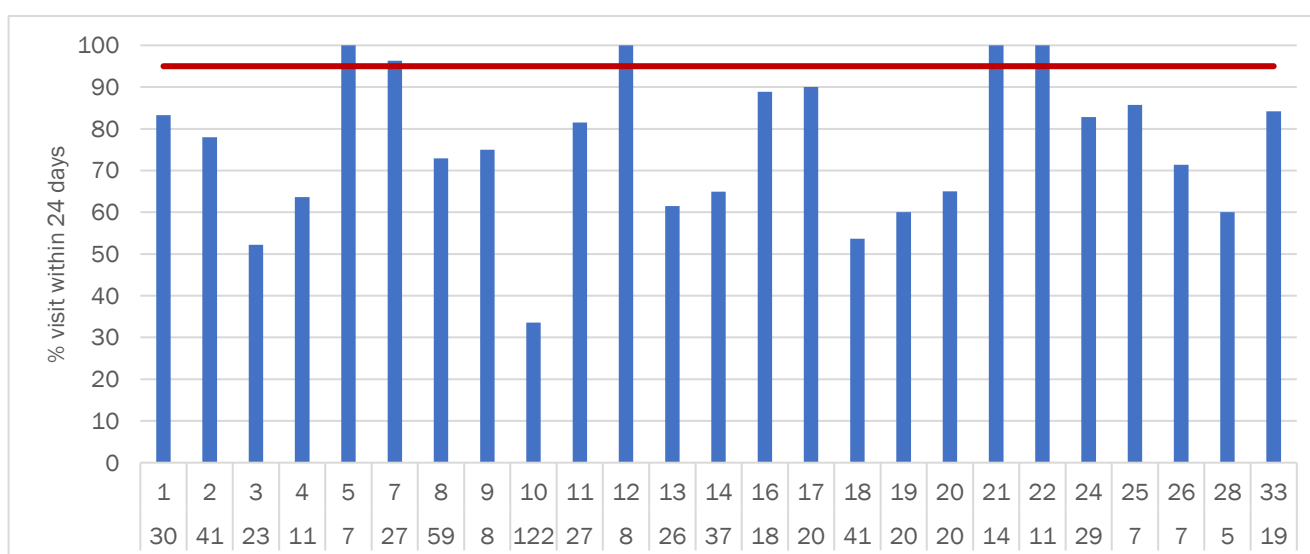
Figure 7a shows the percentage of children who visited the AC within 24 days after final screening per AC. Figure 7b shows the percentage of children for whom the diagnosis was known within 92 days per AC. The bottom rows with numbers indicate the number of children per AC for whom data are available.

Per AC, 80-100% of children received an on-time diagnosis, only for AC 18 this percentage was lower (78%). The target value of 95% was met by 17 ACs (and 8 ACs failed to meet it): many ACs show an improvement over time. AC 13 failed to meet the target value over the last 7 years, but shows an improvement (92% on-time, 2 children were too late). AC 8 met the target value for the first time in 7 years. AC 10 diagnoses relatively a lot of the referred children and therefore contributes strongly to the national rate (13 children too late; in all ACs together, 38 children were too late). AC 18 also contributed strongly to the number of children diagnosed too late (9 vs. 2 for 2021).

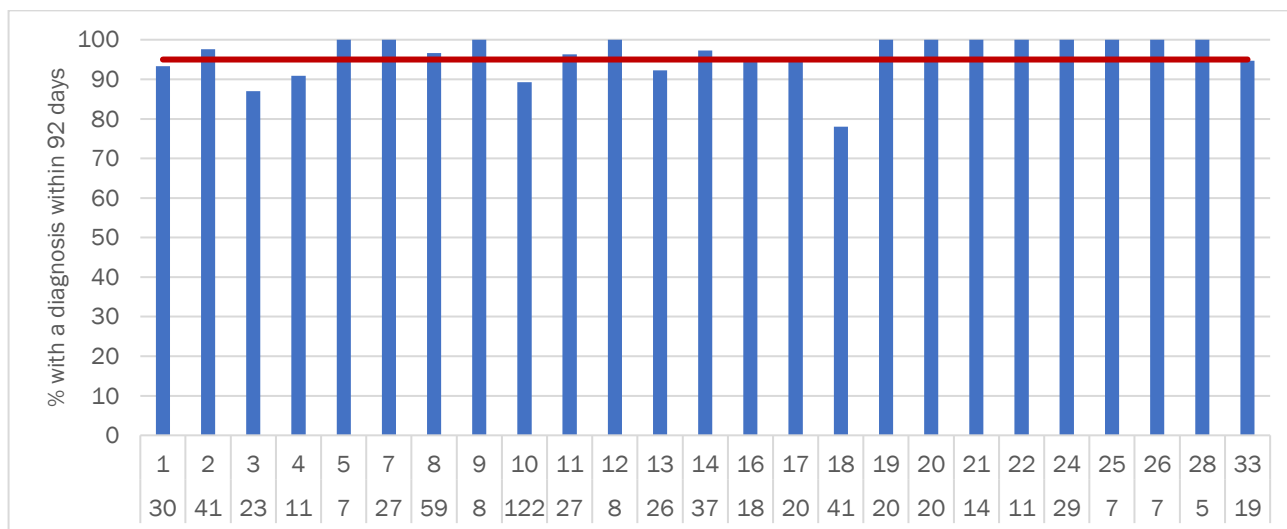
Table 5: Timeliness of referral and known diagnosis nationwide and by type of referral. Target value is 95%. Bold: target value not met.

	Number of children	Data available	Visit AC within 24 days: number	Visit AC within 24 days: %	Diagnosis known within 92 days: number	Diagnosis known within 92 days: %
Total	639	638	430	67.4	600	94.0
Unilateral referral	451	450	290	64.4	420	93.3
Bilateral referral	188	188	140	74.5	180	95.7

Figure 7a: Percentage of children with a visit to the AC within 24 days following final screening, per AC, plotted against the target value (red line). Bottom rows: number of children per AC for whom data are available.



Figuur 7b: Percentage of children for whom the diagnosis was made within 92 days after birth, per AC, plotted against the target value (red line). Bottom rows: number of children per AC for whom data are available.



RESULTS

DETECTED HEARING IMPAIRMENT

The diagnosis is known for 639 children. Of them, 451 were referred due to an inadequate screening result in one ear (unilateral referral) and 188 due to inadequate screening results in both ears (bilateral referral).

An adequate hearing means that no permanent hearing loss of 40dB or more is detected in one or both ears (a smaller or temporary hearing loss may still be present). For 432 of the 639 children for whom the diagnosis is known (68%), an adequate hearing was detected. For the other 207 children, a hearing loss of 40dB or more in one or both ears was detected (Figure 6).

In 142 children, a bilateral hearing loss of at least 40dB was detected, of which 120 also had bilateral failure on the screening and 22 had unilateral failure. Out of these 142

cases, 122 involved perceptive loss, 4 involved permanent conductive loss, and 16 permanent mixed loss.

In 65 children a unilateral hearing loss of 40dB or more was detected, of which 64 also had unilateral failure on the screening and 1 had bilateral failure. Out of these 65 cases, 54 involved perceptive loss, 4 involved permanent conductive loss, and 7 involved permanent mixed loss.

DETECTED NUMBER OF CHILDREN OVER THE YEARS

Table 6 shows the number of children detected by screening by CHS in combination with the number of screened children over the years. The numbers fluctuate strongly over the years. Approximately one-third of hearing-impaired children are additionally detected through neonatal hearing screening at the NICUs. The results of which can be found at www.isala.nl/gehoorscreening.

Table 6: Number of children with hearing loss ≥ 40 dB detected through screening by CHS, per year and on average.

	2022	2021	2020	2019	2018	2017	2016	2015	Average
Bilateral	142	135	125	129	146	119	128	113	130
Unilateral	65	86	81	77	85	74	68	82	77
Together	207	221	206	206	231	193	196	195	207
Number of children eligible for screening	164,415	175,649	164,981	166,367	165,149	166,101	168,790	166,911	167,295
Detection number uni- and bilateral hearing loss by CHS (per 1000 with participation)	1.27	1.26	1.26	1.24	1.40	1.17	1.16	1.17	1.24

VALIDITY OF THE SCREENING PROGRAM IN 2022

POSITIVE PREDICTIVE VALUE (PPV)

The likelihood that a child has permanent hearing loss in one or both ears of at least 40dB at the moment of referral to the AC was 32% in 2022. We call this the positive predictive value. The likelihood of bilateral hearing loss after bilateral failure at the screening is 64% (120/188).

The difference in PPV between children coming from heel prick organizations and those coming from WBC organizations are reported below. The percentage is lower for WBC organizations due to the higher percentage of false positive referrals by these organizations.

PPV heel prick organizations:	34% (152/444)
PPV WBC organizations:	28% (55/195)
PPV together:	32% (207/639)

There seems to be a declining trend over time for the PPV (see Appendix A).

SENSITIVITY

The sensitivity of the program provides an answer to the question of which proportion of the total number of hearing-impaired children is detected through the neonatal hearing screening. This value cannot be reliably determined, as for children in whom a hearing impairment is discovered at a later age it is unknown whether their hearing loss was already present during the hearing screening or only emerged afterwards.

SPECIFICITY

The specificity of the program provides an answer to the question of which proportion of children without hearing loss correctly received an adequate screening result and, thus, was not referred. There were a total of 680 children referred, of whom at least 207 had a hearing loss and 432 did not. The remaining 41 children, for whom it is unknown whether they have a hearing loss, were divided over the two groups in the same proportions. The specificity is calculated by dividing the number of children without hearing loss who were not referred by the total number of children without hearing loss. The estimated specificity is 99.7%, which is lower than in previous years (99.8%). The signal value ($\geq 99.8\%$) was not met in 2022.

APPENDIX A: INDICATORS NEONATAL HEARING SCREENING BY CHS: OVERVIEW OF RESULTS PER YEAR

For each cell the nationwide result is reported first and is followed by those for heel prick and WBC organizations separately in parentheses. Bold numbers indicate that the quality norm or target value of in the year in question was not met.

	2022	2021	2020*	2019	2018	2017	2016
Combination hearing and heel prick screening	78.6%	76.9%	76.6%	76.3%	76.1%	76.1%	76.0%
Participation screening round 1	99.4% (99.5%; 99.2%)	99.5% (99.6%; 99.3%)	99.5% (99.6%; 99.2%)	99.6% (99.7%; 99.4%)	99.6% (99.7%; 99.5%)	99.7% (99.8%; 99.6%)	99.7% (99.8%; 99.4%)
Participation screening round 2	99.3% (99.6%; 98.6%)	99.5% (99.7%; 98.9%)	99.6% (99.6%; 99.4%)	99.6% (99.7%; 99.4%)	99.6% (99.6%; 99.6%)	99.6% (99.7%; 99.3%)	99.7% (99.8%; 99.4%)
Participation screening round 3	99.7% (99.6%; 99.9%)	99.6% (99.8%; 99.3%)	99.7% (99.7%; 99.7%)	99.6% (99.7%; 99.4%)	99.7% (99.7%; 99.8%)	99.7% (99.7%; 99.8%)	99.7% (99.7%; 99.8%)
Participation rounds 1-3	98.4% (98.6%; 97.7%)	98.6% (99.1%; 97.4%)	98.8% (98.9%; 98.3%)	98.8% (99.1%; 98.2%)	98.9% (98.9%; 98.9%)	99.0% (99.2%; 98.7%)	99.1% (99.3%; 98.6%)
Absence of consent	0.33% (546 times)	0.27% (479 times)	0.23% (378 times)	0.15% (251 times)	0.15% (254 times)	0.13% (219 times)	0.15% (257 times)
Child not traced	0.025% (41 times)	0.018% (32 times)	0.025% (42 times)	0.015% (25 times)	0.013% (22 times)	0.012% (20 times)	0.013% (22 times)
Participation AC: diagnosis (all of referred through screening)	94.2%-98.5% nationwide	94.3%-99.1% nationwide	93.7%-98.7% nationwide	91.6%-98.7% nationwide	95.7%-99.3% nationwide	94.5% - 96.7% nationwide	95.4% - 98.5% nationwide
Referral advice followed (visit AC)	94.6%	94.7%	94.5%	92.7%	96.6%	96.1%	97.6%
Completion of diagnosis (% of 1 st visit to AC)	99.4% (i.e., 94.0% followed-up and completed)	99.5% (i.e., 94.3% followed-up and completed)	99.1% (i.e., 93.7% followed-up and completed)	98.6% (i.e., 91.4% followed-up and completed)	98.9% (i.e., 95.5% followed-up and completed)	98.0% (i.e., 94.2% followed-up and completed)	97.0% (i.e., 94.7% followed-up and completed)
Not adequate at round 1	5.1% (4.9%; 5.9%)	4.6% (4.5%; 5.0%)	4.7% (4.7%; 4.8%)	4.4% (4.3%; 4.9%)	4.5% (4.4%; 4.9%)	4.8% (4.7%; 4.9%)	4.6% (4.5%; 5.0%)
Not adequate at round 2	32.1% (28.3%; 43.7%)	31.3% (27.7%; 42.1%)	31.7% (28.7%; 41.2%)	32.8% (29.2%; 43.0%)	32.8% (28.3%; 45.8%)	32.9% (29.1%; 44.8%)	33.2% (29.2%; 44.5%)
Not adequate at round 3	23.0% (23.4%; 22.1%)	22.4% (23.6%; 20.0%)	20.8% (21.0%; 20.3%)	21.4% (22.4%; 19.5%)	20.4% (22.3%; 16.8%)	20.1% (19.9%; 20.4%)	18.6% (19.2%; 17.5%)
Referral to AC (after OAE-OAE-AABR), vs. number of participants in 1 st screening (at 100% participation)	0.37% (0.32%; 0.57%)	0.32% (0.29%; 0.42%)	0.31% (0.28%; 0.41%)	0.31% (0.28%; 0.41%)	0.30% (0.28%; 0.38%)	0.32% (0.27%; 0.45%)	0.29% (0.25%; 0.39%)
Overall referral rate (incl. hospital protocol and OAE-AABR(-AABR))	0.41%	0.38%	0.38%	0.37%	0.35%	0.35%	0.32%
Timeliness screening round 1 (<28d)	99.4% (99.5%; 98.8%)	99.2% (99.5%; 98.3%)	89.4% (90.4%; 86.2%)*	99.3% (99.3%; 99.0%)	99.4% (99.4%; 99.2%)	99.4% (99.5%; 99.3%)	99.4% (99.5%; 99.1%)
Timeliness screening round 2 (<35d)	98.2% (99.0%; 95.6%)	97.8% (98.7%; 95.2%)	85.8% (88.1%; 78.3%)*	98.3% (98.4%; 97.8%)	98.3% (98.8%; 97.1%)	98.3% (98.9%; 96.5%)	98.0% (98.8%; 95.9%)
Timeliness screening round 3 (<42d)	97.2% (98.6%; 94.4%)	97.0% (98.1%; 94.8%)	81.7% (84.3%; 76.1%)*	98.0% (98.1%; 97.7%)	97.6% (97.8%; 97.1%)	97.6% (98.1%; 96.7%)	97.0% (97.2%; 96.5%)
Interval between final screening and 1 st diagnostic examination (<24d)	67.4% (74.7%; 50.8%)	65.2% (73.7%; 44.8%)	64.9% (72.9%; 46.3%)*	65.6% (68.3%; 59.4%)	68.2% (70.2%; 63.2%)	67.5% (74.7%; 51.2%)	70.9% (70.8%; 71.2%)
Timeliness diagnosis (<92 d)	94.0% (95.3%; 91.3%)	92.6% (94.8%; 87.4%)	82.6% (86.9%; 72.6%)*	93.5% (95.6%; 88.8%)	86.4% (86.5%; 86.3%)	86.2% (89.3%; 79.2%)	85.1% (85.9%; 83.5%)
Birth records in NIS (<3 working days)	22% < 3 calendar days 40% < 4 calendar days	22% < 3 calendar days 40% < 4 calendar days	22% < 3 calendar days 39% < 4 calendar days	24% < 3 calendar days 43% < 4 calendar days	25% < 3 calendar days 44% < 4 calendar days	24% < 3 calendar days 44% < 4 calendar days	26% < 3 calendar days 45% < 4 calendar days
Number with unilateral hearing loss	65	86	81	77	85	74	68
Number with bilateral hearing loss	142	135	125	129	146	119	128

	2022	2021	2020*	2019	2018	2017	2016
Detection number uni- and bilateral hearing loss by CHS (per 1000)	1.27 (1.18; 1.57)	1.26 (1.23; 1.39)	1.26 (1.22; 1.36)	1.24 (1.17; 1.48)	1.40 (1.41; 1.40)	1.17 (1.15; 1.22)	1.16 (1.12; 1.29)
Positive Predictive Value (PPV) for uni- and bilateral hearing loss combined	32% (34%; 28%)	35% (37%; 30%)	35% (38%; 30%)	37% (39%; 34%)	42% (44%; 36%)	35% (38%; 29%)	38% (41%; 32%)
PPV for bilateral hearing loss after bilateral failure at screening	64%	60%	60%	62%	63%	59%	65%
False positive results	>64%	>61%	>61%	>57%	>56%	>61%	>59%
Specificity	99.7%	99.8%	99.8%	99.8%	99.8%	99.8%	≥99.8%
Sensitivity	Cannot be determined	Cannot be determined	Cannot be determined	Cannot be determined	Cannot be determined	Cannot be determined	Cannot be determined
Children screened with AABR	146	154	210	188	248	240	235

*In 2020, the hearing screening was suspended for 6 weeks due to COVID-19. This had a strong impact on the average timeliness of execution in 2020.

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