

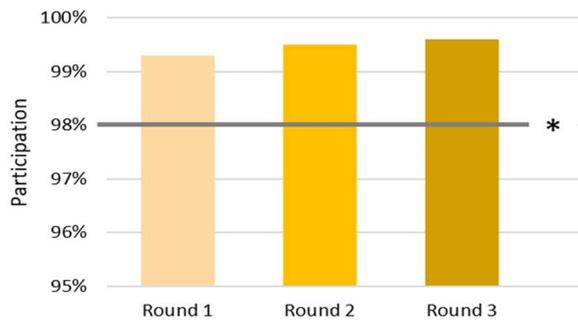
NEONATAL HEARING SCREENING BY CHILD HEALTH SERVICES IN THE NETHERLANDS

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 in both ears 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

162.660 children eligible

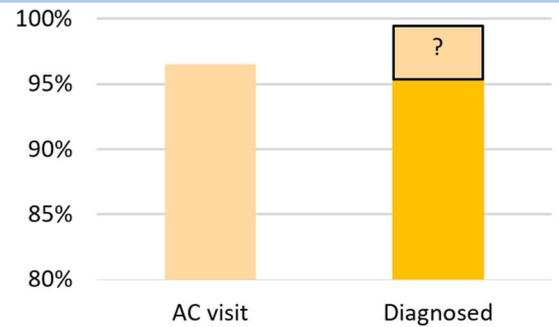
Participation



- Screening participation rates are high.

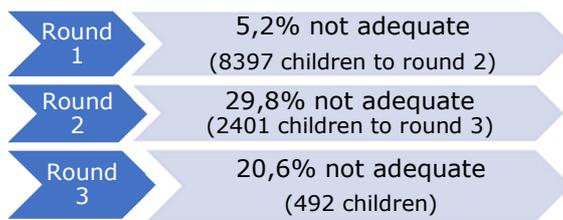
DIAGNOSIS# AT THE AC

598 children referred

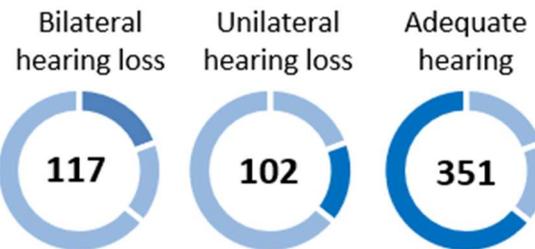


- Between 95.6% and 99.2% of the referred children received a diagnosis#.

Referral / findings



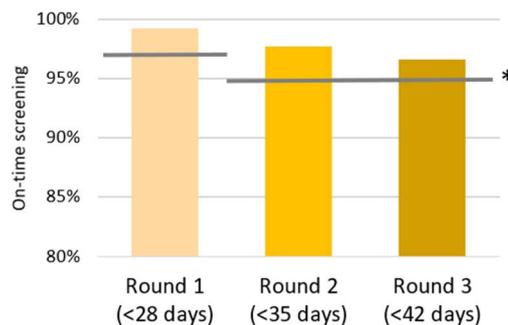
- The number of referrals to the AC by the standard three-round screening (i.e., OAE-OAE-AABR) is low (0.32%).
- Another 99 children were referred through other screening routes (mainly OAE-AABR).
- A total of 598 children were referred to the AC (0.37%).
- 3 CHS organizations did not meet quality norm of ≤7% refers in round 1.



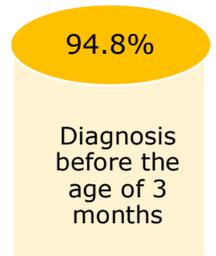
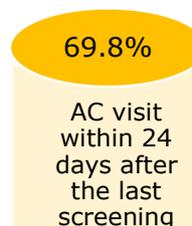
- 219 children with hearing loss ≥ 40 dB were identified.
- 38% of the 570 children with a known diagnosis have hearing loss (PPV):



Timeliness



- The signal values for timely screening were met. Many WBC organizations did not achieve these.



- The diagnosis should be made within 3 months in ≥ 95%. This condition was almost 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 Centre for Management of Prevention Programmes and Crisis Management (RPO) 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 RIVM-RPO 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 in both ears after these three rounds of screening, referral to an audiological center (AC) follows.

A small proportion of children follows a different screening protocol (OAE-AABR or AABR-AABR). More information about this and the neonatal hearing screening program can be found in the neonatal hearing screening script of CHS (<https://www.pns.nl/draaiboek-gehoorscreening>).

SCREENING AT HOME OR AT THE CONSULTATION OFFICE

Many children receive their first hearing screening during a home visit by the Child Health Services (CHS), during which the heel prick screening also takes place. The CHS organizations that offer the screening combined with the heel prick screening are referred to as heel prick organizations. In so-called WBC organizations, the heel prick screening is performed by midwives or in the hospital, and the hearing screening is offered at the well-baby clinic (WBC) when the child is a few weeks old.

MONITOR FOR 2024

This monitor reports the results of the neonatal hearing screening program of children born in 2024. The indicators established for this purpose were used (see [the set of indicators](#) of the neonatal hearing screening script of CHS).

DIFFERENCE WITH THE PREVIOUS MONITOR

Changes at CHS organizations

In 2024, part of the area of heel prick organization 32 was transferred to heel prick organization 19.

Changes at audiological centers (ACs)

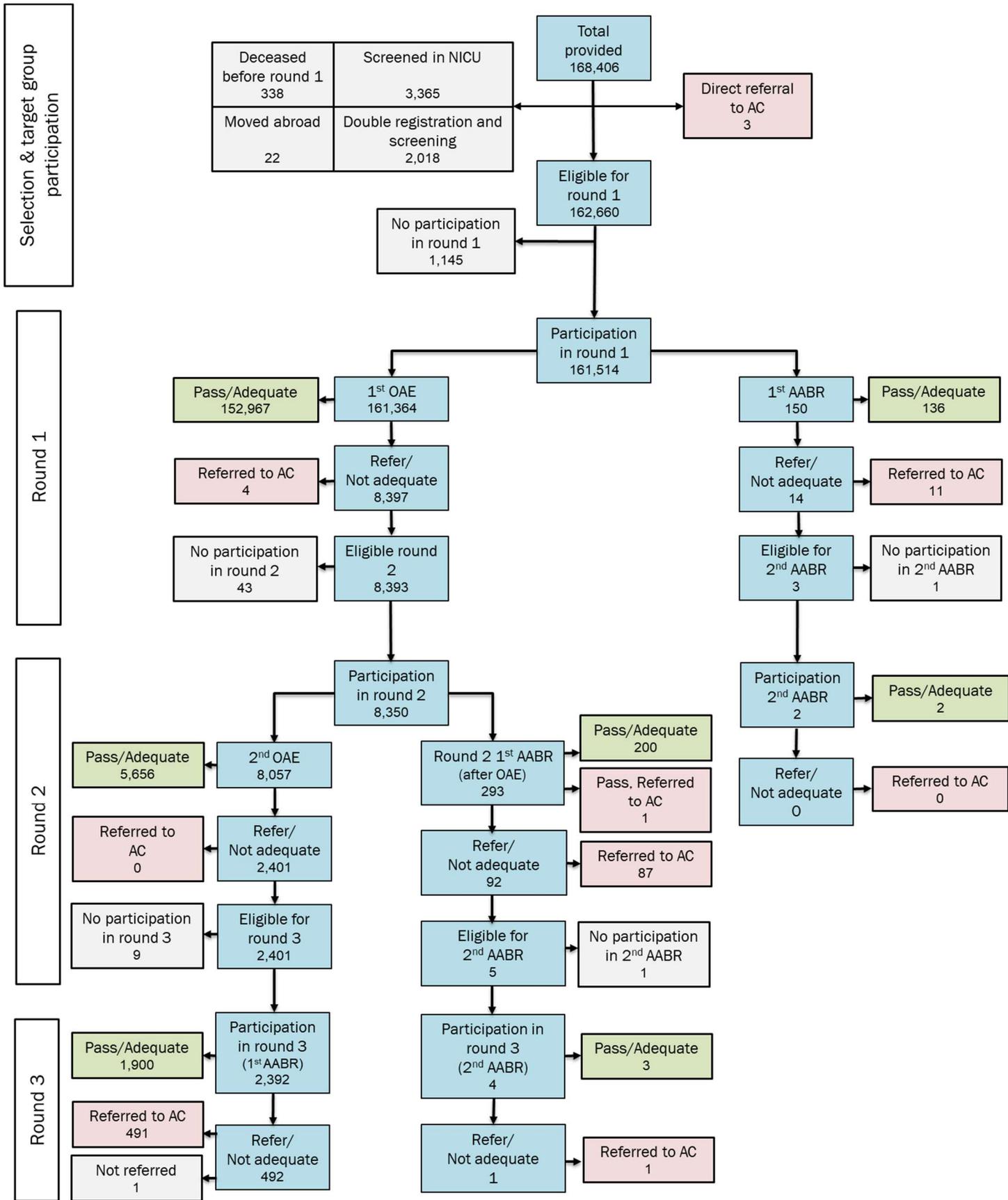
In 2024, data have been provided by 23 ACs, the same as previous year. The number of referred children per AC can fluctuate strongly.

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 2024

Figure 1: Flowchart neonatal hearing screening of 2024



PARTICIPATION

PARTICIPATION AT NATIONAL LEVEL

In 2024, 162,660 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, just like in 2023 and 2022, higher than in previous years (75 to 77%; see Figure 2a and 2b, and Appendix A).

Table 1 shows that the signal values for participation ($\geq 98\%$ per round) were amply surpassed in all three rounds of screening. A total of 1,146 children did not participate in round 1, 43 in round 2, and 9 in round 3.

For 674 of the 1,146 children who did not participate, the parents did not give consent for the screening. This equals 0.41% of the children who were eligible for the screening and is higher than in previous years (Figure 2c, see Appendix A for the numbers). Furthermore, 33 children did not participate because they could not be traced. Other reasons were screening outside of the Netherlands (225), too old (41), meningitis (14), double no-show without notification (139), and other (20).

The reason for not participating in round 2 or 3 often was refusal by parents or no-show, or the reason 'other'. 65% (28/43) 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 56% (5/9). For the 19 children who have not yet obtained adequate results in both ears, participation in the follow-up process is especially important.

As in previous years, the participation rate in 2024 was lower among WBC organizations than among heel prick organizations for round 1 and round 2 of screening (Table 1, Appendix A).

Figure 2a: Number of children screened per performing organization

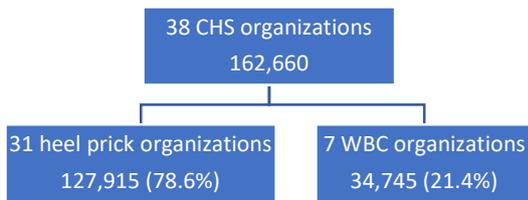


Table 1: Participation per round of screening by heel prick and WBC organizations in 2024

	Signal value	Heel prick org. number (denom.)	% participation 2024 (2023)	WBC org. number (denom.)	% participation 2024 (2023)	Total number (denom.)	% participation 2024 (2023)
Round 1 (OAE or AABR)	$\geq 98\%$	127,915	99.4% (99.4%)	34,745	99.0% (99.0%)	162,660	99.3% (99.3%)
Round 2 (OAE/AABR after OAE)	$\geq 98\%$	6,353	99.6% (99.5%)	2,040	99.0% (98.7%)	8,393	99.5% (99.3%)
Round 3 (AABR after 2xOAE)	$\geq 98\%$	1,580	99.6% (99.3%)	821	99.6% (99.1%)	2,401	99.6% (99.3%)
Multiplication of round 1-3			98.6% (98.3%)		97.7% (96.8%)		98.4% (97.9%)

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

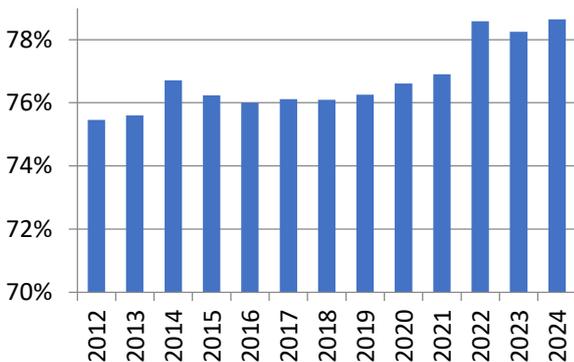
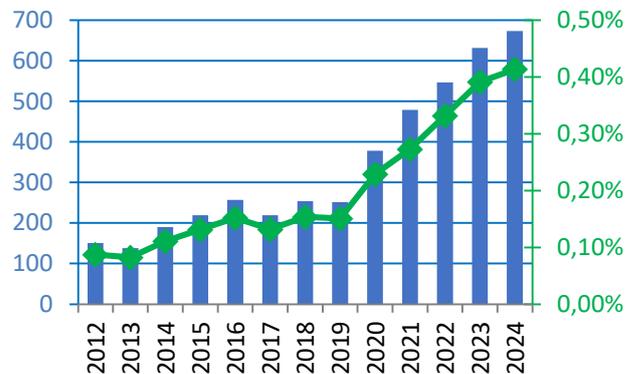


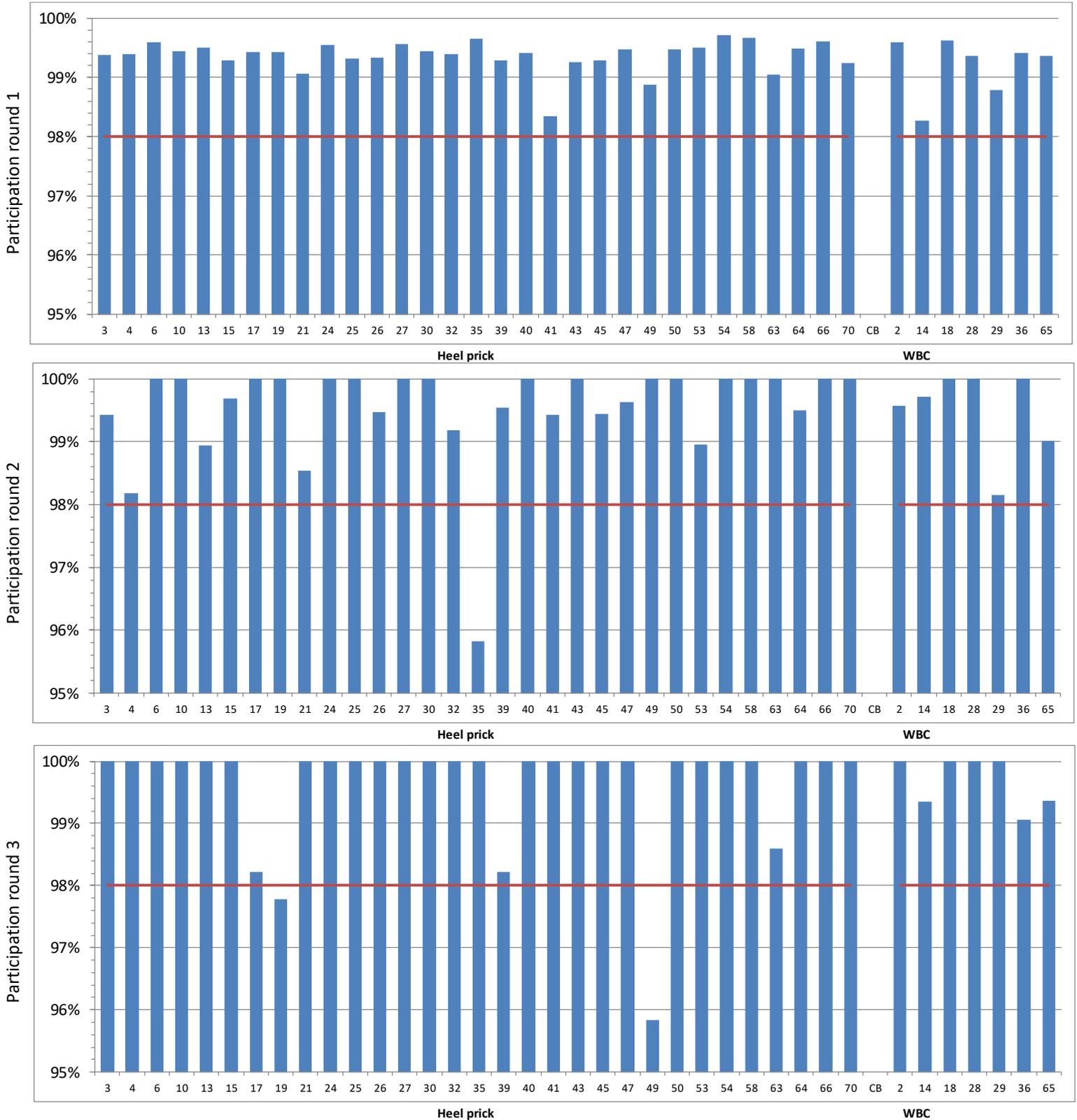
Figure 2c: Number of parents who did not consent with screening (blue) and percentage of number eligible (green).



PARTICIPATION AT ORGANIZATIONAL LEVEL

Figure 3 shows that all CHS organizations met the signal value of at least 98% for screening round 1. One organization (35) failed to meet the signal value for screening round 2, but that is the result of only 1 child that did not participate. Organization 29 met the signal value for the first time in 4 years (98.2%, 15 children did not participate). Two organizations (19 and 49) failed to meet the signal value for round 3, but only 1 and 2 children, respectively, 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 2024, all signal and target values were met both nationally and by the heel prick organizations. Only the timeliness of the screening by WBC organizations in round 2 and 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, one WBC organizations (14) failed to meet the signal value of 97%. In round 2, WBC organizations 64, 14, 29 and 65 failed to meet the signal value of 95%, and in round 3, organizations 50, 64, 2, 14, 28, 29, 36 and 65 failed to meet the signal value of 95%. In total, 82 children did not receive the third screening on time. Of these, 23 came from organization 29, 10 from organization 14, and 9 from organization 65. At organization 64, the percentage of children screened on time in the third round was very low (81%; 30/37).

In 2024, only one of the 7 WBC organizations met the signal value for timeliness in round 3. This was better in previous years (4 out of 7 in 2023). At organization 65, less than 95% have been screened on time in the third round for years. Actions have already been directed towards this, and there is some improvement visible compared to previous years. For two years in a row, a substantial number of children was screened late in the third round at WBC organizations 14 and 19.

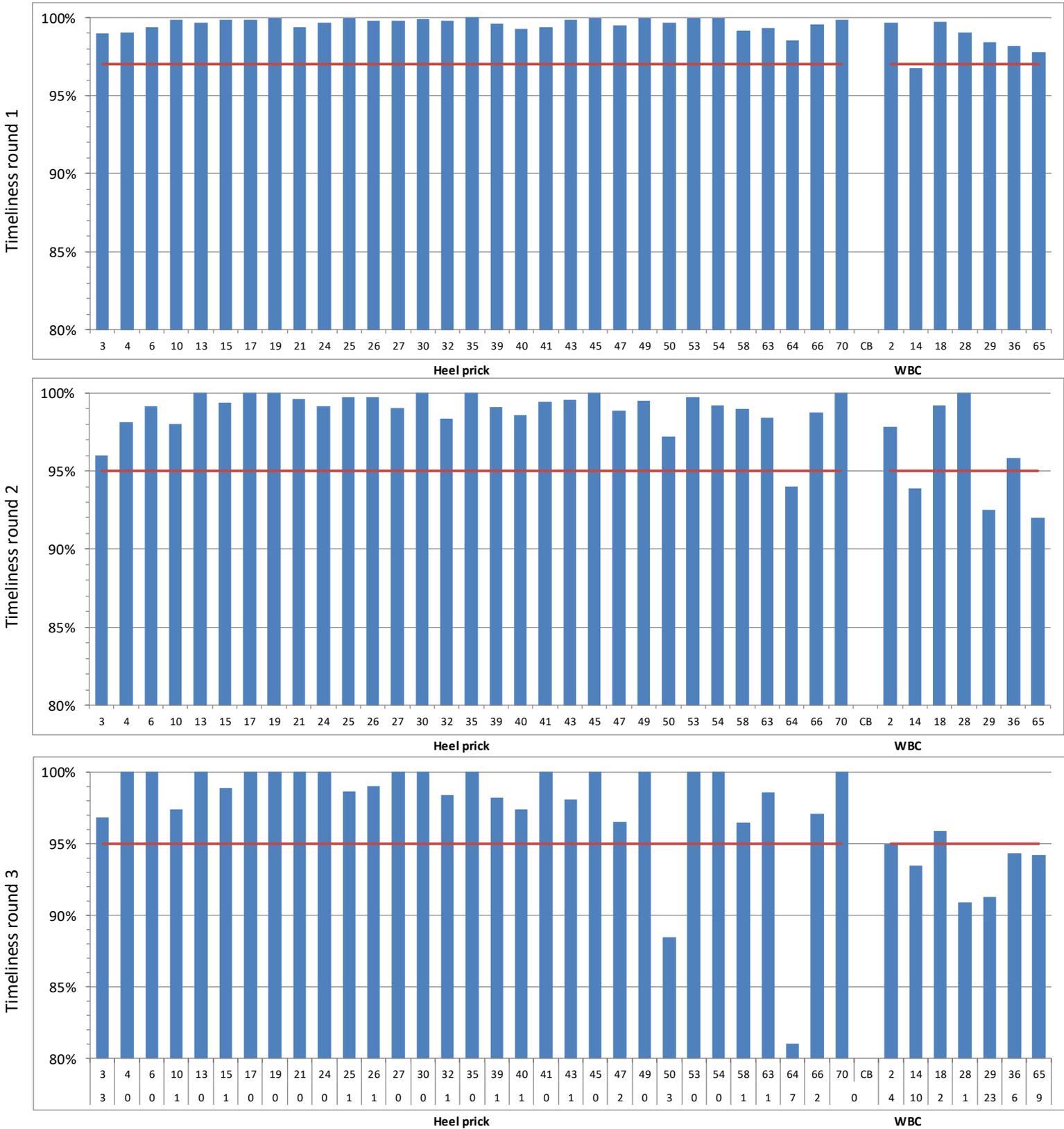
Table 2: Timeliness per screening round by heel prick and WBC organizations in 2024

	Signal value	Heel prick org. number (denom.)	% timely screened 2024 (2023)	WBC org. number (denom.)	% timely screened 2024 (2023)	Total number (denom.)	% timely screened 2024 (2023)
Round 1 (OAE+AABR)	≥97% before day 28	127,101	99.6% (99.6%)	34,413	98.4% (98.6%)	161,514	99.3% (99.4%)
Round 2 (OAE+AABR*)	≥95% before day 35	6,330	98.9% (99.1%)	2,020	94.1% (94.8%)	8,350	97.7% (98.0%)
Round 3 (AABR*)	≥95% before day 42	1,574	98.3% (98.7%)	818	93.3% (93.0%)	2,392	96.6% (96.8%)

Bold numbers indicate that the signal or target value was not met.

* In the numbers for round 2, the 2 children with a second AABR after AABR in round 1 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).
 Because of the small numbers, the number of children who were screened late is also shown below the graph for round 3.



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 in round 1 for screenings with OAE decreased compared to 2023 (Table 3 and Appendix A). The upward trend observed between 2019 and 2024, did not continue in 2024 (see Table 3 and Appendix A), but the refer rate remains high compared to 2019. Therefore, more children need a second screening. More and more CHS organizations are using the Echoscreen III (ESIII), which gives a higher refer rate than the ESII (Van der Ploeg e.a. Stijging referpercentage bij 1^e OAE-screening in 2023, oct 2024; about effect of type of device (ESI/II vs ESIII), age, experience with ESIII and type CHS (at home/WBC); in Dutch). The quality norm for round 1 ($\leq 7\%$) is met nationally. Collectively, the WBC organization have a higher refer rate compared to heel prick organizations (respectively 5.9% and 5.0%). If the proportion of children with hearing loss is stable and the first round has a high refer rate, it is expected that the refer rate in the second round will be relatively low, because more children without hearing loss will undergo a second screening. This is currently not the case: the signal value for the second round is not met by the WBC organization.

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 older children have 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 598 children (including those with [alternative and hospital protocols](#)) were referred to the AC (0.37%, red boxes in Figure 1).

ALTERNATIVE SCREENING PROTOCOLS

There were 150 children (0.09%) screened exclusively with the AABR method (the hospital protocol), because they had increased risk of auditory neuropathy or were hospitalized for a long period of time. This number is similar to 2021-2022, and lower than in 2017-2020 (between 188 and 248), and 2023 (165). Children mainly follow this protocol because of meningitis (26x) or long hospital stay (31x), but in 68 cases the reason is unclear ('other reason'). Of these 150 children, 11 children ultimately received a referral (see Figure 1). The referral rate for this protocol is high (7.3%, Table 4). One child with a bilateral inadequate first AABR test did not participate in a second AABR test, since the referral was made by a specialist outside the screening program.

Exclusive screening with the AABR happened approximately equally frequent at WBC organizations as at heel prick organizations in 2024 (respectively 0.09% and 0.11%). At organization 41 and 28, the hospital protocol is used ten times as frequent (1.0% for both, respectively 34 and 6 children). It is possible that these organizations don't perform the AABR test as part of the screening programme by the CHS, but at the request of paediatricians in special cases where an AABR screening in the hospital is required. From mid-2025, this reason can be registered.

A total of 293 children received a screening with OAE in round 1 and AABR in round 2. This is more than in 2021-2023 (266-273). As in previous years, the referral rate in these children was high (30.0%, see Table 4 and Figure 1). This [alternative protocol](#) is applied sometimes, for example in case of schisis (78x), hearing loss in the family (84x), or a syndrome (39x). The reason is also often unclear (63x 'other'). For one child with a bilateral inadequate AABR test, the parents refused further participation.

Table 3: Refer rates per screening round by heel prick and WBC organizations in 2024

	Norm/ signal value	Heel prick org. number (denom.)	% refer 2024 (2023)	WBC org. number (denom.)	% refer 2024 (2023)	Total number (denom.)	% refer 2024 (2023)
Round 1 (OAE)	$\leq 7\%$	126,990	5.0% (5.1%)	34,374	5.9% (6.7%)	161,364	5.2% (5.4%)
Round 2 (OAE)	$\leq 40\%$	6,098	25.9% (27.5%)	1,959	41.9% (38.4%)	8,057	29.8% (30.4%)
To round 3 (at 100% participation for rounds 1 and 2)			1.3% (1.4%)		2.5% (2.6%)		1.5% (1.7%)
Round 3 (AABR)	*	1,574	20.5% (20.3%)	818	20.7% (16.7%)	2,392	20.6% (19.1%)
Referral to AC (at 100% participation for rounds 1-3)	$< 0,5\%$		0.27% (0.28%)		0.51% (0.43%)		0.32% (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.

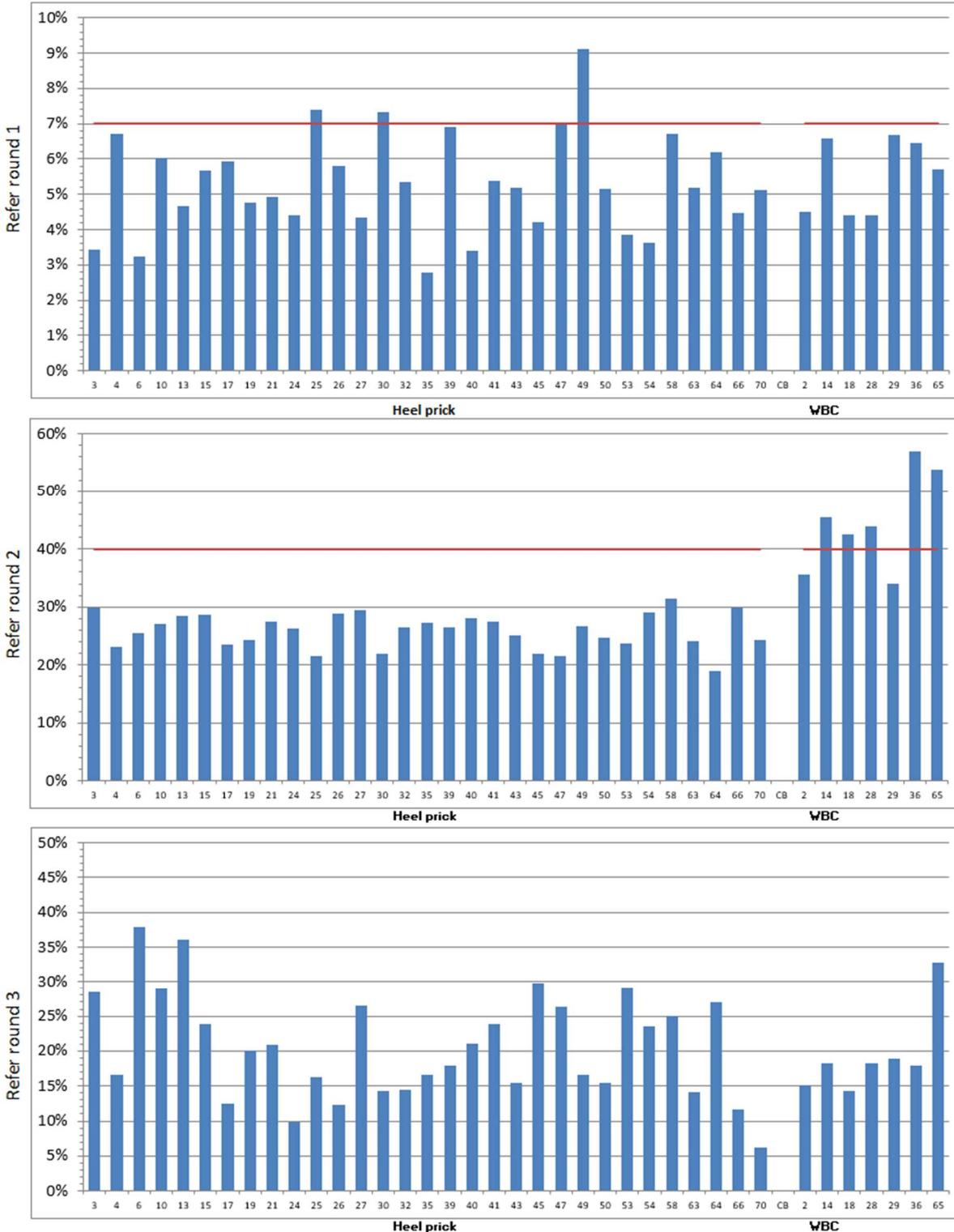
Table 4: Referrals to the AC after exclusive screening with the ABR method (hospital protocol) and in children screened first with the OAE and subsequently with the ABR

	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)	111	8 (7.2%)	39	3 (7.7%)	150	11 (7.3%)
AABR in round 2 (following OAE)	232	70 (30.2%)	61	18 (29.5%)	293	88 (30.0%)

REFER RATES AT ORGANIZATIONAL LEVEL

Figure 5a shows that in screening round 1, 3 CHS organizations did not meet the quality norm of at most 7% refers in 2024 (CHS 25, 30, 49). These CHS organizations also failed to meet the norm in 2023. At round 2, the signal value of ≤40% was met by all heel prick organizations, but 5 WBC organizations did not meet the signal value.

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



REFERRAL RATES

The quality norm for the referral rate after 3 rounds ($\leq 0,5\%$) was in 2024 not met by four CHS organizations (Figure 5b).

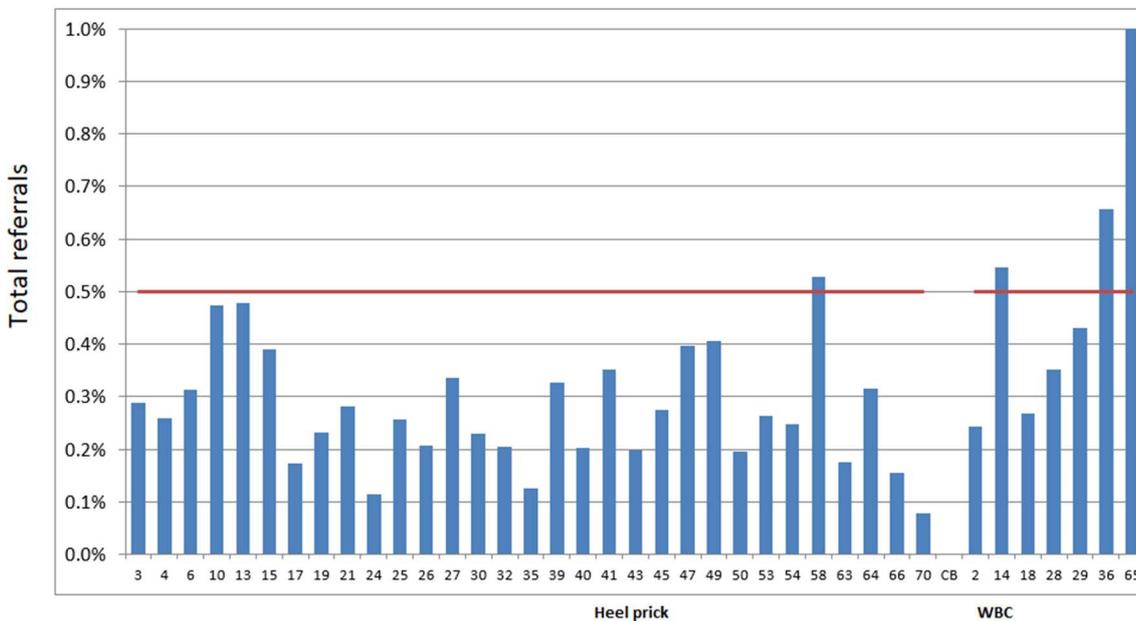
NATIONAL LEVEL

Of the children born in 2024, 598 children were referred to an audiological center (Figure 1). This includes one child who scored adequately on the AABR after an initial inadequate OAE: this child was referred based on family history of hearing problems. Three of them were referred before the screening. The total referral rate is therefore 0.37% (598/161,514). 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 0.32%. This is comparable to previous years (0.30-0.32%), only 2022 had a high referral rate (0.37%, Appendix A).

There are 491 referrals according to the standard protocol of 2x OAE and 1x AABR. One child who followed the standard screening protocol received a refer at every round, but was nevertheless not referred and therefore is not counted. A reason for this can be that the parents refuse the referral.

Of the 443 children who followed a special protocol (293 with 1x OAE and 1x or 2x AABR, and 150 with 2x AABR), 99 (22.3%) received a referral.

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



RESULTS DIAGNOSTIC PROCESS 2024

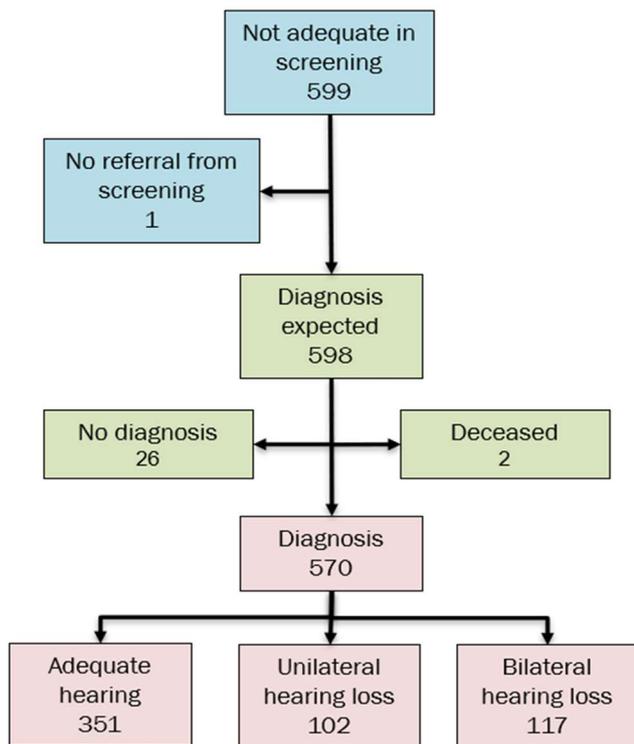
This section of the monitor deals with the execution of the diagnostic process after the neonatal hearing screening in 2024.

PARTICIPATION

Of the 598 referred children (Figure 6), at least 577 children (96.5%) visited the AC at least once. For 570 of these 577 (98.8%), 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 28 of the referred children (5%) no diagnosis was provided. This limits the insight into the diagnostic outcomes. Reasons for the lack of diagnosis were no consent for reporting (12x), no participation in follow-up examination (3x), deceased (2x), medical problems (2x), or missing report (9x). When the deceased children are excluded, participation in diagnostics are at least 95.6% (570 with known diagnosis divided by 596). A maximum of 99.2% received a diagnosis, since 3 children definitely did not participate in (follow-up) examination and 2 children were not further examined due to medical problems.

Figure 6: Diagnostic examination of children of 2024



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 2024: 69.8% of the 562 children of whom both dates are known visited the AC in time (Table 5). As in previous years, the target value was not met (respectively 65.2%, 67.4%, and 71.9% in 2021 till 2023). In 2024, there is a big difference between heel prick and WBC organizations (77.9% versus 51.2%, see Appendix A), just like in previous years.

There is a difference between uni- and bilateral refer: children with a bilateral refer more often visit the AC within 24 days (Table 5).

Timeliness completing diagnosis nationwide

For 563 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). This condition was not achieved for 29 children, but it was for 94.8%. The target value of $\geq 95\%$ was almost realized. In 2024, 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 more timely for uni- or bilateral referral varies over the years.

Since 2019, the percentage of children with an on-time diagnosis has improved compared with the years before 2019 (see Appendix A). This is presumably due to the extra attention the ACs devote to the timely completion of the diagnosis. In one year (2023) the target value was achieved. In 2020, the result (82.6%) was poorer due to the temporary suspension of the screening due to COVID-19.

Timeliness of completing diagnosis per AC

Figure 7 shows the percentage of children who visited the AC within 24 days after final screening per AC and 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, 90-100% of children received an on-time diagnosis in 2024, only for ACs 4, 12, and 33 this was lower (resp. 50%, 81.8%, and 80%). The target value of $\geq 95\%$ was met by 13 ACs (and 10 ACs failed to meet it): 4 ACs show an improvement compared to 2023, and 9 a deterioration.

In total, 29 children were diagnosed too late. Two ACs had more than two children too late (6 at AC 8, 8 at AC 10). These ACs therefore contribute strongly to the number of children with a diagnosis that was too late, but at both ACs this is partly because it diagnoses a relatively large number of the referred children (Figure 7b). However, the percentage of children who visited the AC within 24 days after the final screening is also very low, particularly at AC 10 (Figure 7a).

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	570*	562/563 [@]	392	69.8	534*	94.8
Unilateral referral	416	412	283	68.7	390	94.7
Bilateral referral	153	149/150 [@]	109	73.2	143	95.3

*For one child, it was not known whether the referral was unilateral or bilateral; this child is only included in the total number.

[@]For 'Diagnosis known', there is one additional child with date registration compared to 'Visit AC'.

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.

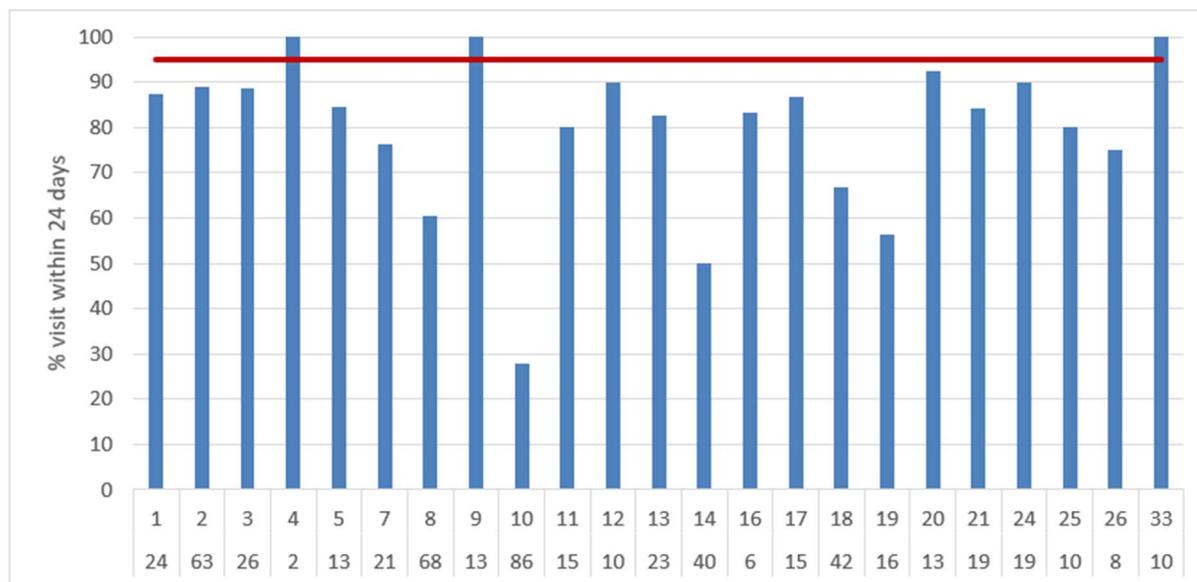
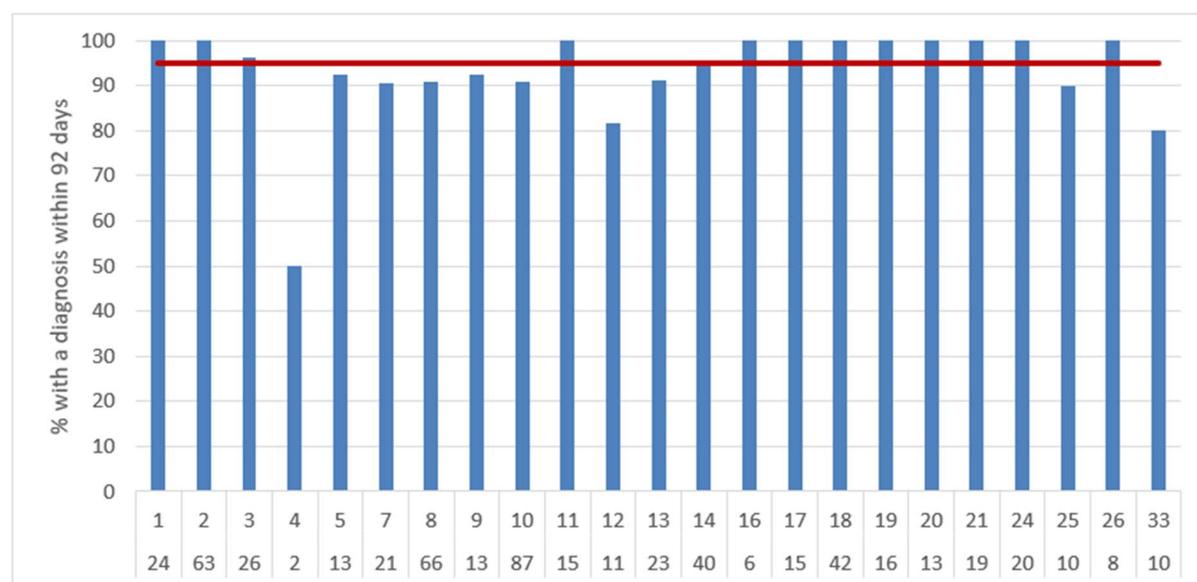


Figure 7b: Percentage of children for whom the diagnosis was made within 92 days after birth, per AC, plotted against the target value (red line). Bottom rows: number of children per AC for whom data are available.



RESULTS

Detected hearing impairment

The diagnosis is known for 570 children. Of them, 416 were referred due to an inadequate screening result in one ear (unilateral referral) and 153 due to inadequate screening results in both ears (bilateral referral). For one child, it was not known whether the referral was unilateral or bilateral (diagnosis: adequate hearing).

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 351 of the 570 referred children for whom the diagnosis is known (62%), an adequate hearing was detected. For the other 219 children (38%), a hearing loss of 40dB or more in one or both ears was detected (Figure 6). In 117 children, a bilateral hearing loss of at least 40dB was detected. Of them, 96 also had bilateral failure on the screening, however 21 were referred due to unilateral failure on the screening. Out of these 117 cases, 104 involved perceptible loss, 2 involved permanent conductive loss, 10 permanent mixed loss, and in one child, the type of hearing loss was permanent conductive hearing loss in one ear and permanent mixed hearing loss in the other ear.

In 102 children, unilateral hearing loss of at least 40 dB was detected. Of them, 96 also had unilateral failure on the screening, but 6 had bilateral failure. 79 involved perceptible loss, 8 involved permanent conductive loss, and 11 involved permanent mixed loss, and 4 children had auditory neuropathy (see [link](#) for explanation of the types of hearing loss).

Detected number of children over the years

Table 6 shows the number of children detected via screening by CHS in combination with the number of screened children over the years. The numbers with unilateral and bilateral hearing loss fluctuate strongly over the years, but the sum of it and therefore the detection rate is usually quite stable. In 2024, the detection number was high compared to previous years, as was also the case in 2018. Approximately one-third of hearing-impaired children are additionally detected through neonatal hearing screening at the NICUs: see www.isala.nl/gehoorscreening for the results.

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

	2024	2023	2022	2021	2020	2019	2018	2017	2016	Average
Bilateral	117	108	142	135	125	129	146	119	128	128
Unilateral	102	92	65	86	81	77	85	74	68	81
Total	219	200	207	221	206	206	231	193	196	209
Number of children eligible for screening	162,660	161,171	164,415	175,649	164,981	166,367	165,149	166,101	168,790	166,142
Detection number uni- and bilateral hearing loss by CHS (per 1000 with participation)	1.36	1.25	1.27	1.26	1.26	1.24	1.40	1.17	1.16	1.26

VALIDITY OF THE SCREENING PROGRAM IN 2024

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 38% in 2024. We call this the positive predictive value.

The likelihood of bilateral hearing loss after bilateral failure at the screening is 63% (96/153). This is comparable to the years up to 2023: in 2023, there was an exceptionally low value (54%, Appendix A).

The difference in PPV between children screened by heel prick organizations and by WBC organizations is 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: 43% (172/397)
 PPV WBC organizations: 27% (47/173)
 PPV together: 38% (219/570)

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 598 children referred, of whom at least 219 had a hearing loss and 351 did not. The remaining 28 children, for whom it is unknown whether they have a hearing loss, were divided over the two groups of with/without hearing loss 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 99.8%.

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 in the year in question was not met.

	2024	2023	2022	2021	2020*	2019	2018
Combination hearing and heel prick screening	78.6%	78.3%	78.6%	76.9%	76.6%	76.3%	76.1%
Participation screening round 1	99.3% (99.4% 99.0%)	99.3% (99.4%; 99.0%)	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%)
Participation screening round 2	99.5% (99.6% 99.0%)	99.3% (99.5%; 98.7%)	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%)
Participation screening round 3	99.6% (99.6% 99.6%)	99.3% (99.3%; 99.1%)	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%)
Participation rounds 1-3	98.4% (98.6% 97.7%)	97.9% (98.3%; 96.8%)	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%)
Absence of consent	0.41% (673 times)	0.39% (631 times)	0.33% (546 times)	0.27% (479 times)	0.23% (378 times)	0.15% (251 times)	0.15% (254 times)
Child not traced	0.020% (33 times)	0.029% (46 times)	0.025% (41 times)	0.018% (32 times)	0.025% (42 times)	0.015% (25 times)	0.013% (22 times)
Participation AC: diagnosis (all of referred through screening)	95.6%-99.2% Nationwide	96.2%-99.7% Nationwide	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
Referral advice followed (visit AC)	96.5%	96.2%	94.6%	94.7%	94.5%	92.7%	96.6%
Completion of diagnosis (% of 1 st visit to AC)	99.8% (i.e., 96.5% followed-up and completed)	99.8% (i.e., 96.0 followed-up and completed)	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)
Refer/referral							
Not adequate at round 1	5.2% (5.0%; 5.9%)	5.4% (5.1%; 6.7%)	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%)
Not adequate at round 2	29.8% (25.9%; 41.9%)	30.4% (27.5%; 38.4%)	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%)
Not adequate at round 3	20.6% (20.5%; 16.7%)	19.1% (20.3%; 16.7%)	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%)
Referral to AC (after OAE-OAE-AABR), vs. number of participants in 1 st screening (at 100% participation)	0.32% (0.27%; 0.51%)	0.32% (0.28%; 0.43%)	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%)
Overall referral rate (incl. hospital protocol and OAE-AABR(-AABR))	0.37%	0.36%	0.41%	0.38%	0.38%	0.37%	0.35%
Timeliness							
Timeliness screening round 1 (<28d)	99.3% (99.6%; 98.4%)	99.4% (99.6%; 98.6%)	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%)
Timeliness screening round 2 (<35d)	97.7% (98.9%; 94.1%)	98.0% (99.1%; 94.8%)	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%)
Timeliness screening round 3 (<42d)	96.6% (98.3%; 93.3%)	96.8% (98.7%; 93.0%)	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%)
Interval between final screening and 1 st diagnostic examination (<24d)	69.8% (77.9%; 51.2%)	71.9% (79.0%; 55.4%)	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%)
Timeliness diagnosis (<92 d after birth)	94.8% (96.7; 90.6%)	95.9% (96.4%; 94.6%)	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%)
Birth records in NIS (<3 working days)	23% < 3 calendar days 45% < 4 calendar days	23% < 3 calendar days 43% < 4 calendar days	22% < 3 calendar days 40% < 4 calendar days	22% < 3 calend. days 40% < 4 calend. 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

	2024	2023	2022	2021	2020*	2019	2018
Other results							
Number with unilateral hearing loss	102	92	65	86	81	77	85
Number with bilateral hearing loss	117	108	142	135	125	129	146
Detection number uni- and bilateral hearing loss by CHS (per 1000)	1.36 (1.35; 1.37)	1.25 (1.24; 1.27)	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)
Positive Predictive Value (PPV) for uni- and bilateral hearing loss combined	38% (43%; 27%)	36% (40%; 26%)	32% (34%; 28%)	35% (37%; 30%)	35% (38%; 30%)	37% (39%; 34%)	42% (44%; 36%)
PPV for bilateral hearing loss after bilateral failure at screening	63%	54%	64%	60%	60%	62%	63%
False positive results	>59%	>62%	>64%	>61%	>61%	>57%	>56%
Specificity	99.8%	99.8%	99.7%	99.8%	99.8%	99.8%	99.8%
Sensitivity	Cannot be determined						
Children screened with AABR	150	165	146	154	210	188	248

*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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