



Summary: Hearing Screening

Portugal

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Allison Mackey & Inger Uhlén
Karolinska Institutet, Stockholm Sweden

Hearing screening representatives for Portugal: Luisa Monteiro, ENT Unit, Hospital Lusíadas
Lisbon

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1. Glossary of Terms: Hearing Screening

Abnormal test result	A test result where a normal “pass” response could not be detected under good conditions. The result on screening equipment may indicate “no response,” “fail,” or “refer.”
Attendance rate	<p>The proportion of all those <u>invited for screening</u> that are <u>tested and receive a result</u>,</p> <ul style="list-style-type: none"> • <u>Invited for screening</u> includes all those that are offered the screening test. • <u>Tested and receive a result</u> could be a “pass” or “fail”. <p>Attendance rate provides information on the willingness of families to participate in screening.</p>
Attendance rate in first year of life	<p>See definition of Attendance rate.</p> <p>The calculation cut-off is after <u>one year of life</u>.</p>
Compliance with referral (percentage)	<p>The percentage of those who are <u>referred from screening</u> to a diagnostic assessment that actually <u>attend</u> the first diagnostic assessment.</p> <p>Percentage of compliance provides information on the willingness of families to attend the diagnostic assessment after referral from screening.</p>
Coverage	<p>The proportion of those <u>eligible for screening</u> that are <u>tested and receive a result</u> within a <u>specific time</u>.</p> <ul style="list-style-type: none"> • <u>Eligible for screening</u> includes those within the population that are covered under the screening or health care program. • <u>Tested and receive a result</u> could be a “pass” or “refer to diagnostic assessment”. • <u>Specific time</u> can be defined, such as 1 month after birth, 3 months after birth, etc. <p>Coverage provides information on the overall effectiveness and timeliness of a complete screening programme.</p> <p>Factors such as being offered screening, willingness to participate, missed screening, ability to complete the screen, and ability to document the screening results will influence the coverage.</p>
Coverage in first year of life	<p>See definition of Coverage.</p> <p>The <u>specific time</u> is pre-defined as within the first year of life.</p> <p>In other words, the coverage is the proportion of those eligible for screening that complete the screening sequence to a final result within the first year of life.</p>
False negatives	The percentage of <u>infants/children with a hearing loss</u> (defined by the target condition) that <u>receive a result of “pass”</u> during screening.



	Example: If 100 infants with hearing loss are screened, and 1 infant passes the screening, the percentage of false negatives is 1%.
False positives	<p>The percentage of <u>infants/children with normal hearing</u> that <u>receive a result of “fail”</u> from the final screening test.</p> <p>Example: If 100 infants with normal hearing are screened, and 3 infants fail the screening and are referred for diagnostic assessment, the percentage of false positives is 3%.</p>
Guidelines	Recommendations or instructions provided by an authoritative body on the practice of screening in the country or region.
Hearing screening professional	A person qualified to perform hearing screening, according to the practice in your country or region.
Inconclusive test result	A test result where a normal “pass” response could not be detected due to poor test conditions.
Invited for screening	Offered screening.
Outcome of hearing screening	An indication of the effectiveness or performance of screening, such as a measurement of coverage rate, referral rate, number of infants detected, etc.
Permanent hearing loss	<p>A hearing impairment that is <i>not</i> due to a temporary or transient condition such as middle ear fluid.</p> <p>Permanent hearing loss can be either sensorineural or permanent conductive.</p>
Positive predictive value	<p>The percentage of infants/children referred from screening who have a confirmed <u>hearing loss</u>, as described by your protocol or guideline and indicated in the Target Condition (see definition).</p> <p>For example, if 100 babies are referred from screening for diagnostic assessment and 90 have normal hearing while 10 have a confirmed hearing loss, the positive predictive value would be 10%.</p>
Preschool or (pre)school children	All children between 3-6 years of age.
Preschool or (pre)school screening	<p>Screening that takes place during the time children are between 3-6 years of age.</p> <p>This refers to <i>any</i> hearing screening during this age. The location of the screening is irrelevant to the definition.</p>



Prevalence	The number or percentage of individuals with a specific disease or condition. Prevalence can either be expressed as a percentage, proportion, or as the value per 1000 individuals within the same demographic.
Programme	An organized system for screening, which could be based nationally, regionally or locally.
Protocol	Documented procedure or sequence for screening, which could include which tests are performed, when tests are performed, procedures for passing and referring, and so forth.
Quality assurance	A method for checking and ensuring that screening is functioning adequately and meeting set goals and benchmarks.
Referral criteria	A pre-determined cut-off boundary for when an infant/child should be re-tested or seen for a diagnostic assessment. For example, referral criteria may be “no response” at 35 dB nHL.
Risk babies / Babies at-risk	All infants that are considered to be at-risk or have risk-factors for hearing loss according to the screening programme. Two common risk factors are admission to the neonatal-intensive care unit (NICU) or born prematurely. However, other risk factors for hearing loss may also be indicated in the screening programme.
Sensitivity	The percentage of infants/children with hearing loss that are identified via the screening program. For example, if 100 babies with hearing loss are tested, and 98 of these babies are referred for diagnostic assessment while 2 pass the screening, the sensitivity is 98%.
Specificity	The percentage of infants/children with normal hearing that pass the screening. For example, if 100 babies with normal hearing are tested, and 10 of these babies are referred for diagnostic assessment and 90 pass the screening, the specificity is 90%.
Target condition	The hearing loss condition you are aiming to detect via your screening programme. This includes: <ul style="list-style-type: none"> • The <u>laterality of the condition</u>, whether the program aims to detect both unilateral and bilateral hearing loss or just bilateral hearing loss. • The <u>severity of the condition</u>, whether the program aims to detect hearing loss ≥ 30 dB HL, ≥ 35 dB HL, ≥ 40 dB HL or ≥ 45 dB HL
Well, healthy babies	Infants who are <i>not</i> admitted into the NICU or born prematurely. Well, healthy babies may or may not have additional risk factors for hearing loss, according to the procedures indicated in the specific screening programme.



2. Abbreviations

ABR – auditory brainstem response

aABR – automatic auditory brainstem response

ANSD – auditory neuropathy spectrum disorder

ASSR – auditory steady-state response

CI – cochlear implant

CMV – cytomegalovirus

dB HL – decibel hearing level

dB nHL – decibel normalized hearing level

dB SNR – decibel signal-to-noise ratio

DPOAE – distortion product otoacoustic emissions

HA – hearing aid

NICU – neonatal intensive care unit

OAE – otoacoustic emissions

TEOAE – transient-evoked otoacoustic emissions



3. Background

In Portugal, hearing screening is performed nationally and organized regionally. The following report contains information with regards to childhood hearing screening in the entire country of Portugal with specific data presented for the Lisbon region.

3.1. General

Portugal has a total area of 92 212 km² with a population of 10 562 178 in 2011 (Instituto Nacional de Estatística – Portugal (Statistics Portugal), 2018).

In Portugal, all births are registered to the Direção-Geral da Saúde (Department of Public Health). The number of live births in Portugal in 2017 was 86 154 (Instituto Nacional de Estatística – Portugal (Statistics Portugal), 2018).

The World Bank income classification categorizes Portugal as a high-income country (The World Bank, 2018). The gross domestic product (GDP) in 2016 was €18 060 per capita in Portugal (Instituto Nacional de Estatística – Portugal (Statistics Portugal), 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for Portugal in 2015 was 1722 USD or €1514 per capita (World Health Organization (WHO), 2018).

An infant mortality rate of 2.9 per 1000 is reported for Portugal in 2015 (United Nations Statistics Division, 2016). Similarly, Statistics Portugal reports an infant mortality rate of 2.7 per 1000 for 2017 (Instituto Nacional de Estatística – Portugal (Statistics Portugal), 2018).

3.2. Neonatal hearing screening

In Portugal, neonatal hearing screening is conducted universally, with all babies in the country having access to hearing screening, though participation is not obligatory for parents. Screening is available in all regions in Portugal, at all maternity hospitals, including private and state-owned hospitals, mainland and Atlantic islands. Hearing screening for well babies started in Portugal in 2001 and was fully implemented across the country by 2008. For at-risk infants, hearing screening was available in only a few maternity hospitals in 1998, and also became fully implemented across the country by 2008. Neonatal hearing screening is funded by parents, health insurance and the state, though it is not embedded in the Preventive Child Health Care screening system. Neonatal hearing screening is organized by central or regional Health Ministries for maternity hospitals under the National Health Authority and independently for private hospitals.

National guidelines are available as is a screening protocol used across the country. Across Portugal, the same protocol is followed for performing hearing screening.

3.3. Preschool hearing screening

There is no preschool hearing screening programme in Portugal.



4. Guidelines & Quality Control

There are national guidelines for hearing screening in Portugal.

The national guidelines (DGS Standard) came into effect in 2015. Prior to then, local committees were responsible implementing and organizing neonatal hearing screening in individual hospitals. The content of the general hearing screening programme in 2015 was decided on by the National Health Authority and the Public Health Organization (DGS) in consultation with an advisory board of ENTs (Direção-Geral da Saúde (DGS), 2015). The guidelines were last revised in 2016, and funding for revisions is provided by the government.

Quality assurance of hearing screening programmes is theoretically imposed by the government in the form of clinical audits, as stipulated in the Standard (Direção-Geral da Saúde (DGS), 2015); however, these audits have not yet occurred. At the current time, data are only collected on a local or regional level voluntarily. Annual reports are not yet available.

There have been studies on hearing screening programmes in Portugal, where data is collected locally and presented at national meetings. There has not been research performed measuring the effectiveness of neonatal hearing screening in Portugal.



5. Process: Screening, Diagnosis, Intervention

5.1. Neonatal hearing screening

Well-babies and at-risk babies are screened in the hospital, private clinic, NICU or pediatric clinic after discharge from the NICU. The percentage of infants born in a maternity hospital in Portugal was 99.3% in 2016, where the average length of stay is estimated to be 3 days. Parents/caregivers of well and at-risk babies are invited to participate in neonatal hearing screening directly in the maternity hospital by maternity ward staff and hospital audiologists.

Neonatal hearing screening for well and at-risk babies should be completed before 1 month of age.

At-risk babies are those that have at least one of the risk factors listed in the guidelines (Direção-Geral da Saúde (DGS), 2015). These include the following: viral infections (cytomegalovirus, herpes, rubella, or toxoplasmosis), NICU admission lasting more than 48 hours, prematurity, APGAR index less than 5, birth weight less than 1500 grams, hypoxia or hyperbilirubinemia, neonatal infections, family history of hearing loss, malformation or syndrome associated with hearing loss, craniofacial abnormalities, postnatal infection (specifically, bacterial meningitis), later syndromes associated with hearing loss, traumatic brain injury, or exposure to ototoxic drugs.

Data on the prevalence of CMV or meningitis is not available in Portugal.

The target condition for screening for well and at-risk babies is a bilateral hearing loss of 40 dB HL or worse.

5.2. Neonatal diagnostic assessment

The diagnostic assessment after neonatal hearing screening referral should be completed by 3 months of age or 3 months corrected age for both well and at-risk infants.

5.3. Preschool hearing screening

Not applicable.

5.4. Intervention approach

In Portugal, treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants. Infants are fitted with hearing aids from less than 6 months of age or older, and are fitted cochlear implants from 6 months of age or older.

The fitting criteria in Portugal for a hearing aid is a bilateral hearing loss of at least 40 dB HL.

6. Protocols

Hearing screening protocols are described for neonatal hearing screening (well and at-risk) as well as for preschool hearing screening when applicable.

- The Test performed is the screening technique used
- The Age of the child is indicated in hours, days, months or years
- Referral criteria may be the lack of an OAE response at specified frequencies, a response-waveform repeatability constant, the absence of an aABR response at a specified intensity, or an absent behavioural response at a specified intensity. Referral criteria may be defined within a protocol or limited based on the device used.
- The Device is the screening device used.
- Unilateral Referrals indicates whether children are referred if only one ear fails screening.
- The Location is where the screening takes place

6.1. Neonatal hearing screening (well)

The process for neonatal hearing screening for well babies is described in Table 1. A 2-step protocol is in effect, whereby the first test may either be an OAE or aABR performed in the maternity hospital before discharge. Only one aABR fail is sufficient to warrant referral to the ENT department for evaluation. If the infant fails the OAE, a rescreening occurs as soon as possible after discharge (around week 2). The rescreening test may be an OAE or aABR. A subsequent fail at rescreening would warrant a referral to the ENT department for a diagnostic assessment.

The 3rd stage (if only OAE are used in the 1st and 2nd stages) is the diagnostic/audiologic assessment stage. They all have the same protocol.

According to a 2013 master's thesis analyzing the status of neonatal hearing screening across Portugal, the bulk of institutions surveyed (26 out of 32) indicated that they used OAE for both steps of screening. Five institutions used a combined OAE and aABR screening for both steps 1 and 2 (Canas, 2013).

The second step of screening occurs between 2 and 4 weeks after initial screening, varying by institution (Canas, 2013).

Table 1: Process for neonatal hearing screening for well, healthy infants in Portugal.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1/aABR	24-72 hours	Predefined criteria / 35 dB nHL		Yes	Maternity hospital
OAE2/aABR	>10 days	Predefined criteria / 35 dB nHL		Yes	Maternity hospital

6.2. Neonatal hearing screening (at-risk)

The screening process for all at-risk infants is described in Table 2. A one-step process is in effect where aABR is performed as soon as possible after 36 weeks gestational age or before discharge from the NICU.

Although not expressed in the guidelines, it is recommended that at-risk babies are also screened with OAE in addition to aABR during this initial step. At-risk infants that pass neonatal hearing screening

may be followed-up and rescreened every 6 months until 2 years of age. Follow-up screening on a bi-annual basis is typically performed with aABR. Children are only referred to ENT and audiologic assessment if they fail the screening; however, an ENT consultation may also be performed if requested by parents or when a medical prescription is required by the insurance company.

Table 2: Process for neonatal hearing screening at-risk infants in Portugal.

Test	Age	Referral criteria	Unilateral Referrals?	Location
aABR (+OAE recommended)	24-72 hours	35 dB nHL	Yes	NICU

6.3. Preschool hearing screening

Not applicable.



7. Professionals

7.1. Neonatal hearing screening (well)

Neonatal hearing screening is typically performed by audiologists and nurses. Some pediatricians perform screening (Canas, 2013).

For audiologists, nurses and pediatricians involved in hearing screening, there is a 1-week formal training programme; however, it is not certified or accredited. Furthermore, training is not updated or revalidated.

7.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is also performed by audiologists and nurses. See 5.1 for training details.

7.3. Preschool hearing screening

Not applicable.



8. Results: Neonatal Hearing Screening

8.1. Coverage and attendance rates

Outcome data of the screening programme presented here are derived from data collected from maternity wards across the Lisbon region in 2014 (Monteiro, Lisbon questionnaire data (unpublished), 2014). Coverage rate is defined according to the published standard as the number of infants screened out of the number of infants born each year (Direção-Geral da Saúde (DGS), 2015).

In 2014, the coverage rate in Lisbon region was 92.75%, which includes both well infants and at-risk infants (Monteiro, 2014). The number of infants that missed being *offered* screening is not specified, and therefore, attendance rate is not indicated.

A 2013 master's thesis indicates that the majority of institutions (43%) surveyed report 1% of infants drop-out between steps 1 and 2 of hearing screening.

8.2. Referral rates

The referral rates for neonatal hearing screening in Lisbon region are presented below in Table 3 for well infants and at-risk infants combined.

Table 3: Referral rates for neonatal hearing screening (all babies) in Lisbon region, Portugal (Monteiro, 2014)

Test	Referral Rate
OAE1 / OAE+aABR	12.1%
OAE2	Data unavailable

Pass rates assume a 100% attendance rate at each step.

The final referral rate for well, healthy babies to a diagnostic assessment was 2.4% in the Lisbon region in 2014 (Monteiro, 2014). Data are unavailable regarding the referral rate to a diagnostic assessment for at-risk babies.

8.3. Diagnostic assessment attendance

Data are unavailable in Portugal or Lisbon region regarding the compliance to diagnostic assessment.

8.4. Prevalence / Diagnosis

Data are unavailable regarding the prevalence of neonatal hearing loss in Portugal or Lisbon region.

Data are unavailable regarding the prevalence of auditory neuropathy in Portugal or Lisbon region.

8.5. Treatment success

It is unknown how many children per year are fitted with hearing aids each year; however, it was estimated that 139 children were fitted with cochlear implants in 2016 (Monteiro, Personal presentation, 2017). It is not specified how many children were fitted after neonatal hearing screening or due to post-natal acquired hearing loss.

8.6. Screening evaluation

Actual data on the sensitivity or specificity of neonatal hearing screening are not available. However, it was indicated that there is around one infant per year diagnosed with hearing impairment who



passed neonatal hearing screening. In addition, the specificity of the first-step of hearing screening was estimated to be 86.7% (Monteiro, 2014).

A positive predictive value of a referral to diagnostic assessment was calculated to be 9.6% (i.e., out of the 581 babies referred to a diagnostic assessment in 2014, 525 had normal hearing; Monteiro, 2014).



9. Results: Preschool Hearing Screening

9.1. Coverage and attendance rates

Not applicable.

9.2. Referral rates

Not applicable.

9.3. Diagnostic assessment attendance

Not applicable.

9.4. Screening evaluation

Not applicable.



10. Costs: Neonatal Hearing Screening

Financing of neonatal hearing screening in Portugal is organized by the National Health Service, or by parents for private hospitals. Screening is free of charge for parents in the public health domain. There is no financial reward when parents attend hearing screening, nor a penalty for those who do not attend hearing screening.

A cost-effectiveness analysis of neonatal hearing screening in Portugal has not been completed.

10.1. Screening costs

Data are unavailable regarding the total cost of hearing screening in Portugal nor are data available regarding the cost per infant screened.

10.2. Equipment costs

The cost an OAE/aABR screening device is approximately €10 000 but depends on the manufacturer. Maintenance costs and the cost for disposables are unknown. There is no fixed time in which devices should be replaced; they are typically replaced only when they are no longer functional.

10.3. Staff costs

Data are unavailable regarding the number of hearing screening professionals in Portugal.

The average annual salary for a screening professional is roughly estimated to be €15 000 or €7 per hour. Data are unavailable regarding the cost for training hearing screening professionals.

10.4. Diagnostic costs

The total cost of diagnostic confirmation is not indicated.

10.5. Amplification costs

In the Portugal, all children with hearing loss are treated, except for children of deaf parents who refuse hearing aids or cochlear implant for their children.

Treatment costs for the first year of hearing aid intervention is roughly estimated to be €2000 to €4000. Hearing aid fitting is generally an outsourcing service and not performed in the hospitals. Most parents pay for hearing aids out of pocket. The neonatal hearing screening programme only funds hearing aids if the family income is equal or below a minimum salary criterion. Infants also typically wait a long time to be fitted if the family applies to free hearing aids. In these cases, hospitals usually have a small “bank” of used hearing aids that are fitted provisionally until children are fitted with their own hearing aid.

For cochlear implants, device costs range from €16 400 plus 6% VAT in public hospitals and €25 000 plus 6% VAT in private hospitals. It is estimated that 3 ENT consultations occur per year, plus speech therapy sessions twice per week, though costs vary. The process for cochlear implant fitting is faster than for hearing aids. There is no waiting list and cochlear implants are funded under the neonatal hearing screening programme, including all cost except for replacement parts.

10.6. Social costs



Data are unavailable regarding special schools for deaf and hard-of-hearing students. In mainstream schools, extra support is provided to children in the form of support teachers and speech therapists. All costs for mainstream or special education schools are unknown.



11. Costs: Preschool Hearing Screening

11.1. Screening costs

Not applicable.

11.2. Equipment costs

Not applicable.

11.3. Staff costs

Not applicable.



12. References

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