



Summary: Hearing Screening

Austria (Upper Austria)

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Disclaimer: This is a summary report representing the responses from a screening expert working within hearing care services of the country or region reported. This report is the product of professional research conducted for the EUSCREEN study and does not represent conclusions made by the authors. It is not meant to represent the position or opinions of the EUSCREEN study or its Partners. Efforts were made to cross-check the information supplied; however, not all information supplied is fully verified by the authors.

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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	<p>A pre-determined cut-off boundary for when an infant/child should be re-tested or seen for a diagnostic assessment.</p> <p>For example, referral criteria may be “no response” at 35 dB nHL.</p>
Risk babies / Babies at-risk	<p>All infants that are considered to be at-risk or have risk-factors for hearing loss according to the screening programme.</p> <p>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.</p>
Sensitivity	<p>The percentage of infants/children with hearing loss that are identified via the screening program.</p> <p>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%.</p>
Specificity	<p>The percentage of infants/children with normal hearing that pass the screening.</p> <p>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%.</p>
Target condition	<p>The hearing loss condition you are aiming to detect via your screening programme. This includes:</p> <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	<p>Infants who are <i>not</i> admitted into the NICU or born prematurely.</p> <p>Well, healthy babies may or may not have additional risk factors for hearing loss, according to the procedures indicated in the specific screening programme.</p>

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 Austria, hearing screening is organized locally, regionally and nationally. Neonatal hearing screening is implemented across the entire country, and provided in almost all hospitals. A national guidance document has been published by the Austrian ENT society, though screening is not established in federal law. Neonatal hearing screening protocols and data collection are regionally centered. Preschool hearing screening is organized locally, with each local social welfare authority organizing its own programme.

The following report contains information with regards to hearing screening for the Region of Upper Austria.

3.1. General

The country of Austria has a total area of 83 879 km² and a population of 8 739 806 as of 2016 (Statistics Austria, 2018). Upper Austria has an area of 11 982 km² and a population of 1 472 422 in 2017. In Austria, each birth is registered. The number of live births in Austria was 81 722 in 2014 and 87 633 in 2017. In Upper Austria, the number of live births was 15 394 in 2017 (Statistics Austria, 2018).

The World Bank income classification categorizes Austria as a high-income country (The World Bank, 2018). The gross domestic product (GDP) was €37 400 per capita in 2015 (Statistics Austria, 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure in Austria in 2015 was 4 536 USD or €3 960 per capita (World Health Organization, 2018).

Infant mortality rate in the country of Austria was 3.0 and 3.1 per 1000 in 2014 and 2015, respectively (United Nations Statistics Division, 2016; Statistics Austria, 2018).

3.2. Neonatal hearing screening

In Austria, neonatal hearing screening is conducted universally, with all babies in the country having access to hearing screening, though participation is not obligatory for parents. Hearing screening for well and at-risk babies started in 1995 and was fully implemented in 1998 when a national ENT declaration was published, though screening was not a mandatory service. Neonatal hearing screening is funded by hospitals, and since 2003 has been embedded in the Preventive Child Health Care screening system as part of the Mother-Child Passport (Federal Ministry of Labor, Social Affairs, Health and Consumer Protection, 2018).

Neonatal hearing screening is organized by the hospitals, though most hospitals do not publish official protocols. While there is a national guidance document available (Audiology Association & Austrian ENT Society, 2017), regions across Austria follow their own protocol for screening well and at-risk infants. There is a protocol for screening for the region of Upper Austria.

3.3. Preschool hearing screening

In Austria, preschool hearing screening is not universally performed and not implemented across the country. In some areas, teachers may screen children's hearing and in other areas a speech-language pathologist may perform hearing screening in schools. Regions in Austria that do perform screening may screen differently, and there is no set protocol used throughout Austria.

The regions that are known to perform preschool hearing screening are Upper Austria and Tyrol. Preschool hearing screening in Upper Austria was fully implemented across the region in 2017 and is funded by the region. It is not part of the Preventive Child Health Care Programme, though it is linked to the universal speech-development screening that is also performed in kindergartens at this age. Prior to the implementation of universal preschool hearing screening in 2017, only a whisper test was administered (Holzinger, Heitz, & Kraxberger, 2017). Pure-tone screening is now available in every kindergarten across Upper Austria.

4. Guidelines & Quality Control

The neonatal hearing screening programme is decided on by the Ministry of Health in Vienna, in that hearing screening (where available) is offered as part of the Mother-Child Passport, even despite the fact that neonatal hearing screening may not be offered in all hospitals in Austria (Federal Ministry of Labor, Social Affairs, Health and Consumer Protection, 2018). Neonatal hearing screening was implemented in the Mother-Child Passport in 2003.

Though not established in law, national guidelines for neonatal hearing screening exist in Austria, published by the Austrian ENT society, with an original declaration published in 1998. The guidelines were recently updated in 2017, with recommendations added for bilateral screening and the use of aABR among children in the NICU (Audiology Association & Austrian ENT Society, 2017).

The protocols themselves are established regionally or locally, though some hospitals do not have official protocols. In Upper Austria, the regional health council is responsible for control of childhood hearing screening and provides funding for revisions. A multidisciplinary commission led by the health council decides on these revisions. In 2016/2017, the region of Upper Austria implemented a tracking programme for neonatal hearing screening, and in 2017 Upper Austria implemented universal screening of preschool children.

Quality assurance of hearing screening programmes is not imposed by the federal government, and data are not collected on a national level. Any data collection performed is done so on a local level by individual institutions or on a regional level, such as in Upper Austria. Data collection in Upper Austria is imposed by the regional government, and data collection occurs via a simple documentation tracking system that does not permit tracking of individual children. Data are collected annually, but because the tracking system started in 2017, official annual reports are not yet available.

There is data collection ongoing in Upper Austria regarding the neonatal hearing screening programme; however, there have not been any studies performed on the effectiveness of hearing screening in Upper Austria. Concerning the whole country of Austria, some studies have been found concerning the effectiveness of neonatal hearing screening (Weichbold, Nekahm-Heis, & Welzl-Müller, 2005; Weichbold, Nekahm-Heis, & Welzl-Mueller, 2006).

5. Process: Screening, Diagnosis, Intervention

5.1. Neonatal hearing screening

In Austria, infants are screened in the hospital maternity ward, in the NICU in cases of risk. According to the Birth Registry report, 98.4% of infants are born in hospitals each year and 1.3% are born at home (Teil des Instituts für Integrierte Versorgung der Tirol Kliniken GmbH, 2018). The average length of stay in the maternity hospital after birth is 3 days or 4 days in cases of a cesarean section. Families are invited to participate in screening directly in person at the hospital or in the NICU by the staff in the maternity hospital (nurses, speech therapists, NICU staff). Parents are asked to provide written content to having their baby's hearing screened.

The target condition for screening both well- and at-risk infants is a bilateral or unilateral hearing loss of >25-30 dB HL. Screening should be completed by 1 month of age for both well and at-risk infants.

Infants that undergo a different screening protocol from well, healthy babies (i.e., considered "at-risk"), are those who are admitted to the NICU. Data are unavailable on the childhood/infant prevalence of CMV infections or meningitis in Upper Austria.

5.2. Neonatal diagnostic assessment

The diagnostic assessment after neonatal hearing screening referral should be completed by 3 months of age. Tests performed for confirmation of hearing loss include a clinical-ABR and ASSR.

5.3. Preschool hearing screening

In Upper Austria, preschool screening takes place in the kindergartens by a speech therapist. Children are invited to participate in screening via a letter.

The target condition for preschool hearing screening is a unilateral or bilateral hearing loss of >25 dB HL.

5.4. Intervention approach

In Austria, treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants. Children are fitted with hearing aids from < 6 months of age and with cochlear implants from 1-2 years of age.

Fitting criteria for hearing aids in Austria is a hearing loss of at least 30 dB HL. Hearing aids may be fit on children with unilateral hearing loss a severity of less than 85 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 in Upper Austria is summarized in Table 1, whereby a 2-step OAE - OAE protocol is in effect. The first OAE is performed in the maternity hospital after birth when possible. The protocol in Upper Austria recommends that both screening and rescreening (when applicable) occurs before discharge. In 8% of births discharge occurs less 1 day after delivery or earlier (Teil des Instituts für Integrierte Versorgung der Tirol Kliniken GmbH, 2018), and families are instead invited to return to the maternity hospital for screening or rescreening. In some rare cases, rescreening may occur with an aABR instead of an OAE. If the infant does not pass the second OAE (or aABR), a referral to the ENT department for a diagnostic assessment is made.

Table 1: Screening process for well babies in Upper Austria.

Test	Age*	Referral criteria	Device	Unilateral Referrals?	Location
OAE1	24-72 hours	Various	Various	Yes	Maternity ward
OAE2 / aABR	Before discharge	35-40 dB nHL (not defined in protocol)		Yes	Maternity ward

*There is no standardization as to the age at which screening is performed. The ages noted here are recommended by the protocol for Upper Austria.

6.2. Neonatal hearing screening (at-risk)

There are no guidelines specified for NICU infants as stipulated by the protocol specific to Upper Austria; however, recommendations defined by the Austrian ENT society would also be recommended in Upper Austria. That is, that all NICU infants are screened with aABR in place of OAE testing (Audiology Association & Austrian ENT Society, 2017).

6.3. Preschool hearing screening

In Upper Austria, hearing screening is performed in kindergartens at 4 1/2 years of age. Pure-tone audiometry screening (with headphones) is performed. If one or more thresholds are worse than 25 dB HL a referral is made to an ENT for a diagnostic assessment.

Table 2: Process for preschool hearing screening in Upper Austria



Test	Age	Referral criteria	Unilateral Referrals?	Location
Pure-tone screening	4.5 years	25 dB HL	Yes	Kindergarten schools

7. Professionals

7.1. Neonatal hearing screening (well)

Screening for well-babies is performed by nurses or speech-language therapists, depending on the hospital.

There is no specific training programme for screening professionals. An introduction to screening is integrated into the 3-year education of speech therapists. Otherwise, screening staff are trained on the job. Upper Austria has started workshops for screening staff; however, there is no obligatory training update or monitoring of screening professionals.

7.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is performed by nurses or speech-language therapists. See 7.1 for details.

7.3. Preschool hearing screening

Preschool screening is performed by speech-language therapists.

8. Results: Neonatal Hearing Screening

8.1. Coverage and attendance rates

In Upper Austria, the neonatal hearing screening programme tracking system has identified a 98.4% coverage rate for 2017 according to internal data, including both well and at-risk infants. The coverage rate is the percentage of infants born in Upper Austria who have been screened with step 1.

It is unknown the percentage of infants that referred from step 1 attended step 2 rescreening.

8.2. Referral rates

The pass rates for neonatal hearing screening of well, healthy infants are presented below in Table 3. Rates are presented for data derived from the neonatal hearing screening programme tracking system in Upper Austria in 2017.

Table 3: Referral rates for neonatal hearing screening (all babies) in Upper Austria.

Test	Referral Rate
Step 1	94%
Step 2	51.2%

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

The final referral rate to a diagnostic assessment for all babies was 3.5% in 2017.

8.3. Diagnostic assessment attendance

Out of the infants referred from neonatal hearing screening, 88.5% attended a diagnostic assessment. A total of 3.89% of all infants received a diagnostic assessment in 2017.

Figures at the level of the diagnostic assessment may show inconsistencies due to various factors related to tracking and reporting from ENT clinics. For example, children may be seen at more than one ENT clinic or reporting from the ENT clinics include children who were not referred from hearing screening.

8.4. Prevalence / Diagnosis

Data on the prevalence rates of neonates in Upper Austria is derived from the neonatal hearing screening programme tracking system.

Table 4: Prevalence rate (per 1000) of permanent hearing loss among neonates in Upper Austria region.

	Bilateral		Unilateral	
	≥ 40 dB HL	≥ 80 dB HL	≥ 40 dB HL	≥ 80 dB HL
Upper Austria (2017)	0.8	0.33	0.69	0.6

Because the prevalence rates are derived from the neonatal hearing screening programme tracking system, the percentage of infants diagnosed with hearing loss of various degrees after neonatal hearing screening matches the prevalence rates provided. In other words, 0.0825% and 0.0687% of infants are diagnosed with a permanent bilateral and unilateral hearing loss of ≥ 40 dB HL after neonatal hearing screening.

The prevalence rates of preschool-age children are not available in Austria; however, data published by Holzinger Weishaupt, Fellingner, Beitel and Fellingner (2016) indicates the prevalence rates of a cohort of school-age children in Austria (average age 10.5 years), presented in Table 5.

Table 5: Prevalence rate (per 1000) of sensorineural hearing loss among school-age children (average 10.5 years of age) in Austria (Holzinger, Weishaupt, Fellingner, Beitel, & Fellingner, 2016).

	Bilateral			Unilateral		
	≥ 25 dB	≥ 40 dB	≥ 80 dB	≥ 25 dB	≥ 40 dB	≥ 80
School-age children		2.2			1.39	

Data are unavailable regarding the prevalence of auditory neuropathy or the percentage of children diagnosed with permanent hearing loss after preschool hearing screening in Upper Austria.

8.5. Treatment success

Data are unavailable on the percentage of children fitted with hearing aids or cochlear implants in Upper Austria.

8.6. Screening evaluation

In Upper Austria, 94.6% of referrals have normal hearing. The positive predictive value of a refer is 4.2% for well babies.

Data are unavailable on the sensitivity or specificity of neonatal hearing screening in Upper Austria, nor are data available for at-risk infants.

9. Results: Preschool Hearing Screening

9.1. Coverage and attendance rates

All children attending kindergarten (2 years before entering school) are invited to participate in preschool hearing screening. This encompasses 97.5% of all children 4.5 years of age in Upper Austria (Federation of Austrian Industries, 2015).

Coverage/attendance rates are not yet available as the screening programme began in 2017. Data may be updated when available.

9.2. Referral rates

Referral rates are not yet available as the screening programme began in 2017. Data may be updated when available.

9.3. Diagnostic assessment attendance

Data are not available.

9.4. Screening evaluation

Data are not available.

10. Costs: Neonatal Hearing Screening

There has not been a cost effectiveness analysis completed in Upper Austria.

10.1. Screening costs

The costs for neonatal hearing screening in Upper Austria are unknown.

10.2. Equipment costs

(Information extracted to protect commercially sensitive data).

10.3. Staff costs

The number of screening staff in Upper Austria is unknown. The cost for a speech therapist ranges from €55 500 to €67 500, and the cost for a nurse ranges from €50 000 to €60 000. This is the total cost for staffing each screener, not limited to salaries.

10.4. Diagnostic costs

Diagnostic costs are not indicated.

10.5. Amplification costs

In Austria, all children are treated for hearing impairment.

Data are not available regarding the costs of intervention in Upper Austria.

In Styria, data are not available on the costs for hearing aid intervention. The cost for cochlear implant fitting in Styria is €42 000, including €25 000 for the implant itself and the remainder for surgery costs, consultation and follow-up. After the first year, the cost for ongoing intervention is approximately €7000 per year.

10.6. Social costs

There are 4 specialized schools across Austria for deaf and hard-of-hearing students (a figure which is constantly decreasing). Approximately 700 children attend these specialized schools, though most children attend mainstream schools where support is provided. Children with hearing impairment are supported in schools with support teachers. Data on costs are unavailable.

In Upper Austria, there is one school for the deaf and hard-of-hearing, with approximately 80 students with hearing loss. Children with normal hearing also attend this school. Children are provided support in mainstream schools in Upper Austria, though resources are limited.

11. Costs: Preschool Hearing Screening

11.1. Screening costs

Data are not available.

11.2. Equipment costs

The cost of a screening device for preschool hearing screening is €1 600.

11.3. Staff costs

The cost for a speech therapist ranges from €55 500 to €67 500. This is the total annual cost, not limited to just salary.

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