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RESEARCH

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# Hearing loss among teachers: a major public health challenge

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## Abstract

**Background** Hearing loss is highly prevalent and the third largest cause of years lived with disability. The most frequent cause of adult-onset hearing loss is older age. As the retirement age increases in many countries, a growing number of workers will experience hearing loss, which may affect work participation. Limited research has been done on the consequences of hearing loss in workers in communicative professions. The present study examines the associations of hearing loss with work ability and sick leave among teachers.

**Methods** Dutch teachers were recruited via schools, educational sector organizations, and trade unions. Teachers completed a survey questionnaire and performed a valid and reliable online speech-in-noise screening test for hearing loss. The survey measured work ability with the single-item Work Ability Score (range 0–10); scores were dichotomised into poor-moderate (score 0–7) and good-excellent (score 8–10) work ability. Teachers were asked if they had been on sick leave in the past three months (no / yes; if yes: how many days). Robust Poisson regression analyses were performed to examine the cross-sectional associations of hearing loss with both work ability (poor to moderate versus good to excellent) and sick leave (yes versus no), adjusted for age, sex, level of education, type of work tasks (only teaching versus a mixture with other (e.g. management) tasks, current work hours per week, and working as a physical education teacher.

**Results** A total of 737 teachers participated in the study, of whom 86 (12%) had poor and 146 (20%) insufficient hearing. Teachers with poor and insufficient hearing had a higher prevalence of poor-moderate work ability than good hearing teachers (Prevalence Ratio (PR) = 1.67, 95% CI: 1.36–2.06 and PR = 1.40, 95% CI: 1.16–1.70, respectively). Teachers with poor hearing had a higher prevalence of sick leave than good hearing teachers (PR = 1.60, 95% CI: 1.21–2.01).

**Conclusions** Among teachers, hearing loss was associated with poorer work ability and more sick leave. The results highlight the need for periodic hearing screening as recommended by the WHO. Earlier detection of hearing loss could enable timely work accommodations to prevent work disability of teachers.

**Keywords** Hearing loss, Work, Teachers, Work ability, Sick leave, Disability pension

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## Background

Hearing loss is a major public health issue. Hearing loss is the third most important cause of years lived with disability in the general population, after low back pain and migraine [1]. In terms of number of people needing rehabilitation services, hearing disability is the second biggest contributor, after low backpain [2]. Worldwide, 1.57 billion people had hearing loss in 2019, accounting for 20.3% of the global population. In 2050, an estimated 2.45 billion people worldwide will have hearing loss [3]. The WHO's World report on hearing highlights that addressing hearing loss with public health measures will significantly improve the lives of affected individuals and their families, but also yield significant economic benefits and productivity gains [3]. These yields can be significant, because for 2019, global economic costs of hearing loss were estimated to exceed \$981 billion [4]. Almost half of these costs, \$458 billion, was due to societal costs associated with reduced quality of life, based on a monetary valuation of years lived with disability due to hearing loss. Another \$182 billion could be attributed to productivity losses, besides health care costs amounting to \$314 billion. Older age is a major cause of hearing loss [5]. Given the increasing retirement age in many countries [6], more and more people will be hindered by hearing loss in their work.

Despite the increasing problem of hearing loss in ageing working populations, surprisingly few studies have addressed hearing loss and its consequences for work. More research on this issue is important, because for workers with hearing loss communicating with others is strenuous, especially in background noise [7]. With background noise, even mild hearing loss can lead to an increased listening effort [8]. Hearing loss has been associated with increased fatigue [9, 10] and a higher need for recovery after work [11, 12]. Nachtegaal et al. [13] showed that hearing loss was significantly associated with higher levels of distress, depression, and somatisation. Hearing loss is also associated with a lower self-reported productivity [14]. Gupta et al. [15] reported that working-age adults with a hearing disability had lower employment rates compared to the general Canadian population (55% and 80%, respectively). In a previous study, we showed that hearing loss was associated with poorer work capabilities, which is a barrier for sustained employability [16]. This means that these workers might be at increased risk of work disability.

Poor work ability, as assessed by the work ability index, and in particular its first item (work ability score), has been shown to be a predictor of disability pension [17–19]. We found only one study that examined work ability among workers with hearing loss. Svinndal et al. [9] reported that a higher degree of hearing loss was associated with poorer work ability, but the work ability of

normally hearing workers was not investigated. Associations between hearing loss and sick leave, another predictor of disability pension [20], have been investigated in only a limited number of studies. In a systematic literature review, Friberg et al. [21] found inconclusive evidence for the direction and magnitude of associations between hearing loss and sick leave. Kramer et al. [7] showed that a heterogeneous group of workers with hearing loss more often reported sick leave compared to good hearing workers. Nachtegaal et al. [14] reported a significant relationship between hearing ability and sick leave, which lost significance after confounder adjustment. Jørgensen et al. [22] concluded that hearing loss was weakly associated with sick leave, whereas Svinndal et al. [9] found no significant association between the degree of hearing loss and sick leave, though work ability was poorer among workers with a higher degree of hearing loss.

A possible explanation for these inconclusive findings may be that these studies examined heterogeneous groups of workers. We hypothesise that hearing loss especially impacts the work outcomes of people in communicative jobs, e.g. teaching. In their daily work, teachers require a combination of speech understanding, sound localisation, and detection. In primary and secondary education, auditory functioning is especially challenging in the classroom setting, which typically accommodates 25–30 pupils under suboptimal acoustic conditions. Taken together, these aspects could make teaching a highly demanding profession for a person with hearing loss. Therefore, teachers with hearing loss may be at particular risk of poor work ability and more sick leave, and ultimately premature work exit. This would interfere with the public health interest to promote the participation of a healthy workforce in an essential sector such as education. The aim of the present study was to investigate the associations of hearing loss with work ability and sick leave among teachers.

## Methods

### Study design and sample

This cross-sectional study used data from the “Hearing loss and sustainable employability study”, conducted between April 2014 and June 2015 among teachers in primary, secondary, and professional education [16]. For that study, we used a questionnaire developed by Abma et al. [23], supplemented by a validated online hearing test and questions regarding hearing. A convenience sample of teachers was recruited via schools, educational sector organisations, and trade unions. These organisations received written information about the study and the study aim, including a link to the online survey. The organisations distributed the information and the link among their employees and members. The Medical

Ethics Committee of the University Medical Center Groningen reviewed and approved the study (reference M13.142047).

### Hearing status

The online survey included a link to the Dutch National Hearing Test (NHT; <https://hoortest.nl/>), a valid and reliable freely available online speech-in-noise screening test for hearing loss [24]. This adaptive speech-in-noise test evaluates a participant's capacity to understand digit triplets against a background of masking noise. By analyzing the average signal-to-noise ratio (SNR) of 20 digit triplets, the test calculates the participant's speech reception threshold (SRT) score, which corresponds to 50% intelligibility. The results of this test have a strong correlation ( $r$ ) with the pure tone average (PTA) findings, with  $r=0.73$  for PTA at 0.5, 1, and 2 kHz, and  $r=0.77$  for PTA at 0.5, 1, 2, and 4 kHz [25]. Compared to the Dutch speech-in-noise sentences test using headphones as the gold standard, the NHT sensitivity was 0.91 and specificity 0.93 [25].

Based on their individual SRT score, participants were categorized into three groups: "good" (SRT < -5.5 dB SNR), "insufficient" (-5.5 dB SNR ≤ SRT ≤ 2.8 dB SNR), and "poor" (SRT > 2.8 dB SNR) [24]. After completing the NHT, teachers received their result in terms of "good", "insufficient", or "poor" and were then asked to report this result in the survey. They also responded to a question about the use of hearing aids (yes/no). If the response was positive, teachers were assigned to the poor hearing group, irrespective of their NHT result.

### Outcome measures

The survey measured work ability with the validated single-item work ability score (WAS) [17–19]. The WAS compares current work ability with lifetime best on a range from 0 (i.e., completely unable to work) to 10 (i.e., work ability at its best). Scores were dichotomised into poor-moderate (score 0–7) and good-excellent (score 8–10) work ability [26].

Sick leave was self-reported. Teachers were asked if they had been on sick leave in the past three months (yes/no). If the response was positive, they were asked how many sick leave days they had had in the past three months. We used the 3-months recall period because self-reported sick leave has been shown to have better reliability for short recall periods [27]. Both questions regarding sick leave are presented in the supplementary material.

### Covariates

Age (≤ 45, 46–55, and ≥ 56 years), sex (men; women), level of education (high = higher professional education and university; low/medium = lower and medium

professional education), type of work tasks (teaching versus a mix of teaching with other tasks, such as management, staff, or supportive tasks), and current work hours per week (< 30, 30–36, 37–40, and > 40 h) were retrieved from the survey. Teachers were also asked if they held a position as physical education teacher (yes/no), because physical education teachers may be exposed to harmful noise levels [28].

### Statistical analysis

The statistical analyses were conducted in IBM SPSS Statistics for Windows, version 24.0 (Armonk, NY, released 2016) and R, Version 4.3.3 (R Core Team, 2023). As less than 1% of the data was missing, no data was imputed. We performed Kruskal-Wallis and Chi-square tests in SPSS to compare the baseline characteristics and outcome measures of teachers with good, insufficient, and poor hearing. To examine the associations of hearing loss with work ability (poor-moderate versus good-excellent) and sick leave (yes versus no), we used Poisson regression analyses with robust variance estimation, adjusted for age, sex, level of education, type of work tasks, current work hours per week, and working as a physical education teacher. The robust Poisson regression approach was used because of the high prevalence of poor-moderate work ability and sick leave being respectively 42% and 32%, as recommended by Barros and Hirakata [29]. Poisson regression models were fitted in R using the `glm()` function with a log-link function and Poisson family. Robust standard errors were calculated using the sandwich package. Prevalence ratios (PRs) were derived by exponentiating the regression coefficients. Significance was assessed at the 5% level with 95% confidence intervals (CI).

### Results

A total of  $N=880$  persons completed the online survey;  $N=79$  (9.0%) were non-teaching staff and were excluded from the analyses. Among the remaining 801 teachers, 68 did not report their NHT result in the survey. Four of these 68 teachers reported the use of hearing aids and were therefore included in the poor hearing group, the remaining 64 teachers were excluded. The final study sample consisted of 737 teachers, of whom 505 (69%) had good hearing, 146 (20%) insufficient hearing, and 86 (12%) poor hearing (Table 1). Teachers with poor and insufficient hearing were more likely to be men (49% and 47%, respectively), as compared to good hearing teachers (34%). Teachers with poor and insufficient hearing were older (55.9 and 52.5 years, respectively) than good hearing teachers (48.0 years).

Among teachers with poor hearing, 54 (73%) had poor to moderate work ability, compared to 77 (53%) of those with insufficient and 180 (36%) of those with

**Table 1** Baseline characteristics of teachers, n (%)

	Poor hearing n = 86	Insufficient hearing n = 146	Good hearing n = 505	p value Chi square
Age (years)				< 0.01
≤45	7 (8)	29 (20)	182 (36)	
46–55	22 (26)	44 (30)	150 (30)	
≥56	57 (66)	73 (50)	173 (34)	
Sex				< 0.01
Men	42 (49)	68 (47)	171 (34)	
Women	44 (51)	78 (53)	334 (66)	
Educational level				0.08
Low/medium	12 (14)	15 (10)	36 (7)	
High	74 (86)	131 (90)	469 (93)	
Type of work tasks				0.56
Teaching only	72 (84)	129 (88)	442 (88)	
Mix of teaching and other tasks	14 (16)	17 (12)	63 (12)	
Physical education teacher				0.42
Yes	6 (7)	10 (7)	50 (10)	
No	80 (93)	136 (93)	455 (90)	
Current work hours per week				0.35
<30	22 (26)	31 (21)	130 (26)	
30–36	23 (27)	48 (33)	127 (25)	
37–40	25 (29)	29 (20)	118 (23)	
>40	16 (19)	38 (26)	125 (25)	
Work ability score				< 0.01
Poor/Moderate	54 (73)	77 (53)	180 (36)	
Good/Excellent	32 (37)	69 (47)	325 (64)	
Sick leave in the past three months				< 0.01
Yes	40 (49)	47 (32)	151 (30)	
No	42 (51)	98 (68)	352 (70)	

**Table 2** Associations between hearing loss, work ability, and sick leave among teachers

	Work ability				Sick leave			
	Poor– moderate n (%)	Good– excellent n (%)	Poor-moderate N = 311 PR (95% CI) <sup>a</sup>	p value	Yes n (%)	No n (%)	Yes N = 238 PR (95% CI) <sup>a</sup>	p value
Good hearing	180 (36)	325 (64)	1		151 (30)	352 (70)	1	
Insufficient hearing	77 (53)	69 (47)	1.40 (1.16–1.70)	< 0.001	47 (32)	98 (67)	1.10 (0.83–1.44)	0.52
Poor hearing	54 (63)	32 (37)	1.67 (1.36–2.06)	< 0.001	40 (47)	42 (49)	1.60 (1.21–2.10)	< 0.001

<sup>a</sup>Prevalence Ratio (95% confidence interval) adjusted for age, sex, level of education, type of work tasks, current work hours per week, and working as a physical education teacher

good hearing (Table 1). For both teachers with poor and teachers with insufficient hearing the prevalence of poor-moderate work ability was higher than for good hearing teachers. The Prevalence Ratios were 1.67, 95% CI: 1.36–2.06 and 1.40, 95% CI: 1.16–1.70, respectively (Table 2).

Of teachers with poor hearing, 40 (47%) had been on sick leave in the preceding three months, compared to 47 (32%) of those with insufficient and 151 (30%) of those with good hearing (Table 1). Teachers with poor hearing had a higher prevalence of having been on sick leave than good hearing teachers (Prevalence Ratio 1.60, 95% CI: 1.21–2.10) (Table 2). Teachers with poor hearing reported on average 5.6 (standard deviation [SD] 14.2) sick leave days in the past 3 months as compared to 2.1

(SD 7.2) days in teachers with good hearing ( $p = 0.001$ ). Teachers with insufficient hearing reported 3.2 (SD 9.8) sick leave days. The prevalence of teachers with insufficient hearing having been on sick leave was not significantly higher as compared to good hearing teachers (Prevalence Ratio 1.10, 95% CI: 0.83–1.44) (Table 2).

## Discussion

To the best of our knowledge, this is the first study that investigates the associations of hearing loss with work ability and sick leave in teaching, a profession with high auditory demands. Our results show that teachers with poor hearing report poorer work ability and more sick leave compared to those with good hearing. Teachers



with insufficient hearing experience poorer work ability than good hearing teachers. Poor work ability is a potential predictor of future work participation problems, such as sick leave and early work exit into disability pension [17–20]. Hearing loss poses a potential threat to the sustainable employability of teachers [16], and conceivably also for workers in many other communicative jobs. Hearing loss therefore warrants more attention from occupational health professionals.

Our finding that hearing loss is associated with poorer work ability concurs with the results of the cross-sectional study of Svinndal et al. [9] among a heterogeneous group of workers with hearing loss. Our results add that workers with hearing loss have poorer work ability than good hearing workers. We also found that teachers with poor hearing had higher prevalences of sick leave than good hearing teachers. This is in line with the results of Kramer et al. [7], who found that the proportion of workers reporting sick leave was significantly higher in hearing-impaired workers than in good hearing workers. Nachtegaal et al. [14] found higher odds of sickness absence with decreasing hearing ability, though significance was lost when they adjusted the analyses for other chronic conditions and educational level. Jørgensen et al. [22] found a statistically significant but weak association between hearing loss and sick leave, that was not significant for the subgroup of workers with disabling hearing loss ( $\geq 35$  dB). This contrasts with our finding that, as compared with good hearing teachers, only teachers with poor hearing had a significantly higher Prevalence Ratio of having been on sick leave. The different findings may be due to the definition of sick leave. Jørgensen et al. [22] defined sick leave as physician-certified sick leave, i.e. episodes of more than 16 days, while the present study also included short-term sick leave episodes. Our findings regarding sick leave also differ from the results of Svinndal et al. [9], who reported no significant association between the degree of hearing loss and sick leave. This may partly be explained by the fact that they did not include sick leave of normally hearing workers in their analysis. Another explanation may be that Svinndal and colleagues [9] included workers from all kinds of professions, and not a specific group of workers in communicative jobs with high auditory demands, such as the teachers in our study. It is conceivable that workers in communicative jobs are more hindered by hearing loss than for example solitary workers in jobs with less auditory demands.

### Strengths and limitations

A strength of our study is that we focused on the possible consequences of hearing loss in a profession with high auditory demands, i.e. teachers. Another strength is that the hearing status was determined by using a valid

and reliable online digits-in-noise hearing screening test (NHT), rather than worker-reported. This enabled us to classify teachers into three categories based on their hearing abilities: good, insufficient, and poor hearing. The inclusion (most likely in the insufficient hearing group) of workers who were previously unaware of their hearing loss has enhanced our knowledge in comparison to previous studies that focused only on individuals who were already aware of their hearing disability [7, 9]. This is particularly relevant because of the global upward trend in mild hearing loss, due to age-related hearing loss in an ageing global population [30].

The cross-sectional design is a limitation of the study. Longitudinal studies are required to investigate the prospective associations of hearing loss with future work outcomes. Another limitation of our study is that we used a convenience sample. Therefore, we have no information on the characteristics of the non-participant teachers and it was not possible to determine whether the study population was representative. Teachers with hearing loss may have been more motivated to participate in the survey. An over-representation of teachers with hearing loss in the study population could result in overestimated associations with work ability and sick-leave. Alternatively, associations may have been underestimated by a healthy worker effect if teachers experiencing work problems because of hearing loss exited their job. A further limitation of our study is that we used self-reported data, which is inherent to questionnaire surveys. Respondents may misremember, exaggerate, or underreport certain aspects, leading to recall and information bias. It has been shown that self-reported sick leave is subject to recall bias. We dealt with potential recall bias by using a short (three months) recall period [27]. In addition, teachers' responses may be socially desirable. In our study, teachers were instructed to report the results of the National Hearing Test (NHT) in the survey immediately following the hearing screening test, minimizing recall bias. However, misclassification may have occurred if teachers with "insufficient" or "poor" NHT results were reluctant to disclose this in the survey, and reported a "good" result instead. As a consequence, they would be incorrectly assigned to the good hearing group, herewith underestimating the associations between hearing loss, work ability and sick leave. Finally, we could not rule out residual confounding by variables that were not measured in this convenience sample.

### Implications for public health

The WHO World report on hearing highlights key public health interventions for providing ear and hearing care services across the life course. They are summarised in the acronym "H.E.A.R.I.N.G.": Hearing screening and intervention, Ear disease prevention and management,

Access to technologies, Rehabilitation services, Improved communication, Noise reduction, and Greater community engagement. The report emphasises that implementation of these public health interventions will significantly improve the lives of affected individuals and their families [3].

As part of these interventions, the WHO recommends hearing screening for all adults from the age of 50 onwards [31], for example with the hearWHO app [32], to increase the awareness of hearing loss. This app is available in a growing number of languages. It uses the same validated digits-in-noise technology as the NHT we applied in the present study. In line with the Dutch occupational health guideline for hearing impairment and tinnitus [33], we specifically recommend to add a validated speech-in-noise screening test to periodic health examinations in the occupational healthcare setting, especially for workers in communicative professions such as teaching. Earlier identification of hearing loss could forestall negative effects of unrecognized hearing loss and facilitate timely audiological and occupational rehabilitative interventions, to prevent work disability.

In many cases, hearing loss will not be the direct cause of sick leave. Kramer et al. [7] showed that hearing-impaired workers presented with stress-related complaints such as fatigue, strain, and burnout. They argue that these complaints may become apparent earlier and more prominently than the actual hearing loss itself. It is conceivable that fatigue and strain could lead to repeated spells of short-term sick leave, which may be interpreted by employers as signs of motivation or performance problems [34]. Workers may indeed perform less well because of their hearing disability [14]. To prevent incomprehension and discussions about work functioning, occupational health professionals should consider hearing loss and advise an online hearing test when workers in communicative jobs report sick with fatigue, strain, or burnout, or when workers in communicative jobs experience problems in their work performance. The Dutch occupational health guideline for hearing impairment and tinnitus [33] recommends to refer workers with a hearing disability to an audiologist if work performance and communication are negatively affected or if working conditions have to be accommodated.

Qualitative studies by Zuriekat et al. [35, 36] found that, from the perspective of both workers and audiologists, audiological rehabilitation of workers with hearing loss needs improvements to deliver sufficient support and quality care. The authors argue that further research in this field is required. A recent cross-sectional study by Granberg et al. [37] among workers with hearing loss demonstrated a pattern regarding work and health factors for a sustainable working life, e.g. lower levels of mental strain, a supportive work environment, less

auditory demands, and a more quiet sound environment at work. Occupational health professionals and audiologists could take these factors into account when providing care for workers with hearing loss. The importance of interventions that focus on how to cope with hearing loss in the workplace and how to accept the loss has already been demonstrated [38]. Therefore, when starting an audiological rehabilitation program, it is important to carefully assess whether only technical measures, like the provision of hearing aids and workplace accommodations, are sufficient. A multidisciplinary approach needs to be considered when tailoring a worker's audiological rehabilitation program to reduce the risk of early work exit of people with hearing loss.

## Conclusion

Among teachers, hearing loss was associated with poorer work ability and more sick leave. Hence hearing loss might be a risk factor for work participation, particularly among older workers in communicative jobs. Public health professionals should take these findings into account in their efforts to maintain a healthy workforce. Periodic hearing screening of teachers could identify hearing loss and enable timely work accommodations and audiological rehabilitation to maintain work participation and prevent premature work exit in disability pension.

## Abbreviations

CI	Confidence interval
NHT	National hearing test
PR	Prevalence ratio
PTA	Pure tone average
SD	Standard deviation
SNR	Signal-to-noise ratio
SRT	Speech reception threshold
WAS	Work ability score
WHO	World health organization

## Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-025-21876-4>.

Supplementary Material 1

## Author contributions

AGS and FIA were involved in designing the study. CAMR, SHS, and AGS contributed to the analysis. All authors contributed to the interpretation of the results. AGS, UB, and CAMR contributed to the writing of the manuscript. All authors reviewed, discussed, and approved the manuscript.

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No funding was received for this study.

## Data availability

The data that support the findings of this study are available on reasonable request from the corresponding author.

## Declarations

### Ethical approval and consent to participate

The Medical Ethics Committee of the University Medical Center Groningen reviewed and approved the study (reference M13.142047). Participants were informed that their participation in this study was voluntary and that the data collected would be used for research purposes only. They were guaranteed anonymity and confidentiality. As was customary when the study was conducted, all participants gave informed consent by participating in the study.

### Consent for publication

Not applicable.

### Competing interests

The authors declare no competing interests.

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