Hearing ability, need for recovery after work, and psychosocial work characteristics

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ABSTRACT

The main aim of the study is to address the relationship between hearing ability and need for recovery. In addition, the role of hearing ability in the relationship between psychosocial work characteristics (i.e. job demands and job control) and need for recovery was assessed. The sample comprised 925 normally hearing and hearing impaired working adults (aged 18-65 years) participating in the National Longitudinal Study on Hearing. Hearing ability was determined using the National Hearing (speech-in-noise) Test over the Internet. Psychosocial work characteristics and need for recovery were assessed using the Job Content Questionnaire and the Dutch Questionnaire on the Experience and Assessment of Work. Regression models revealed a significant association between hearing ability and need for recovery after work, poorer hearing leading to an increasing need for recovery. Additionally, poorer hearing led to a higher odds for risky levels of need for recovery. Hearing ability did not influence the significant relationship between psychosocial work characteristics (i.e. job demand and job control) and need for recovery after work. Implications for clinical practice, such as the necessity of having adequate enablement programs for this specific group of patients, are discussed.
INTRODUCTION

Although the prevalence of hearing impairment is the highest among persons older than 65 years of age, a considerable number of younger individuals are experiencing hearing problems as well. Community surveys in different countries worldwide revealed that the prevalence in the working-age adult population (i.e. 18 to 65 years) varies between 10 to 20% (Davis 1989; Karlsøe et al. 2000; Mathers et al. 2003; Hannaford et al. 2005).

Hearing impairment inevitably affects areas of life, including communication, social life, interpersonal relationships, community life, and psychosocial health (Kramer 2005). Significant restrictions in the engagement in major life areas like work and education have also been reported, in particular among individuals with hearing impairment aged between 18 and 65 years. A recent review of Danermark (2005) showed that persons with auditory impairments comprise a vulnerable group on the labour market. Several studies demonstrated an association between hearing acuity and both educational level and employment status, with lower levels of education and a higher unemployment rate among those with hearing impairment compared to an age-matched normally hearing population (Parving and Christensen 1993; Järvelin et al. 1997). Others found that people with hearing impairment were overrepresented in the group of workers taking early retirement (Danermark and Gellerstedt 2004). Morata et al. (2005) evaluated the impact of hearing impairment on e.g. job performance by focus groups and in-depth interviews among workers with self-reported hearing loss and occupational noise exposure. Their research revealed that misunderstanding environmental sounds at work generally leads to embarrassment, fear, distress, anxiety and a feeling of losing control.

Another condition often observed among employees with hearing problems is a lack of energy or fatigue. For example, Grimby and Ringdahl (2000) compared a group of hearing impaired adult full-time workers with a group of normally hearing employed people below 65 years of age and used various measures of quality of life as outcome indicators. An important finding of that study is that
hearing impaired full-time workers reported a higher degree of psychosocial distress in terms of ‘lack of energy’ and ‘social isolation’. Similar findings were also reported by Ringdahl and Grimby (2000), Backenroth et al. (2003), and Danermark and Gellerstedt (2004). There are indications that people with auditory difficulties are overrepresented in the group taking (long-term) sick leave (Danermark 2005). Especially sick leave due to psychological distress seems to occur more often in employees with hearing impairment compared to normally hearing controls (Kramer et al. 2006). In itself, fatigue is a common phenomenon. It is widely reported in the general population and frequently reported among employees, in particular among those with chronic diseases (Fransen et al. 2003). The degree to which employees are able to recover from fatigue and distress at work is an important factor influencing their physical and mental functional status, and thus the ability to cope with work. The so-called ‘need for recovery after work’ is seen as an acute and short term effect of work (Sluiter et al. 1999).

A widely used model in research on occupational stress is the Job Demand Control (JDC) model (Karasek and Theorell 1990; Karasek et al. 1998). This model offers a helpful framework to understand the mechanisms behind the development of stress, fatigue, and strain among employees. It makes a distinction between different psychosocial work conditions, such as psychological job demands and job control (Karasek and Theorell 1990; Karasek et al. 1998). Psychological job demands refer to the mental workload and psychological requirements of an employee’s work. Job control is related to the social autonomy over making decisions and the breadth of skills usable on the job (Karasek and Theorell 1990). According to the JDC model, high psychological job demands combined with a lack of control are associated with psychological strain and health problems (Karasek et al. 1998). This assumption is supported by several studies, which indeed demonstrated significant relationships between poor mental health and an imbalance between job demands and job control in various groups of employees (Bültmann et al. 2002; Lindström 2005). Recent research revealed that employees with a hearing impairment more often perceive an imbalance between job demands and job control (high demands and low control) than normally hearing
It is assumed that in the longer term, repeated inefficient recovery after work acts as an intermediate stage between exposure to stressful (psychosocial) working conditions and the development of psychosomatic health problems (Sluiter et al. 1999; Sluiter et al. 2003) which in turn might lead to an increase in sick leave. Jansen et al. (2002) showed that the need for recovery after work is indeed influenced by the psychosocial work characteristics job demands and job control. They examined the relationship between need for recovery, prolonged fatigue, and psychosocial distress in a large cohort of 12,095 employees from 45 different companies and organizations. It appeared that high job demands and low job control resulted in an increased need for recovery. Furthermore, they found higher levels for need for recovery in employees with chronic diseases compared to healthy employees. Combining these results with the findings of e.g. Danermark and Gellerstedt (2004), who reported that employees with a hearing impairment experience lower levels of job control compared to normally hearing employees, one may expect the need for recovery to be higher in employees with a hearing impairment compared to those with normal hearing. Also, the relationship between hearing impairment and need for recovery might be influenced by the psychosocial work characteristics job demands and job control. Reversely, hearing impairment, which can be considered as a chronic condition, might have an effect on the association between the psychosocial work characteristics (job demands & job control) and need for recovery.

To our knowledge, the international literature does not contain any scientific information about an association between hearing ability and need for recovery after work. The main aim of the present study is therefore to examine that relationship (H1). We hypothesize that this effect is influenced by the job characteristics. Additionally, when demands are high and control is low, it may be more difficult for those with hearing problems to compensate for their loss during task execution. So, the role of hearing ability in the association between the
psychosocial work characteristics and need for recovery was also investigated (H2). The hypotheses are schematically described in Figure 3.1.

**Methods**

**Procedure**

Data for this study were derived from the Dutch “National Longitudinal Study on Hearing” (NL-SH). The NL-SH is an ongoing prospective cohort study examining the relationship between hearing impairment and several domains in the life of adults between 18 and 70 years of age, and is conducted over the Internet. A website was used to enrol and inform the participants and to collect data. Both normally hearing and hearing impaired persons are participating. A more detailed description of the NL-SH can be found in Nachtegaal et al. (2009). The Medical Ethics Committee of the VU university medical center approved the study. The
cross sectional data analysed in this study are part of the baseline data of the NL-SH, collected in the period between November 2006 and January 2008.

**Participants**

The baseline sample of the NL-SH includes 1599 adults. However, as we aimed to study working conditions in the present study, only those who reported to work 12 hours or more per week were selected. A cut-off of 12 hours per week was chosen, as this is one of the criteria used by “Statistics Netherlands” to define the working population. 990 participants of the baseline sample met this criterion. Their ages ranged from 18 to 65 years. The sample comprised people with a wide variety of jobs varying from blue collar jobs (e.g. service mechanic) to white collar jobs (e.g. manager). Sixty-four persons could not be included because of missing data. Hence, data of 925 participants (342 men and 583 women) were analyzed. Missing data analyses showed that the 64 excluded participants were significantly older (mean age=47.4; SD=11.1) compared to the 926 persons included (Mean age= 44.3; SD= 10.6) (p=0.028). Hearing ability did not differ significantly between these groups (p=0.681)

**Outcome Measures**

*Hearing ability*

Hearing ability was determined using the “National Hearing Test”, an adaptive speech-in-noise test over the Internet. The test uses digits that are presented against a background of masking noise, according to an adaptive (one up, one down) procedure (Smits et al. 2004; Smits et al. 2006a). With the test, the Speech-Reception-Threshold in noise (SRT$_n$, signal-to-noise ratio corresponding to 50% intelligibility) is determined. Participants were allowed to use either headphones or speakers. They were advised though, to perform the test in a quiet room when speakers were used. The National Hearing Test scores can be classified into three categories representing: good (SRT$_n$<-5.5dB), insufficient (-5.5≤SRT$_n$≤-2.8) and poor hearing (SRT$_n$>-2.8dB) (Smits et al. 2006b).
A series of studies has been performed to examine the validity and reliability of the hearing test over the Internet (Smits et al. 2004, Smits and Houtgast 2006, Smits et al. 2006a, Smits et al. 2006b). These investigations yielded high correlations with generally used tests ($r=0.87$ for the standard speech-in-noise sentences test by Plomp and Mimpen (1979); $r=0.73$ for $\text{PTA}_{(0.5, 1, 2)}$; $r=0.77$ for $\text{PTA}_{(0.5, 1, 2, 4)}$). Also, Smits et al. (2004) determined sensitivity and specificity of the test for an adult population taking the Dutch speech-in-noise sentences test using headphones as the standard (sensitivity=0.91; specificity=0.93). Smits et al. (2006a) concluded that the telephone and Internet versions of the test are equally feasible and reliable, except that older people prefer delivery by telephone. Additionally, Nachtegaal et al. (2009) showed a test-retest correlation of $r=0.87$ for the NL-SH participants in an earlier study. Hearing ability of the participants is described in the Results section.

Need for Recovery after work

Need for recovery after work was measured using the Need for Recovery scale, an 11-item scale assessing the short term effects of fatigue caused by work activities. It is a subscale of the Dutch Questionnaire on the Experience and Assessment of Work (further referred to as the VBBA, which is the acronym of the name of the questionnaire in Dutch). The VBBA was developed in the early 1990s and has been used frequently since then. It is a reliable and valid instrument (Van Veldhoven and Meijman 1994; De Croon et al. 2006). Examples of characteristic items are: “In general, it takes me over an hour to feel fully recovered after work” or “At the end of the day I am really feeling worn out”. Each question has two answer categories: “yes” or “no”. Items were recoded such that a higher score indicates a higher need for recovery. Individual scores on the 11 items were added and transformed into a scale ranging from 0 to 100, with a higher score indicating a higher need for recovery (Van Veldhoven and Meijman 1994). Broersen et al. (2004) identified risk categories for ‘need for recovery’ and demonstrated that a cut-off point of six positive items (scale score of 54.5 or higher) was indicative for an increased risk for psychological problems. Missing values were substituted by
the scale mean of the remaining items. When more than four items were missing for an individual subject, the complete scale was excluded from the analyses.

**Psychosocial work characteristics**

A validated Dutch version of the *Job Content Questionnaire* (JCQ) was used to measure the psychological work characteristics (i.e. job demands, job control, and social support) (Karasek et al. 1998). Answers were given on a four point scale, varying from “strongly agree” to “strongly disagree”. (Weighted) scale scores were computed with the job content instrument scale construction formulae (Karasek 1985). A maximum of 1 missing item per (sub)scale was accepted in the calculation of the (sub)scale score. Otherwise, the particular (sub)scale score was not computed and was excluded from analyses.

The following subscales were derived from the JCQ: *Psychological job demands* refers to the psychological requirements of an employee’s tasks. The scale contains five items addressing excessive work, conflicting demands, and work pace. Scale scores ranged from 12 to 48 with a higher score indicating a higher demand. *Job Control* was assessed by two subscales: skill discretion and decision authority. Skill discretion is covered by 6 items dealing with learning new things and task variety. Decision authority contains three items dealing with the freedom to make decisions. The total scale score (sum of the two subscales) was computed only when both subscale scores were available. The summed scores ranged from 24 to 96. A higher score indicates more control. *Social support* at work refers to overall levels of helpful social interaction both from co-workers and from supervisors. It was determined by the sum of the subscales supervisor support and co-worker support (Karasek et al. 1998). Each subscale contains four questions addressing helpfulness of the supervisor or competence of co-workers. The social support score was computed only when both subscales scores were available. The total social support score ranged from 8 to 32, with a higher score indicating more social support.
Confounders

As it is likely that demographic and socio-economic variables influence the need for recovery after work; age, gender, educational level, income, and number of working hours per week, were examined for confounding effects. Another potential confounder is social support, as the support from colleagues and/or supervisors may work as a buffer for psychological strain (Karasek et al. 1998). Confounding effects from headphone versus speaker use during the National Hearing test (64.8% of the participants used speakers) were investigated to examine if this test condition influenced the relationship between hearing ability and need for recovery. Previous studies showed that job demands and job control had an effect on the need for recovery (e.g. Jansen et al. 2002). Others found that job control is lower in employees with a hearing impairment (e.g. Danermark and Gellerstedt 2004). This implies that the relationship between hearing ability and need for recovery might be confounded by job demands and job control. Therefore, confounding effects from job demand and job control were tested.

For the association between psychosocial work characteristics (i.e. job demands and job control) and need for recovery confounding effects were examined as well. Variables tested for confounding effects in this relationship were age, gender, educational level, income, number of working hours per week, social support, and hearing ability. Educational level was determined by asking the participants to report their highest completed educational level: low (no finished elementary school to lower vocational), mid (general intermediate to general secondary), or high education (higher vocational to post-academic). Income was measured by asking the participants to choose their gross monthly income category. Four categories were distinguished: low (less than € 1050), mid (between €1050 and €2550), high income (more than €2550), and unknown (don’t know; don’t want to report). Number of working hours per week was determined by asking the number of hours a worker was expected to work in a week. To avoid over-control for strongly related potential confounders, correlations between the potential confounders were calculated. Correlations were all smaller than \( r = 0.31 \) (the highest correlation was found between job control and educational level).
Statistical analyses

To address the first aim of this study (i.e. to explore the association between hearing ability and need for recovery after work) linear regression analyses were performed primarily with ‘need for recovery after work’ as the dependent variable and hearing ability as the independent variable. In a subsequent step, we specifically looked at need for recovery risk categories (as identified by Broersen et al. 2004) in relation to hearing impairment. Hence, we conducted an additional logistic regression analyses, with ‘low’ and ‘high’ need for recovery as a dichotomized outcome.

All analyses were performed without adjustment for confounders in the first step. In the second step, the association was adjusted for those confounders that appeared to be relevant. A variable was considered as a relevant confounder when the regression coefficient of hearing ability changed with 10% or more after adding the potential confounder to the analysis. Additionally, the potential confounder had to be associated with both the determinant (hearing ability) and the outcome (need for recovery). First, the confounding effects were investigated for all potential confounders separately. Then, the confounder which caused the largest relevant change was added to the model. With this new model, the remaining variables were checked for confounding again, after which the confounder causing the largest change was added to the model. When none of the remaining potential confounders caused a relevant change of the regression coefficient, the process was stopped. Confounding effects were examined for the demographic and socio-economic variables mentioned under the section Confounders, including social support, job demands and job control. Next, effect modification was examined by adding an interaction term (potential effect modifier*hearing ability) to the analysis. When this interaction term was statistically significant the concerning variable was considered as an effect modifier. Effect modification was checked for: age, gender, headphone use, social support job demand, and job control. Analyses are presented without adjustment for relevant confounders in the first step, in the second step adjustments were made for all confounders that appeared to be relevant. When significant effect modification was found, subgroup analyses were performed.
In the additional regression analyses (H2), the role of hearing ability in the associations between psychosocial work characteristics (i.e. job demands and job control) and need for recovery was examined. Again, potential confounding effects were examined. Possible effect modification was checked for age, gender, and social support. The role of hearing ability, was evaluated by controlling for confounding and significant effect modification as well.

All analyses were performed using SPSS 15.0.

RESULTS

Description of the study population and hearing ability.

Means and standard deviations of the continuous outcome measures, stratified by National Hearing Test category, are shown in Table 3.1.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Good (n=495)</th>
<th>Insufficient (n=209)</th>
<th>Poor (n=221)</th>
<th>Total (n=925)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Mean 43.0</td>
<td>45.3</td>
<td>46.3</td>
<td>44.3</td>
</tr>
<tr>
<td></td>
<td>SD 10.3</td>
<td>10.2</td>
<td>11.3</td>
<td>10.6</td>
</tr>
<tr>
<td>Sex men (n) men (n) women (n)</td>
<td>215</td>
<td>66</td>
<td>61</td>
<td>342</td>
</tr>
<tr>
<td>Hearing ability (SRT&lt;sub&gt;n&lt;/sub&gt;)</td>
<td>-7.3</td>
<td>-4.3</td>
<td>0.6</td>
<td>-4.7</td>
</tr>
<tr>
<td></td>
<td>1.1</td>
<td>0.8</td>
<td>2.1</td>
<td>3.5</td>
</tr>
<tr>
<td>Need for recovery</td>
<td>37.8</td>
<td>46.4</td>
<td>47.5</td>
<td>42.1</td>
</tr>
<tr>
<td></td>
<td>30.1</td>
<td>30.2</td>
<td>31.6</td>
<td>30.8</td>
</tr>
<tr>
<td>Job control</td>
<td>76.8</td>
<td>76.9</td>
<td>74.8</td>
<td>76.4</td>
</tr>
<tr>
<td></td>
<td>10.5</td>
<td>11.9</td>
<td>11.6</td>
<td>11.1</td>
</tr>
<tr>
<td>Psychological job demands</td>
<td>34.2</td>
<td>34.3</td>
<td>33.7</td>
<td>34.1</td>
</tr>
<tr>
<td></td>
<td>5.1</td>
<td>5.2</td>
<td>5.5</td>
<td>5.2</td>
</tr>
<tr>
<td>Social support</td>
<td>23.7</td>
<td>23.3</td>
<td>22.9</td>
<td>23.4</td>
</tr>
<tr>
<td></td>
<td>3.6</td>
<td>3.8</td>
<td>4.0</td>
<td>3.8</td>
</tr>
<tr>
<td>No. work hours</td>
<td>32.4</td>
<td>31.6</td>
<td>29.3</td>
<td>31.5</td>
</tr>
<tr>
<td></td>
<td>10.2</td>
<td>9.4</td>
<td>10.5</td>
<td>10.2</td>
</tr>
</tbody>
</table>

As demonstrated, 495 participants (55%) were classified as having a good hearing ability. Hearing ability was insufficient in 22% of the participants, and the
remaining 23% scored poorly on the National Hearing Test. On average, women had significantly poorer scores on the test compared to men (mean SRT\textsubscript{n} = -4.4, SD= 3.5 vs. mean SRT\textsubscript{n} = -5.4, SD= 3.4) and were significantly younger (mean age=42.4, SD= 10.3 vs. mean age= 47.6, SD= 10.3) (both p<0.001). Participants worked on average 31.5 hours per week (SD=10.2), with men working significantly more hours (mean=36.5, SD=9.5) compared to women (mean=28.5, SD=9.4) (p<0.001).

**H1: Hearing ability and need for recovery**

Linear regression analyses showed a significant association between hearing ability and need for recovery after work (p<0.001). People with poorer hearing ability reported a higher need for recovery compared to people with better hearing. For every dB signal-to-noise ratio (dB SNR) poorer hearing test score, the need for recovery increased with about 1.4 points (b=1.35; 95%-CI=0.79 – 1.92).

<table>
<thead>
<tr>
<th>Hypothesis H1</th>
<th>Need for recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td></td>
</tr>
<tr>
<td>Model 1</td>
<td></td>
</tr>
<tr>
<td>Hearing ability</td>
<td>1.35 0.79 – 1.92 &lt;0.001</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td></td>
</tr>
<tr>
<td>Model 1</td>
<td></td>
</tr>
<tr>
<td>Hearing ability</td>
<td>1.09 1.05 – 1.13 &lt;0.001</td>
</tr>
</tbody>
</table>

Job demands and job control did not lead to a relevant change of the regression coefficient (job demands: 4.05%; job control: -1.66%). The relationships between hearing ability and job demands/job control confirmed the absence of confounding effects from job demands and job control. Hearing ability and job demands were not significantly associated (b=-0.04; 95%-CI=-0.14 – 0.06;
p=0.418). Only a trend was found between hearing ability and job control (-0.18; 95%-CI = -0.38 – 0.03; p=0.091). Other potential confounders did not lead to a relevant change (i.e. ≥ 10%) of the regression coefficient either (age: 1.94%; gender: -2.90%; educational level: 2.27%; income: 1.05%; social support: -3.43%; working hours: 2.38%; headphone use: 1.48%). Additionally, no significant effect modification was found (job demands p=0.240; job control p=0.291; age p=0.856; gender p=0.317; social support p=0.451; headphone use p=0.536). Therefore, only unadjusted analyses are reported in Table 3.2. Furthermore, a significant adverse relationship between hearing ability and the health-risk category in need for recovery (need for recovery > 54.5) was found (p<0.001). The odds for high need for recovery after work increased by 9% for every dB SNR decreasing hearing ability (OR=1.09; 95%CI=1.05 – 1.13).

H2: Role of hearing ability, psychosocial work characteristics & need for recovery

As shown in Table 3.3, a significant relationship between psychosocial work characteristics and need for recovery was found after adjustment for the relevant confounders social support and educational level: the higher the job demands and the lower the job control, the higher the need for recovery (job demands: b=1.41; 95%CI=1.03-1.79; p<0.001; job control: b=-0.27; 95%CI= -0.46 – -0.07; p=0.008).

Table 3.3. Association from psychosocial work characteristics with need for recovery. Unadjusted and adjusted regression coefficients (b), 95% confidence intervals (CI) and p-values.

<table>
<thead>
<tr>
<th>Hypothesis H2</th>
<th>Need for recovery</th>
<th>95%-CI</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job demand</td>
<td>1.42</td>
<td>1.09 – 1.80</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Job control</td>
<td>-0.23</td>
<td>-0.42 – -0.04</td>
<td>0.016</td>
</tr>
<tr>
<td>Model 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job demand</td>
<td>1.41</td>
<td>1.03 – 1.79</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Job control</td>
<td>-0.27</td>
<td>-0.46 – -0.07</td>
<td>0.008</td>
</tr>
</tbody>
</table>

Model 1: unadjusted analysis
Model 2: adjusted for social support & educational level
Hearing ability did not meet the criteria for relevant confounding in the significant relationship between psychosocial work characteristics and need for recovery (1.07% change for the regression coefficient of job demands, and -1.87% of job control). Significant effect-modification from hearing ability was observed neither (p=0.258 for job demands and p=0.486 for job control).

DISCUSSION

Findings & comparison with previous studies

Whereas need for recovery after work has been investigated in relation to several other health conditions (Jansen et al. 2002; Weijman et al. 2004), its relationship with hearing impairment has not been studied so far. The results of the present study show a significant association between hearing ability and need for recovery after work: for every dB worsening hearing test score, the need for recovery after work increased with 1.35 points. It must be noted, however, that when a significant association is found, the need for recovery after work may still fall within the range where the risk for health complaints is not increased. Therefore, an extra analysis was conducted after categorisation of the need for recovery in a health risk category and a non risk category (Broersen et al. 2004). A significant relationship between hearing ability and the need for recovery risk category was observed. For every dB SNR worsening hearing ability, the odds for showing a considerable (i.e. risky) need for recovery after work increased by 9%. This means that for someone with an insufficient hearing test score of -4.3 dB SNR, the odds for a considerable need for recovery is about 30% higher than for someone with a normal hearing test score of -7.3 dB SNR. For a poor hearing test score of 0.6 dB SNR, the odds for elevated need for recovery is almost 2 times higher compared to the odds for a good hearing test score of -7.3 dB SNR.

It was expected that an imbalance between psychological job demands and job control, which was observed by several previous studies (e.g. Danermark and Gellerstedt 2004), would play a role in the increased need for recovery in hearing impaired employees. In the present study, however, psychological job demands
and job control did not confound or modify the relationship between hearing ability and need for recovery. Only a trend was found for the relationship between hearing ability and job control. This result seems different from previous studies on the relationship between psychosocial work characteristics and hearing impairment (Gellerstedt and Danermark 2004; Danermark and Gellerstedt 2004; Kramer et al. 2006).

One reason why we did not find such a significant association between hearing ability and job control could be the relative small number of employees who reported a low level of control in the present study. Compared to the Dutch sample of employees in the study of Karasek et al. (1998), the mean job control score in our sample was relatively high. This could be caused by the sampling method used in the present study. In general, educational level is higher among Internet users compared to non-users (Fallows 2005). A strong negative correlation between education and job control was found by Karasek et al. (1998). In our sample, educational level was indeed higher compared to that of the general Dutch population (Dutch Statistics 2009a), apparently leading to a relatively high level of job control. An additional reason could be that the other studies included clinical samples predominantly consisting of people with moderate to severe levels of hearing impairment, whereas in the present study, the majority of the participants had mild to moderate levels of hearing impairment. This is supported by an additional analysis which we conducted with the participants classified into the three categories of the National Hearing test: good, insufficient, and poor. The analysis indeed demonstrated a significant, but small (2.35 points), difference in job control between both extreme categories of the National hearing tests scores: good vs. poor (95%-CI=-4.07 – -0.60, p=0.008). Apparently, a lack of job control gradually increases by a decreasing hearing ability, leading to a significantly lower job control in comparison with normally hearing employees only for those individuals with moderate to severe levels of hearing impairment.

The additional analysis (H2) showed a significant association between the psychosocial work characteristics and need for recovery after adjustment for
relevant confounding. This finding corresponds to the results from the occupational studies described in the introduction (Jansen et al. 2002; Sluiter et al. 2003). Hearing ability was no relevant confounder, neither was it a significant effect-modifier. Together with the absence of confounding or modifying effects from job demands and job control in the association between hearing ability and need for recovery, this implies that the increased need for recovery in hearing impaired employees is caused by other factors than high psychological job demands and low job control.

The most likely explanation for an increased need for recovery in employees with a hearing impairment is the extra effort and concentration they need to communicate. These variables are not covered by the job demands and job control scales of the JCQ as used in this study. It is known that communication is highly effortful for people with hearing difficulties (Hétu et al. 1988; Kramer et al. 2006) and workers with hearing problems are far more tired after an hour of listening than their normally hearing colleagues (Edwards 2007). To carry out their work tasks successfully, employees with a hearing impairment need to cope both with their work and with their hearing impairment. To explain this phenomenon the term ‘double workload’ was introduced (Gellerstedt and Danermark 2004). People with hearing impairment need a constant effort to hear, interpret, and to react adequately. It is likely that with a decreasing hearing ability, the effort required for auditory functioning and communication despite the limitations in hearing at work increases, apparently leading to risky levels of need to recover after work.

Possible limitations
When discussing the possible limitations of this study, it should be noted that non-responders were significantly older than the responders (47.3 versus 44.3 years) in the present study. Consequently, the results might be less generalizable for the older age group. There were, however, no differences in hearing ability between the responders and non-responders. Another issue which needs to be addressed is the selection of the sample. Whereas previous studies (e.g. Kramer
et al. 2006) selected participants via an audiological center, participants in the present study subscribed through the Internet. High accessibility to the Internet is required for on-line research purposes. We would like to emphasize that in the Netherlands the proportion of people having access to the Internet at home is one of the highest in the world (83%). Since we focus on people who are working, it is likely that the percentage of people having access to the Internet is even higher: part of those who don’t have access to the Internet at home, will have access to it at other places, for example at work (Dutch Statistics 2009b). For these reasons we argue that in our study, accessibility was sufficiently certain. An advantage from selecting participants through the Internet is that the present sample was not strictly a clinical population, which is the case when selecting participants via audiological centers only. As such, the results of the present study provide knowledge about the consequences of hearing impairment in a broader sample than a strictly clinical patient population.

Another issue that needs to be discussed is the method of measuring hearing ability in the current study (i.e. over the Internet), which implies a lack of control over the testing conditions. Participants were allowed to use either headphones or speakers. When people decided to use speakers, they were recommended to do the test in a quiet environment, as testing with speakers in a noisy environment may influence the results. The majority of participants used speakers. The absence of significant effect-modification or confounding effects from ‘test condition’ did, however, illustrate that the results were not influenced by headphone versus speaker use. We reported on this issue in our previous study (Nachtegaal et al. 2009). In that study, headphone or speaker use had no effects on the relationship between hearing ability and various psychosocial health variables. Furthermore, measuring SRT\textsubscript{n} and not absolute thresholds reduces the effect of the environment. Another study showing extremely similar scores when using speakers versus headphones in a living room environment as well is that from Culling et al. (2005). This study additionally showed that variations in the type of headphone used during speech-in-noise hearing screening tests had negligible effects on speech-in-noise audiometry (Culling et al. 2005). The consistency of the National Hearing test scores is furthermore confirmed by the
satisfactory test-retest reliability for the NL-SH population reported by Nachtegaal et al. (2009).

**Implications**

The findings reported in the present study may have important implications for clinical practice. Despite the fact that the majority of people with hearing impairment are older than 65 years of age, a considerable number of younger individuals are experiencing hearing problems as well. Additionally, we may expect increasing numbers of people over 65 years of age in the workforce in the near future, due to the aging of the population and a tendency to raise retirement age. Ruben (2000) demonstrated that a large dropout of people at work due to hearing impairment may have severe economic implications. Work is a very challenging environment for hearing impaired employees both from a psychosocial and acoustical perspective. Hence, clinical practices should be prepared to implement and carry out adequate aural rehabilitation programs for the specific group of patients who are known with difficulties at work due to their hearing impairment. Examples of such programs are reported in the literature (Hétu and Getty 1991; Kramer 2008). Also, monitoring the need for recovery after work in the audiological rehabilitation of hearing impaired employees or at regular health checks might be useful to take preventive measures to avoid risky levels of need for recovery after work.

Several studies have shown that a high need for recovery is a predictor for the development of health complaints and even for higher levels of sick leave in the longer term (Sluiter et al. 1999; Sluiter et al. 2003; De Croon et al. 2003). Also, employees with a hearing impairment seem to be over represented in the group taking long term sick leave (Danermark 2005) and especially sick leave because of psychological distress seems to occur more often (Kramer et al. 2006). In future studies, the relationship between hearing ability, need for recovery, and the development of health complaints and sick leave deserves further attention. Ideally, sick leave should be measured using a longitudinal design combining a
short recall period with a longer measurement period, and distinguishing sick leave due to psychological distress from sickness absence due to other reasons.

Finally, we argue that it seems important for all professionals in the field (e.g. ENT doctors, general practitioners and occupational physicians) as well as employees to take notice of the association between hearing ability and need for recovery after work. Hearing impairments often gradually develops over time. Even when an employee is still unaware of his or her decreasing hearing ability, his/her mild levels of hearing impairment (hearing test scores in the category ‘insufficient’) may influence the need for recovery after work. When a professional (e.g. general practitioner, occupational physician) is consulted by an employee complaining about high levels of need for recovery after work, the possibility of hearing difficulties causing these complaints should be seriously considered.

CONCLUSIONS

In summary, this study demonstrated a significant association between hearing ability and need for recovery after work. Job demands and job control appeared to significantly predict need for recovery. This relationship was, however, not influenced by hearing ability. The increased need for recovery in employees with a hearing impairment might have implications both for audiological rehabilitation and other areas of health care (e.g. occupational health care). Monitoring need for recovery during audiological rehabilitation might be useful to avoid the development of risky levels of need for recovery, whereas for other professionals the option of an underlying hearing impairment might be considered when they are consulted by an employee with a high need for recovery.
REFERENCES


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