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## Hearing loss and risk of early retirement. The HUNT study

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**Background:** We explore the possible consequences of measured hearing impairment (HI) and perceived hearing difficulties for early retirement in a large population-based study. Furthermore, we study whether having a part-time position was associated with measured HI and perceived hearing difficulties in the same population.

**Methods:** This study included 25 740 persons from the Nord-Trøndelag Health Study (HUNT) aged 20–54 years at baseline in HUNT1 (1984–1986) who also participated in the follow up, HUNT2, including a hearing examination 11 years later. Logistic regression analysis was conducted for men and women separately and in two age strata. Effects of low-, middle- and high-frequency hearing levels were explored, adjusting for each other. Further adjustment was made for socio-economic class and general health in HUNT1. **Results:** The risk of early retirement increased with degree of loss of low-frequency hearing in young and middle-aged men and middle-aged women. The middle-aged men and women experiencing hearing disability had an increased risk of early retirement. Degree of hearing level was not associated with part-time work, but in middle-aged men, awareness of having a hearing loss was associated with part-time employment. **Conclusions:** Degree of low-frequency hearing loss was associated with early retirement but not with part-time work. Perceived hearing disability increased the risk of early retirement in middle-aged men and women and also the risk of part-time work in middle-aged men.  
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### Introduction

Hearing impairment (HI) in adults is one of the most common chronic health problems in the western world today.<sup>1</sup> In Norway, the estimated prevalence of permanent HI in the adult population is ~15%,<sup>2</sup> which compares with other Nordic,<sup>3</sup> European<sup>4</sup> and western<sup>5</sup> countries. Because HI increases with age, the population prevalence is expected to increase to 25% by the year 2020 along with the increase in life expectancy.<sup>3,6</sup>

Risk factors for HI other than age are genetic liability, infections, trauma, toxicity and diseases.<sup>7</sup> Last but not least, HI might be caused by noise exposure. Such exposure is recognized as a major occupational health hazard. In USA, noise-induced HI is the second most reported occupational disease and injury,<sup>8</sup> whereas in Norway, noise-induced HI is the most reported one and count for ~50% of all reported occupational diseases and injuries.<sup>9</sup> Since the late 1980s, the occupational noise exposure has been reduced, but noise-induced HI is still a considerable problem. This could partly be explained by increased exposure of leisure noise<sup>10,11</sup> from exposure to music, motorsports, hunting and sports shooting.<sup>11–13</sup>

Even a mild HI may often have consequences for everyday life. Reduced speech perception and perception of non-verbal sound affect almost all people with HI to some extent.<sup>14</sup> The opportunities to communicate effectively is made difficult, and there may be a number of harmful psychosocial effects of HI in the working-age population; the HI may have impact on work possibilities and

career, mental health, participation in interpersonal relations and health-related quality of life.<sup>15–20</sup>

In an Australian study of adolescents, people with profound HI and deafness since childhood had higher rates of unemployment than those with normal hearing.<sup>20</sup> Other studies confirm that unemployment is more common in young deaf people in Australia<sup>21,22</sup> as well as in USA, Canada<sup>17</sup> and Scandinavia.<sup>23</sup> A quite recent Swedish study reported that growing up with profound HI and deafness strongly affected their possibility to participate in the labour market, and was associated with being recipients of arrangements for social compensation.<sup>24</sup>

Furthermore, it is expected that prevalence and degree of gained HI as an adult are related to earlier retirement from work participation.<sup>25</sup> The prevalence and degree of HI may be estimated audiometrically or from self-reported questionnaire information about hearing acuity in various situations. Applied on the whole population, the former is quite resource demanding, whereas the latter is less reliable.<sup>26,27</sup> A Swedish cross-sectional epidemiological study has reported a higher prevalence of self-reported HI among people being unemployed and/or having early retirement than among employed people. Such a difference could be seen both in men and women and in young and middle-aged groups.<sup>6</sup> Two quite recent cross-sectional studies, observing HI as self-reported hearing difficulties, confirm these results.<sup>17,19</sup> These studies did not adjust for other known individual risk factors for early retirement than increased age and female gender. For example, poor health and low socio-economic status in terms of low educational level and

the position in the labour market (occupational class) may be individual risk factors for early retirement.<sup>28</sup>

There is little evidence on whether part-time work is more prevalent in persons with HI than in their peers. However, a relatively small clinically based cross-sectional study from Holland did not find any differences in degree of part-time work among the hearing impaired and their controls with normal hearing.<sup>18</sup>

## Methods

### Purpose

This study aims to investigate the association between measured as well as perceived HI and self-reported early retirement in a large population-based study, The Nord-Trøndelag Health Study (HUNT) 1 and 2. Furthermore, we wanted to study whether HI was associated with having a part-time position in the same population.

### Study population

The HUNT was performed as two separate cross-sectional surveys, HUNT1 (1984–86) and HUNT2 (1995–97). All inhabitants aged  $\geq 20$  years residing in Nord-Trøndelag county were invited to participate. HUNT2 included as an integrated project the Nord-Trøndelag Hearing Loss Study (NTHLS).<sup>13,29,30</sup> In many aspects Nord-Trøndelag is considered fairly representative of Norway as a whole (geographically, economically, industrially, and sources of income, age distribution and morbidity), but it has no large cities and a somewhat lower level of education than the national average.<sup>31</sup>

This study included men and women aged 20–54 years in HUNT1 who also participated in the follow up, HUNT2 (including the NTHLS) 11 years later. Thus, the participants were under the regular age of pension in Norwegian, of 67 years. Six of the 24 municipalities in the county were not included in the hearing loss study. Altogether 81 660 persons aged  $\geq 20$  years were invited to, and 51 574 (63%) participated in, and gave written consent to the NTHLS. The age group included in the present study, 31–65 years when HUNT2/NTHLS took place, counts 46 790 invited and 32 479 (69%) participating subjects (figure 1). Two questionnaires were returned at the examination site (Q1 and a questionnaire about hearing), and one questionnaire (Q2) was brought home from the examination and returned by mail. Except for 14% of the participants in this age group, who had moved to the county in the time

between HUNT1 and HUNT2, all had also been invited to HUNT1 11 years earlier. As in HUNT2, one HUNT1 questionnaire (Q1) was returned at the site and one (Q2) was brought home and returned by mail by most of the participants. The participation rate for the age group 31–65 years in HUNT2, corresponding to 20–54 years in HUNT1, was 88% for Q1 and 70% for Q2. In all, 25 740 subjects (55.0%) answered Q1 in both HUNT1 and HUNT2, and 22 164 subjects (47%) completed both questionnaires in HUNT1 and Q1 in HUNT2. In the analysis, the valid number of observations varies from 25 740 to 13 027.

The study has been approved by the Norwegian Regional Committee for Medical Research Ethics and the Data Inspectorate.

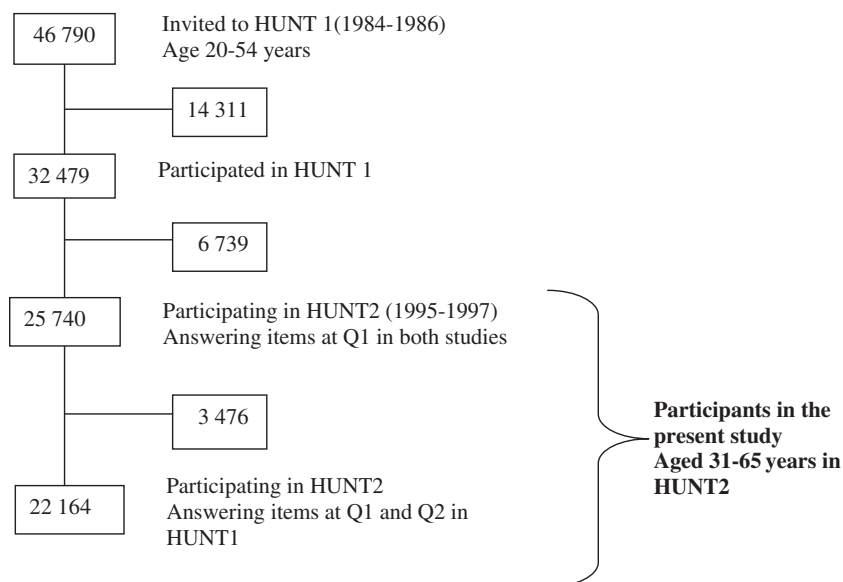
### Measurements

*The position as early retired* in HUNT2 (Q1) was assessed by one item asking the participants what kind of work they had currently, and main source of income. One of several options was early retirement.<sup>30</sup>

*Having part-time work* in HUNT2 (Q1) was assessed by one item asking about number of paid work hours per week.<sup>30</sup> Those working  $< 33$  h but  $> 5$  h were categorized as working part-time.

*Audiometry* in HUNT2. Air-conduction hearing thresholds were obtained by pure tone audiometry with Interacoustics AD25 automatic self-administered audiometers with TDH-39 earphones linked to a personal computer (PC). Data were automatically stored at the PC after testing. A few persons were offered a manual audiometry because they were not able to follow the instruction for the automatic procedure. The standard frequencies included in the tests were 250, 500, 1000, 2000, 3000, 4000, 6000 and 8000 Hz. Thresholds were determined in accordance with ISO 8253-1 (1989).<sup>32</sup> The audiometers were calibrated (ISO 389, 1991)<sup>33</sup> every 6 months. Semi-portable, dismountable, sound attenuation booths were used in rooms specially selected to avoid background noise. Background noise was measured on a random sample and met the recommended standard for test administration (ISO 8253-1, 1989).<sup>32,34</sup> Further information of the test procedure is published elsewhere.<sup>13</sup>

*Self-reported hearing difficulties* was generated from two items, acknowledged HI (“yes”, “no” and “perhaps”) in NTHLS and disability owing to HI (“no”, “little”, “moderate” and “severe”) in HUNT2 (Q1). There are no data available for assessing the first of these items. The disability item was included in HUNT1, taking



**Figure 1** Flowchart: data source for the study of hearing loss and early retirement, the HUNT study

place 11 years earlier. In a subsample of 47 291 subjects who participated in both HUNT1 and HUNT2, the polychoric correlation between hearing disability reported the first and the second time was 0.69. Considering that substantial changes in hearing problems may occur during an 11-year period, the high correlation indicates a high reliability. The two items were summed to generate the new variable.

The highest educational level achieved reported in HUNT1 (Q2) was scored according to the OECD guidelines for classification.<sup>35</sup> The original individual data were grouped into three classes (1=up to 10 years education; 2=vocational or high school education; and 3=college or university).

Position in labour market in HUNT1 (Q2) was measured by a version of the Norwegian standard for occupational classification consisting of 10 discrete groups.<sup>36</sup> Owing to similarities between the Norwegian standard and the internationally used Erikson, Goldthorpe and Portocarero scheme (EGP), an approximation to EGP was constructed.<sup>31,37–39</sup> The EGP categories used here were as follows: (i) Higher grade administrators and professionals, (ii) Lower administrators and professionals, (iii) Routine non-manual employees, (iv) Self-employed, farmers and fishermen, (v and vi) Lower-grade technicians, supervisors of manual work and (vii) Semi- and unskilled manual workers.

General health in HUNT I (Q1) was measured by asking “How is your present state of health?” on a four-point response scale which included the following options “very good” (1), “good”, “not so good” and “poor” (4).<sup>29</sup>

## Statistics

Data were analysed by use of SPSS version 18.0 (PASW SPSS, Chicago, IL, USA).

Mean hearing thresholds were defined as: (i) low-frequency hearing level (250 and 500 Hz, thresholds averaged over frequencies and both ears); (ii) mid-frequency hearing level (1000 and 2000 Hz); and (iii) high-frequency hearing level (3000, 4000, 6000 and 8000 Hz). Test–retest reliability for low-frequency hearing has been observed to be 0.89 for low frequencies, 0.98 for mid frequencies and 0.99 for high frequencies.<sup>13</sup>

The main outcome, early retirement vs. not, was studied using logistic regression analysis (the Enter method). Men and women were studied separately, and two age strata (i.e. 31–45 years and 46–65 years) were defined. Preliminary analyses were run entering the predictors low-, mid- and high-frequency HI as categorical variables with every 10 dB as separate categories. The results showed an almost linear effect, that is, a similar increase in OR

for every 10 dB change in hearing threshold along the whole distribution. The linear trend occurred in both age strata for both men and women. Thus, low-, mid- and high-frequency HI were entered as continuous variables scaled with 10 dB as units. In the first models, the mean hearing thresholds for low-, mid- and high-frequency hearing level were entered together with age (per year). Successively, these models were adjusted for additional possible confounders, that is, educational level, EGP social class and health in HUNT1. Secondly, the association between perceived hearing difficulties and early retirement was assessed, adjusting for low-, mid- and high-frequency HI and educational level, EGP social class and health in HUNT1.

Interaction effects between HI and the other independent variables were studied separately for men and women in each of the age groups with logistic regression analysis, entering HI consecutively in combination with age, education, position in labour market and general health in HUNT1. Also, interaction effects between age, education and position in labour market were checked. Furthermore, interaction effects in the total sample were studied, consecutively entering the products of HI and sex, HI and age and, lastly, sex and age together with the HI variables.

The association between part-time vs. full-time work and hearing capacity was assessed for men and women in two age strata, also with logistic regression analysis. The effect of hearing loss with 10 dB as units was explored by entering mean hearing thresholds for low-, mid- and high-frequency hearing level together with age (per year), and socio-economic variables and health in HUNT1. The association between perceived hearing difficulties and part-time work was assessed, adjusting for low-, mid- and high-frequency HI, age, educational level, EGP social class and health in HUNT1. It was checked for interactions in the described strata of men and women.

In the regression analysis, the lowest score was set as reference whenever possible. The results were reported as ORs with 95% CI.

## Results

### Effect of measured hearing level for early retirement

We found that increased low-frequency hearing level (per 10 dB) was associated with higher odds for early retirement in young and middle-aged men and in middle-aged women when adjusting for age and mid- and high-frequency hearing level (table 1). In these strata, the effect of low-frequency hearing level remained quite stable when adjusting for the additional variables, that is, socio-economic situation (education and position in labour market) and general

**Table 1** Association between low-frequency hearing loss and self-reported early retirement in the HUNT Study

	Early retirement (N)		Model I		Model II		Model III		Model IV	
	Yes	No	OR (95% CI)	R <sup>2</sup> <sub>Adj</sub> (%)	OR (95% CI)	R <sup>2</sup> <sub>Adj</sub> (%)	OR (95% CI)	R <sup>2</sup> <sub>Adj</sub> (%)	OR (95% CI)	R <sup>2</sup> <sub>Adj</sub> (%)
Men										
Aged 31–45 years	119	4264	1.63 (1.27–2.10)	4.5	1.56 (1.18–2.07)	8.3	1.44 (1.05–1.98)	6.2	1.47 (1.07–2.04)	11.1
Aged 46–65 years	1262	6497	1.25 (1.14–1.36)	25.1	1.23 (1.11–1.35)	27.0	1.20 (1.08–1.33)	27.0	1.16 (1.05–1.29)	32.1
Women										
Aged 31–45 years	229	4823	1.17 (0.96–1.43)	2.7	1.14 (0.91–1.42)	4.9	1.07 (0.81–1.42)	4.8	1.02 (0.77–1.35)	8.5
Aged 46–65 years	1698	6848	1.16 (1.07–1.26)	15.7	1.14 (1.05–1.25)	17.1	1.11 (1.01–1.23)	18.4	1.12 (1.00–1.24)	25.1

OR per 10 dB mean bilateral loss.

Model I=adjusted for medium- and high-frequency hearing loss and age per year.

Model II=adjusted for medium- and high-frequency hearing loss, age per year and educational level in HUNT1.

Model III=adjusted for medium- and high-frequency hearing loss, age per year, educational level in HUNT1 and position in labour market in HUNT1.

Model IV=adjusted for medium- and high-frequency hearing loss, age per year, educational level in HUNT1, position in labour market in HUNT1 and general health HUNT1.

R<sup>2</sup><sub>Adj</sub>=Nagelkerke R<sup>2</sup>.

Number of participants in analysis is based on model I, N varies from 25 740 (model I) to 19 184 (model IV) owing to missing information.

**Table 2** Association between perceived hearing difficulties and early retirement in the HUNT Study

	OR (95% CI)
<i>N</i> = 5567	
Men aged 46–65 years	
Perceived hearing difficulties	
No perceived disability	1.00 (reference)
Perceived HI and a small disability	2.77 (1.98–3.89)
Perceived HI and a moderate disability	3.57 (2.43–5.25)
Perceived HI and a severe disability	2.78 (1.62–4.76)
<i>N</i> = 5246	
Women aged 46–65 years	
Perceived hearing difficulties	
No perceived hearing disability	1.00 (reference)
Perceived HI and a small disability	3.70 (2.25–6.08)
Perceived HI and a moderate disability	4.29 (2.32–7.94)
Perceived HI and a severe disability	4.15 (1.94–8.85)

Adjusted for low-, medium- and high-frequency hearing loss, age, educational level, position in labour market and health in HUNT1. Nagelkerke adjusted  $R^2$ : 34.7% for men aged 46–65 years and 26.7% for women aged 46–65 years. Total number of men and women (young and middle aged) in the analysis was 17 672.

health in HUNT1. In the initial analysis, a small effect of high-frequency hearing level was found in the same subgroups (young and middle-aged men, middle-aged women), but this effect vanished when adjusting for additional confounders.

Table 1 shows higher estimates of ORs in the young than in the middle-aged group. The interaction effect between HI and age of the total sample was significant, showing a reduction of the effect of low-frequency HI with age ( $P=0.019$ ). The interaction effect between HI and gender in the total sample showed stronger effects of low-frequency HI in men compared with women ( $P<0.001$ ). In the total sample, there was also a three-way interaction effect, in which the effect of HI on early retirement decreased with age in men but not in women ( $P<0.001$ ).

Because the middle- and high-frequency hearing level did not affect early retirement much besides of what could be explained by low-frequency hearing level, only interaction terms for low-frequency hearing were tested.

### *Effect of perceived hearing difficulties for early retirement*

In the analyses of middle-aged men and women, we found that their perception of hearing difficulties was significantly associated with early retirement when adjusting for low-, mid- and high-frequency hearing level, age, socio-economic situation and general health in HUNT (table 2). Those perceiving a hearing disability (small, moderate or severe) had increased odds for ending up as early retired.

### *Effect of measured hearing level and perceived hearing difficulties on part-time employment*

There was no significant association between measured HI and part-time employment in HUNT2. The effect was studied for both men and women in two age groups for low-, mid- and high-frequency hearing level and, additionally, adjusted for age, education, position in labour market and health in HUNT1.

Only middle-aged men with a self-reported hearing disability (small, moderate or severe) had significantly increased odds for a part-time employment when experiencing a small or moderate hearing disability compared with those not experiencing hearing difficulties in the same age and gender group (table 3).

**Table 3** Association between perceived hearing difficulties and part-time employment in the HUNT Study

Perceived hearing difficulties	Part-time employment vs. full-time employment OR (95% CI)
<i>N</i> = 3933	
Men aged 46–65 years	
No perceived hearing disability	1.00 (reference)
Perceived HI and a small disability	2.23 (1.40–3.56)
Perceived HI and a moderate disability	3.10 (1.80–5.34)
Perceived HI and a severe disability	1.57 (0.61–4.03)

The model was adjusted for low-, mid- and high-frequency hearing loss, age per year, educational level, position in labour market and health in HUNT1.

Nagelkerke adjusted  $R^2$ : 4.8% for men aged 46–65 years.

Total number of men and women (young and middle aged) in the analysis was 13 027.

## Discussion

To the best of our knowledge, this is the first study that has assessed the association between measured degree of HI and early retirement in a large population-based study. Young and middle-aged men and middle-aged women with a low-frequency HI had increased risk for early retirement. Furthermore, perceived hearing disability in middle-aged men and women was associated with risk of early retirement over and above risk associated with measured hearing loss.

Studies using self-reported hearing difficulties as a measure of HI have reported that hearing difficulties are more prevalent in early-retired persons than in those working.<sup>6,17,19</sup> Our study, adjusting for measured HI and other known individual risk factors for early retirement, seems to show that people both experiencing HI and hearing disability had an additional risk for early retirement in men and women aged 46–65 years.

Previously, it has been expected that degree of acquired HI is related to earlier retirement from the work participation.<sup>25</sup> We could confirm this assumption for low-frequency HI in young and middle-aged men and middle-aged women, whereas no independent effect was found of mid- and high-frequency hearing levels. This may not necessarily mean that low-frequency loss is more important than medium and high frequencies. When hearing is gradually lost, low-frequency hearing is usually kept longer intact than high and mid frequencies. Thus, the results may reflect that hearing adequately at some frequencies (usually in the low frequencies band) is the most critical for their work participation. Our results are compatible with those from the studies reporting deaf people being more often unemployed than are normally hearing people.<sup>20–22,24</sup>

People with the same audiometric results may have quite different ability to communicate verbally, partly because not all characteristics about hearing is measured by audiometry, and partly because ability to communicate depends on several factors, both associated with the person himself and his/hers environment. The reliability of audiometric results is high.<sup>13</sup> The reliability of self-reported HI is more questionable,<sup>26,27</sup> but the high correspondence between hearing disability reported in HUNT1 and HUNT2 suggests that our self-report measure is also quite reliable. Early-retired people might be more likely to report having a troublesome life and more disabilities, including hearing disabilities, than those working. A reporting bias that is correlated with the outcome measures (disability-retired persons being more inclined to report that their hearing loss causes disability) will inflate the effects. However, random measurement error not correlated with the outcome will affect the results in the opposite way and attenuate the observed effects. Therefore, self-reported data may not be well suited for



studies of the relation between HI and early retirement or part-time work.

Some other limitations of the present study need to be addressed. Firstly, we do not know when the HI appeared, but it develops most often over several years. The HI observed in HUNT2 may also have existed before HUNT1. Thus, we did not restrict the studies of early retirement to the period between HUNT1 and 2. Secondly, in contrast with several other studies,<sup>6,17,19</sup> we controlled for additional individual risk factors for early retirement than age and gender. Analyses were adjusted for socio-economic status using educational level and socio-economic status from HUNT1. Furthermore, we adjusted for their general health assessed in HUNT1. We might be criticized for using a single subjective health measure instead of using the number of chronic conditions like muscular-skeletal, psychiatric and cardiovascular diagnoses, which is quite prevalent in the early-retired individuals.<sup>28</sup> However, this single health item has been shown to be strongly associated with morbidity, mortality and use of health and social services.<sup>40</sup>

Lastly, this study did not adjust for contextual factors like prevalence of early retirement that may depend on the local situation and development in the municipalities, level of unemployment and level of education.<sup>28</sup> Whereas the prevalence of HI and frequency of retirement could, in principal, co-aggregate in some areas, however, this can hardly have substantially affected the results.

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*Conflicts of interest:* None declared.

### Key points

- Degree of low-frequency HI has impact on early retirement.
- The effect of HI on early retirement is highest in young men and lowest in middle-aged women.
- Degree of hearing loss is not associated with part-time work.

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## Psychosocial work factors and sickness absence in 31 countries in Europe

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**Background:** The studies on the associations between psychosocial work factors and sickness absence have rarely included a large number of factors and European data. The objective was to examine the associations between a large set of psychosocial work factors following well-known and emergent concepts and sickness absence in Europe. **Methods:** The study population consisted of 14 881 male and 14 799 female workers in 31 countries from the 2005 European Working Conditions Survey. Psychosocial work factors included the following: decision latitude, psychological demands, social support, physical violence, sexual harassment, discrimination, bullying, long working hours, shift and night work, job insecurity, job promotion and work–life imbalance. Covariates were as follows: age, occupation, economic activity, employee/self-employed status and physical, chemical, biological and biomechanical exposures. Statistical analysis was performed using multilevel negative binomial hurdle models to study the occurrence and duration of sickness absence. **Results:** In the models, including all psychosocial work factors together and adjustment for covariates, high psychological demands, discrimination, bullying, low-job promotion and work–life imbalance for both genders and physical violence for women were observed as risk factors of the occurrence of sickness absence. Bullying and shift work increased the duration of absence among women. Bullying had the strongest association with sickness absence. **Conclusion:** Various psychosocial work factors were found to be associated with sickness absence. A less conservative analysis exploring each factor separately provided a still higher number of risk factors. Preventive measures should take psychosocial work environment more comprehensively into account to reduce sickness absence and improve health at work at European level.

## Introduction

Sickness absence is considered as a global measure of health status, and as a marker of social, psychological and physical functioning for working populations.<sup>1</sup> It has been shown that the longer the absence, the poorer the health status. Furthermore, sickness absence was found to be a good predictor of subsequent morbidity, including disability and mortality.<sup>2,3</sup> The causes of sickness absence are multifactorial, and work-related factors may play an important role in the occurrence of sickness absence.

Sickness absence leads to substantial human, social and economic costs<sup>4</sup> and, consequently, may be seen as a crucial indicator in occupational health studies. Understanding the role of work-related factors, and especially psychosocial work factors, in sickness absence may be useful to better prevent this outcome.

Psychosocial work factors have been evaluated using various theoretical models that appeared in the literature within the last 2 or 3 decades. Job strain model developed by Karasek *et al.*<sup>5</sup> is composed of three main dimensions, psychological demands, decision latitude comprising two sub-dimensions, skill discretion and decision