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Functional visual and hearing impairment in a population aged 75 years and older in the City of Kuopio in Finland

Associations with mood and activities of daily living

Doctoral dissertation

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Department of Public Health and General Practice,
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ABSTRACT

Sensory functions include sense of sight, hearing, smell, taste and touch. This study concentrates on the sense of hearing and sight, and the term sensory impairment in this report refers to visual and hearing impairment.

Visual and hearing impairments are common among the aged. Though there is knowledge about single sensory (visual or hearing) impairment, very little is known about combined sensory (both visual and hearing) impairment – its prevalence and consequences - in this age group. The present study was undertaken to determine the prevalence and implications of functional visual and/or hearing impairment, especially combined sensory impairment in a general population aged 75 years or older in Finland. Special challenges related to the treatment of the sensory impaired elderly were also studied.

This study was a part of the population based Kuopio 75+ study. The study population consisted of 601 persons, whose sociodemographic characteristics, health history and the level of ability in daily activities and cognition as well as mood was evaluated. The use of home care services was also documented. The visual examination consisted of an assessment of binocular visual acuity for both distance (E-chart) and near (Reading-chart), corrected with the patient's own spectacles. Functional visual impairment was registered, if the binocular visual acuity, either for near or distance vision was less than 0.3 [Logarithm Minimum Angle Resolvable (logMAR) +0.5]. The reasons for the lack of eye examination among the visually impaired elderly were also reported. Functional hearing impairment was registered in three ways. First of all, it was registered if the interviewed person exhibited a clear difficulty in conversation due to poor hearing acuity as observed by the nurse. Secondly, a hearing problem was registered if the person stated that his or her main health problem was difficulty in hearing. Thirdly, it was registered if the person had earlier been provided with a hearing aid (HA). The use of HAs and the subjective reasons for the possible non-use of the HA were also assessed.

Up to 40% of the study population had some kind of functional sensory impairment: 7% combined sensory impairment, 13% functional visual impairment and 20% functional hearing impairment. Combined sensory impairment was common among the aged over 85-years. Subjects with functional sensory impairments exhibited more often depressive symptoms than subjects with intact sensory functions ($p=0.03$; Mann-Whitney test). In particular, those individuals with combined sensory impairment were more likely to suffer depressive moods. Functional visual and combined sensory impairments were associated with a decline of functional ability, and this decline for its part triggered the need for home care services. The annual cost of the use of these services was three-fold higher among these impairment group compared to those with adequate sensory functions.

An ophthalmologist had examined 48% of the visually impaired subjects during the follow-up time (at least two years). Forty-seven percent of these achieved better visual acuity either by cataract operation or by provision of new spectacles. The deteriorated cognitive function (MMSE≤24) and impairment in ADL-functions were the strongest factors associated with the failure to have received an eye examination for visual impairment. Seventeen percent of our study population had earlier been provided with a HA, but 25% of them never used it. The non-use of HAs was associated with decline in cognitive or functional capacity and low income. The most common reported reasons for the non-use of HAs were the difficulty to use the device or its ineffectiveness.

In conclusion, the fact that sensory impairments are common among the aged 75-years or older should not be overlooked. Sensory impairments in this age group associate with a decrease in the functional capacity, depressive mood, extra use of home care services and ultimately costs. It should be remembered that especially elderly persons with functional or cognitive decline are at risk of not receiving adequate treatment.

National Library of Medicine Classification: WT 104, WV 270, WW 140, WW 620
Medical Subject Headings: aged; geriatric assessment; vision disorders; vision, low; hearing loss; comorbidity; hearing aids; activities of daily living; depression; home care services; Finland/epidemiology

To my children Milla and Lasse

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Äänekoski, October 2004

Taina Lupsakko

ABBREVIATIONS

ADL	Activities of Daily Living
ANOVA	Analysis of Variance
ASF	Adequate Sensory Functions
CI	Confidence Interval
CSI	Combined Sensory Impairment
DSI	Depression Status Inventory
DSM- IV	The fourth edition of the Diagnostic and Statistical Manual of mental disorders
EU	European Union
FHI	Functional Hearing Impairment
FVI	Functional Visual Impairment
HA	Hearing Aid
HHIE-S	Hearing Handicap Inventory For the Elderly screening Version
IADL	Instrumental Activities of Daily Living
IQR	Interquartile range
LogMAR	Logarithm Minimum Angle Resolvable
MMSE	Mini-Mental-State Examination
OR	Odd Ratio
SD	Standard Deviation
WHO	World Health Organization

LIST OF ORIGINAL PUBLICATIONS

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CONTENTS

1. INTRODUCTION

Sensory functions include sense of sight, hearing, smell, taste and touch. This study concentrates on the sense of hearing and sight, and the term sensory impairment in this report refers to visual and hearing impairment.

The number of elderly people has increased remarkably in recent decades in the western countries. If we want to design and organize appropriate services for the elderly, we require knowledge about the diseases, impairments (loss of psychological, physiological, or anatomical structure or function) and disabilities (limitations in functional performance resulting from an impairment), which influence the social, psychological and physical capacity of the elderly and increase the need for services. Visual and hearing impairments are among the most common conditions affecting older persons. The prevalence of at least mild visual impairment is reported to range from 7% to 21% in individuals aged 75 years or older (Klein et al. 1991, Attebo et al. 1996, Rubin et al. 1997). Hearing impairment exists in approximately 40% to 50% of those over the age 75 years (Moscicki et al. 1985, Cruickshanks et al. 1998, Smeet et al. 2002).

Visual or hearing impairment either individually or combined may compromise an older person's ability to perform routine activities that define social roles and contribute to quality of life. Diminished vision has been associated with a greater rate of hip fractures, mortality, and disability in functional status. It may also be associated with depressive mood and increased risk to become institutionalized. Vision loss has been ranked behind arthritis and heart disease as the third most common chronic condition that forces elderly persons to require assistance with activities of daily living (LaPlante 1988). Hearing impairment has been associated with a higher subsequent risk for nursing home placement and cognitive decline, poorer quality of life, depressive symptoms, and also with a decrease in the Instrumental Activities of Daily Living (IADLs) –functions.

As with many other health problems encountered in the aged, visual and hearing impairment remain often undiagnosed and untreated. The reasons for this may be poor knowledge about the possibilities of treatment and rehabilitation of these impairments, denial of such loss, and insufficient support from involved professionals. Even though hearing impairment is not usually medically curable; it is often remediable with appropriate audiological evaluation and rehabilitation (for example fitting of hearing aids or other technical devices). The ability to remediate visual disability depends on the cause of the underlying impairments and their relative susceptibility to treatment. Sight can be dramatically improved by some surgical procedures e.g. cataract surgery.

Since the prevalence of these impairments increases with age, some elderly persons have simultaneously visual and hearing impairments. These combined sensory impairments lead to

considerable sensory deprivation. Though there is some knowledge about single sensory impairment, very little is known about combined sensory impairment and its prevalence and consequences in this age group. The present study was undertaken to determine the prevalence and implications of functional visual and/or hearing impairment, especially combined sensory impairment, in a general population aged 75 years or older in Finland. Special challenges related to the treatment of these impairments were also studied.

2. REVIEW OF THE LITERATURE

2.1 Screening for visual and hearing impairment in primary health care centers

2.1.1 Screening for visual impairment

Sight may be differentiated into several qualities such as visual acuity, visual field, contrast sensitivity, dark adaptation and color vision. The ability of the eye to recognize those small details on which the gaze is fixed is called visual acuity. Visual acuity for distance is usually tested by different optotypes of Snellen's charts (Gabriels 1969, Deederer 1970) and for near by the reading charts. A visually impaired elderly patient has usually the first contact with the public health care system via their family physician in a primary health care center. In such circumstances there are only limited possibilities to conduct an examination for eye diseases. In practice, the only parameter that can be measured is visual acuity for distance or near and an evaluation of intraocular pressure.

Screening of visual impairment has been recommended because visual problems among the aged are often not documented as medical services, even though in the majority of older people, vision can be improved with appropriate treatment. Abyad (1997) has reported that primary care screening is important to preserve sight and to prevent disability. However, other studies examining the efficiency of screening test for eye conditions in clinical-based populations have reported inconsistent results (Woods et al. 1997, Wang et al. 1998, Ivers et al. 2001). The vision tests currently in use are not particularly good at detecting eye disease if compared with the complete examination performed by an ophthalmologist. Smeeth et al. (2004) published a systematic review about the effects of mass screening of asymptomatic older people for visual impairment. They found no improvement in vision as a result of screening at two to four years after initial examination. They reported that this may be due to the lack of a clear plan of intervention for the visual problems encountered in the screening phase.

2.1.2 Screening for hearing impairment

Primary care has been criticized for its lack of ability to recognize hearing impairment (Parving et al.1992). A hearing problem is easy to overlook or to simply consider as a part of normal aging. Screening for hearing impairment has been mentioned as one effective method to improve the early detection of the hearing problems in the aged (Lichtenstein 1992, Bunnag et al. 2002). Screening for hearing impairment should start with an otoscopic evaluation and removal of cerumen that sometimes totally occludes the external auditory canal. The whispered and spoken voice tests are often used as the first screening methods (Macphee et al. 1988) of the hearing capacity. The only requirement for these tests is that there should be silent surroundings. Eekhof et al. (1996) reported that the whispered voice test could be a valuable test for assessment of hearing impairment in general practice. Pirozzo et al. (2003) reported 90% or 100% sensitivity and 70% to 87% specificity of the whispered voice test among adult in their review article. They concluded that the whispered voice test is a simple and accurate test for detecting hearing impairment. The greatest difficulty is standardization of the testing procedure (loudness of the whisper and letters, number or word selection for testing).

A more standardized method is a pure-tone audiometry, which attempts to determine the minimal perceived sound intensity through earphones. It can be performed in general practice and it is useful in identifying patients with no need of further audiological examination (Karlsmose et al. 1998). This method is also available in many primary health care centers in Finland and is widely used. An important hearing aid evaluation method is a speech audiometry. It defines the word recognition capacity and if that is very poor, the amplifying of sounds with a hearing aid does not help the patient in any practical way. This measurement is mostly done in special audiological centers.

Furthermore, standardized questionnaires have been used in screening of subjective hearing disability in this age group. Nondahl et al. (1998) used self-reported data from the ten-question Hearing Handicap Inventory For the Elderly-screening Version (HHIE-S), and four additional questions were compared with hearing impairment as measured by the pure-tone air conduction audiometry. They reported, that the single question ` Do you feel you have a hearing loss? ´ was the most sensitive question. Even though the sensitivity was only 71% they commented that for some applications that single question might be sufficient for prevalence surveys of hearing impairment among older adults. Gates et al. (2003) reported that one global question:" Do you have a hearing problem now?" was more effective than the detailed questionnaire (HHIE-S) in identifying older individuals with unrecognized handicapped hearing impairment. They encouraged primary care physicians to ask their patients about hearing problems.

Mulrow et al. (1991) reported in their review article that screening elderly adults for hearing impairment in a primary care setting is a rational practice and it is best done with an audiometry

or a screening questionnaire (HHIE-S) or both. Also Yueh et al. (2003) reported in their review article that older adults can be screened for hearing impairment using simple methods (audiometry, a combination of otoscope and an audiometry, HHIE-S), even though the value of routine screening for improving patient outcomes has not been evaluated in a randomized clinical trial.

2.2 Definitions of visual and hearing impairment

The generally applied identification of visual impairment is determined by a complete eye examination performed by an ophthalmologist and the measurement of visual fields. The World Health Organization (WHO) criteria for the visually handicapped are used to determine visual impairment in the European Union (EU)-countries. A person is identified as being visually handicapped, if he or she has best-corrected, visual acuity less than 0.3 (LogMAR + 0.5) in the better eye, or the visual field is equal to or less than 20 degrees (WHO 1973).

Correspondingly, the generally applied identification of hearing impairment is determined by an aural examination and a standard audiometry. At least two different definitions are used in Finland. The WHO criteria identify a person being as at least mildly aurally handicapped, if the average hearing threshold levels, over the frequencies 0.5 to 2 kHz, are equal to or exceeding 26 dB for the better ear measured by a standard audiometry (WHO 1991). The EU-criteria define this threshold point "exceeding 20 dB" (frequencies 0.5-4 dB) (EU Work Group, 1996).

2.3 Common diseases causing visual and hearing impairment among elderly populations

2.3.1 Diseases causing visual impairment

Aging is accompanied by various physiological changes in vision. Some of the changes are normal age-related phenomena (the capacity to adapt to a change in light intensity, a decrease in color discrimination), and some of these begin as early as middle-age (loss of ability for accommodation in the lens). A major loss of vision is a symptom of some diseases.

The cause of visual impairment depends on age and the population being investigated. In The Framingham Eye Study, from the study population (2631 participants) aged from 52 to 85 years 16% had cataract, 9% macular degeneration, 3% glaucoma, and 3% diabetic retinopathy (Kahn et al. 1977, Leibowitz et al. 1980). Peräsalo (1990) reported that in 56% of blind institutionalized geriatric patients, glaucoma was the cause of their blindness. Many studies have reported that the most predominant causes of visual problems in persons younger than 75 years are myopic

degeneration, diabetic retinopathy and optic neuropathy but for individuals older than 75 years the causes tend to be age-related macular degeneration, cataract, and glaucoma (Klaver et al. 1998, Weih et al. 2000, Hyman et al. 2001, Michon et al. 2002, Dineen et al. 2003, Buch et al. 2004, Evans 2004, a and b, Hsu et al. 2004). Due to the increasing incidence of diabetes in Western countries, the numbers of patients with diabetic retinopathy will increase also among the older age group. In the developing countries, one of the most common reasons of blindness is infection of the eye (e.g. "river blindness").

Visual impairment is often undiagnosed and untreated in the elderly (Attebo et al. 1996, Reidy et al. 1998, Munoz et al. 2000). Recently, it was reported that simple uncorrected refractive error ("old improper spectacles") is the most common cause of bilateral visual impairment across all decades of life but especially in those aged 80 years or more (Weih et al. 2000, VanNewkirk M et al. 2001, Michon et al. 2002, Munoz et al. 2002, Dineen et al. 2003, Evans et al. 2004,a) and furthermore adequate implementation of surgery to treat cataract could reduce visual impairment remarkably (Rahmani B et al. 1996, Klaver et al. 1998, Buch et al. 2004).

The strategy to remediate visual disability depends on the cause of the underlying impairment. No proven methods to prevent cataract are currently available and surgery is the only form of treatment (Snellingen et al. 2004). However, in many cases it is very effective (Klaver et al. 1998, Buch et al. 2004). If the underlying cause is pure refractive error of the lenses, then this could be improved by optical correction or by operation. Since the visual impairment caused by glaucoma is irreversible, early detection is essential. Lowering of intraocular pressure by medication or by surgery prevents progression at both the early and late stages of the disease (Weinreb et al. 2004). Photodynamic therapy with verterporfin in people with choroidal neovascularisation due to age-related macular degeneration ("wet") is effective in preventing visual loss (Lee et al. 2004, Wormald et al. 2004), but unfortunately no curative treatment for age-related macular degeneration currently exists (Byrne et al. 2003). Early detection of diabetic retinopathy by regular examination of the macula is important because this symptom can also be effectively treated.

2.3.2 Diseases causing hearing impairment

There are also age-related changes occurring in hearing ability. These changes usually start in middle-age, and their first sign is the loss of mostly high frequencies from the hearing range. The changes may advance from difficulties to hear in noisy surroundings to almost total loss of hearing. For many patients, hearing impairment is gradual and is not often perceived. People seek help when they become aware of the problem, not when it begins. Three phases of deterioration of hearing capacity have been described: the preclinical phase, the phase interfering with social

communication (hearing impairment greater than 30 dB for 2 kHz) and the phase of social isolation (Cohn 1999).

The most common form of hearing impairment observed in older individuals is termed presbyacusis, an age-associated bilateral sensorineural high frequency loss. The term presbyacusis comes from the Greek words presby (older) and akousis (hearing). The exact cause of the complaint remains undetermined, even though many etiological mechanisms have been proposed. Genetic factors (Gates et al. 1999, Liu et al. 2001, Toppila et al. 2001, DeStefano et al. 2003), atherosclerosis of the inner ear circulation system and cellular degeneration of the neural apparatus have been described as the main explanatory factors for presbyacusis (Cohn 1999, Christensen et al. 2001). Yueh et al. (2003) published a review concerning screening and management of adult hearing impairment in primary care. They reported that cerumen impaction and chronic otitis media may be present in up to 30% of elderly patients with hearing impairment and a primary care clinician can treat these symptoms.

Wallhagen et al. (1997), Davanipour et al. (2000) and Cruickshanks et al. (2003) have conducted longitudinal studies on the risk factors for hearing impairment. Wallhagen et al. (1997) reported that the higher incidence of hearing impairment over the past 30 years was associated with potentially high-noise-exposure occupations for men and with symptoms and conditions associated with ototoxic drugs use for both men and women. Davanipour et al. (2000) reported in their 2-year follow-up, that age group, male sex, hypertension, arthritis, significant depressive symptomology and ever having consumed alcohol were jointly associated with hearing problems. Cruickshanks et al. (2003) reported that male sex, occupation (high-nose), and education (higher level protect) were associated with the incidence of hearing impairment after adjusting for age (5-year follow-up).

Typically, age-related hearing impairment is not medically curable. The rehabilitation strategy depends on the patient's communications needs. The treatment of presbyacusis includes emotional support from family members and health care professionals, environmental modification, and the use of various types of assistive listening devices (e.g. telephone and television amplifiers, hard wired communication devices) and/or hearing aids (HAs). However, only 10-40% of older adults with hearing impairment possess a HA (Gates et al. 1990, Davis 1995, Karlsson et al. 1998, Popelka et al. 1998, Barton et al. 2001, Sorri et al. 2001,a and b, Johansson et al. 2003). Furthermore, too often the treatment compliance (hearing-aid use) is poor in this age group (Sorri et al. 1984, Ward et al. 1993, Popelka et al. 1998, Smeeth et al. 2002).

In Finland, HAs are mostly obtained from the hearing centers, which are a part of secondary or tertiary health care level. The basis for a HA prescription are the subjective need of amplification and the average hearing threshold levels, over the frequencies 0.5, 1, 2 and 4 kHz, equal to or exceeding 30 dB for the better ear. In this age group, persons usually receive only one HA.

Currently, the most common model is the analogue, single channel, behind-the-ear device. In the future, the provision of digital signal processing HAs will be more common.

2.4 Prevalence of visual and hearing impairment in the aged

2.4.1 Finnish surveys of the elderly

The occurrence of the visual and hearing problems has been studied in as a component of wide surveys of the elderly in Turku (Ruikka et al. 1984), Helsinki (Valvanne et al.1992), and Tampere (Jylhä et al. 1992). Ruikka et al. (1984) reported that 45% of women and 41% of men aged 75 years or older had such a low hearing capacity that they had difficulties to hear when they were in a group. Furthermore, 24% of these women and 22% of men had such a low visual acuity that they had difficulties to read. According to Jylhä et al. (1992) the equivalent proportions concerning the hearing acuity was 59% among women and 68% among men aged 80 years and older, and with respect to the visual acuity, 47% among women and 43% among men in this old age group. In the Helsinki aging study, Valvanne et al. (1992) reported that 15 - 40% of men and 15 - 35% of women aged 75 years or older could not hear a whispered voice, and 8 - 27 % of men and 11 - 34% of women in this age group had difficulties to read small text.

2.4.2 International epidemiological eye studies

Many large population- based epidemiological studies have provided precise estimates of the prevalence and causes of visual impairment among the aged (Table 1.) Both sex (women) and age (older) have been shown to be independent predictors of poorer visual acuity. The prevalence of at least mild visual impairment (visual acuity worse than 0.5 or LogMAR + 0.3) among individuals aged 75 and older was 21% in the Beaver Dam Eye Study (Klein R et al. 1991), 17% in the Blue Mountains Eye Study (Attebo et al. 1996), 7% in the Salisbury Eye Evaluation project (Rubin et al. 1997), and 15% in the Rotterdam Study (Klaver et al. 1998). Häkkinen (1984) reported that 13% of the study population (in the city of Turku) aged 75 years or older had best-corrected visual acuity equal to or less than 0.3. According to the study of Hirvelä (1995) 12% of persons aged 70 years or older - in the residential area of the city of Oulu - had visual impairment identified by the WHO criteria (WHO 1973).

Table 1. Summary of population-based prevalence studies concerning visual impairment. All the studies used a standardized ophthalmologic examination and similar acuity charts, and tested the best-corrected visual acuity.

Study	N Age (years)	Prevalence of at least mild impairment [1]
The Baltimore Eye Survey: *Tielsch et al. 1990*	5300 ≥ 40	12%
The Beaver Dam Eye Study: *Klein R et al. 1991*	4926 43-86	11%
The Blue Mountains Eye Study: *Attebo et al. 1996*	3647 ≥ 49	10%
The Salisbury Eye Evaluation Study: *Rubin et al. 1997*	2520 65-84	5%
The Rotterdam Study: *Klaver et al. 1998*	6775 ≥ 55	9%

N; Number of participants, [1] Snellen equivalent equal to or worse than 20/40.

2.4.3 International epidemiological hearing impairment studies

Many epidemiological studies of the extent of hearing impairment among the elderly population have also been published. Results differ according to the methods used and the definitions for hearing impairment. Many studies report that the odds of hearing impairment increase with age and are greater for men than women. The results of selected large international prevalence studies are seen in Table 2.

Table 2. Summary of large (N>1000) international prevalence studies concerning hearing impairment. In these studies, the hearing impairment was measured using the pure-tone audiometry.

Study	N Age (years)	Measured hearing impairment; average threshold point (dB)	Prevalence of hearing impairment (%)
The Framingham Heart Study: *Moscicki et al. 1985*	2293 57-89	BEHL 25 0.5 - 4 kHz	42-47
British Study of hearing impairment: *Davis 1989*	2662 ≥15 years 71+	BEHL 25 0.5 - 4 kHz	16 60
The Epidemiology of Hearing Loss Study: *Cruickshanks et al. 1998*	3753 48-92	WEHL 25 0.5 - 4 kHz	46
NHANES *Reuben et al. 1998*	2506 55-74	BEHL 25 1 - 4 kHz	35
Australian study *Wilson et al. 1999*	9027 ≥15 years 71 +	BEHL 25 0.5 - 4 kHz	22 74
The Blue Mountains Hearing Study: *Sindhusake et al. 2001*	2015 55-99	BEHL 25 0.5 - 4 kHz	39

N; Number of participants, BEHL; Better ear hearing level, WEHL; Worse ear hearing level, NHANES; National Health and Nutritional Examination Survey.

The prevalence of hearing impairment has also been studied in Finland (Uimonen et al. 1997, 1999). According to Uimonen et al. (1999) 33% of the study population aged over 75 years in Northern Finland had a hearing impairment as defined by the WHO criteria but if one used the EU- criteria then almost 65% of them were hearing impaired.

2.4.4 Prevalence of combined sensory impairment

The prevalence of combined sensory impairment has earlier been reported only in a few studies (Table 3). The prevalence rate has ranged from 2% (Carabellese et al. 1993) up to a value of 13% (Keller et al. 1999). Crews et al. (2004) reported an 8.6% prevalence rate among adult ≥ 70 years, and Bergman et al. (2001) reported a value as high as 22% in the age group over 81-year old Gothenburgers.

Table 3.Summary of studies concerning combined sensory impairment.

	Carabellese C 1993	Reuben D 1999	Reuben D 1999	Keller B 1999	Bergman B 2001	Crews J 2004
Number of subjects	1191	783	164	576	523	9447
Age, years	70-75	55-74	55-74	56-102	70-88	≥ 70
Study population	Community-based cohort	Community-based cohort	Community-based cohort	Geriatric clinic	Community-based cohort	Community-based cohort
Sensory assessment	Snellen E-charts, whisper voice test	Snellen E-charts, pure-tone audiometry	Self-reported impairmens	Snellen E-charts, whisper voice test	Best-corrected visual acuity and pure-tone audiometry	Interview; Self-reported vision and hearing problems

Table 3.Summary of studies concerning combined sensory impairment.

	Carabellese C 1993	Reuben D 1999	Reuben D 1999	Keller B 1999	Bergman B 2001	Crews J 2004
Combined sensory impairment, n (%)	20 (2%)	36 (5%)	64 (4%)	75 (13%)	15 (3%) [2]	779 (8.2%)
Main measures	Quality of life questionnaire - mood - IADLs - social relationship - cognitive function	ADLs IADLs	ADLs IADLs	ADLs IADLs	Occurrence of combined sensory impairment	Occurrence of combined sensory impairment Health status Health conditions Activity limitations Social participation
Results [1]	No significant association with mood, IADLs or social relationship. An association with cognitive decline.	An association with ADL - dependency	No association with functional dependency	An association with IADL and ADL-dependency		Associations with measured modalities

[1] Association between combined sensory impairment and measured modalities.
[2] Numbers were calculated using percentage distributions.

2.5 Associations and consequences of sensory impairments in the aged

2.5.1 Associations and consequences of visual impairment

Sensory impairments have serious consequences also in this age group. Diminished vision has been associated with falls (Harwood 2001, McCarty et al. 2002), a greater rate of hip fractures (Felson et al. 1989, Cummings et al. 1995, Ivers et al. 1998), mortality (Thompson et al. 1989, McCarty 2001, Reidy A et al. 2002), nursing home placement (Osterweil et al. 1995, Wang et al. 2003), and disability in functional status (Carabellese et al. 1993, Rudberg et al. 1993, Salive et al. 1994, West et al. 1997, Wallhagen et al. 2001). When the visual acuity is worse than 0.5 (LogMAR + 0.3), it doubles the risk of functional disability compared with normal vision (Dargent-Molina et al. 1996). Also Valvanne et al (1992) reported an association between visual impairment and problems in the IADLs in the Helsinki Aging study. Furthermore, visual impairment has been associated with depression (Carabellese et al. 1993, Rovner et al. 1998, Ip et al. 2000, Brody et al. 2001, Tsai et al. 2003) in this age group. Nursing home residents with visual impairment are in need of greater assistance with activities of daily living (ADLs) than their visually intact peers (Marx et al. 1992). Additionally community-dwelling elderly persons with visual impairment more often need help with the IADLs (Branch et al. 1989, Kelly 1995).

The consequences of visual impairment have been studied as a part of the longitudinal Beaver Dam Eye Study (USA) and the Blue Mountains Eye Study (Australia). The baseline examination of the Beaver Dam Eye Study was conducted between 1988 and 1990 (4926 participants), the five- year follow-up between 1993 and 1995 (3684 participants), and the ten-year follow-up between 1998 and 2000 (2764 participants). During the five-year follow-up 9.5% of the population had died (Klein R et al. 1995). After controlling for age and sex, there were three factors, nuclear sclerotic cataract severity, cataract surgery and visual impairment, which were noted as risk indicators for poorer survival. The five-year follow-up data also revealed a consistent relationship between falls, fractures, gait time, and visual functions (Klein et al. 1998, Klein et al. 2003,a). With a 10-year follow-up, Klein et al. (2001) reported that people who were 75 years of age or older at baseline were 15 times more likely to suffer the development of vision impairments than people younger than 75 years of age at baseline. Those who were 75 years or older at baseline and entered a nursing home over the 10-year period were 2.6 times as likely to develop visual impairment as those 75 years or older who did not enter a nursing home or group home. Furthermore, Klein et al. (2003,b) reported that poorer visual capacity was associated with the slowest gait time, the lowest peak expiratory flow rate, handgrip strength, and inability to stand up from the seated position in one try.

The Blue Mountains Eye Study is a population-based study of eye diseases in older community dwelling people aged 49 years or older. Participants (3654) underwent a detailed eye examination for the first time between 1991 and 1993 (Attebo et al. 1996). After five years, 2326 subjects returned to the follow-up examination. During the 5-year follow-up time, 604 of the participants had died. After adjusting for factors known to be significantly associated with mortality (age, male sex, low self-rated health, low socioeconomic status, systemic medical conditions, and negative health risk behavior), the presence at baseline of any visual impairment was independently associated with increased mortality risk (Wang et al. 2001). Ivers et al. (1998, 2003) reported that visual impairment predicts the increased risk of falls and hip fractures and Wang et al. (2003) reported 7% increase in the risk of subsequent nursing home placement for those with baseline visual impairment. Furthermore, noncorrectable visual impairment was associated with reduced health-related quality of life and self-rated health (Wang et al. 2000, Chia et al. 2004). Even unilateral visual impairment caused by eye diseases had a measurable impact on the health-related quality of life (Chia et al. 2003). Visual impairment affected negatively the independence of elderly people, particularly older women, and it increased the use of community support service (Wang et al. 1999a, b).

2.5.2 Associations and consequences of hearing impairment

Hearing impairment has been associated with poorer quality of life (Mulrow et al. 1990, Carabellese et al. 1993, Maggi et al. 1998, Strawbridge et al. 2000, Espmark et al. 2002), and depressive symptoms (Herbst et al. 1980, Jones et al. 1984, Carabellese et al. 1993, Cacciatore et al. 1999, Tsuruoka et al. 2001). Furthermore, Bazargan et al. (2001) has reported that impaired hearing capacity showed a significant relationship with paranoid ideation. An association between hearing impairment and worsened functional status has been found in many studies (Carabellese et al. 1993, Lee et al. 1999, Keller et al. 1999, Wallhagen et al. 2001, Dalton et al. 2003). However, in at least two studies, those subjects with hearing impairment did not show any major loss in ADLs (Mulrow et al. 1990, Rudberg et al. 1993). Hearing impairment has also been associated with shortened survival in men. The impact of hearing deficit on mortality was mediated by psychosocial parameters (mood and social relationship levels) (Appollonio et al. 1995). Furthermore, poor hearing has been shown to be associated with higher subsequent risk for nursing home placement (Osterweil et al. 1995).

The connection between hearing impairment and cognitive function is complicated. Uhlmann et al. (1986) reported in their longitudinal study that a decline in cognitive function (after one year follow-up) in senile dementia of the Alzheimer's type was nearly twice as great in the group with hearing impairment even when controlled for age and initial cognitive function. Cacciatore et al.

(1999) in their cross-sectional study detected a strong relationship between decreasing hearing function and cognitive function and this was independent of the effect of age and education. Anstey et al. (2001) did not find any association between hearing impairment and cognitive domain during a two-year follow-up. As a part of the Framingham Heart Study, Gates et al. (2002) reported (3-12 year follow-up) that central auditory speech-processing deficits may represent an early manifestation of probable Alzheimer's disease and may precede the actual diagnosis of dementia by many years.

2.5.3 Associations and consequences of combined sensory impairment

Double sensory impairment leads to a considerable sensory deprivation. Little is known about the consequences of combined sensory impairment in the aged. Keller et al. (1999) and Reuben et al. (1999) reported in their studies that there was an association between combined sensory impairment and functional decline (Table 3). Reuben et al. (1999) reported that those with hearing impairment, vision impairment and both impairments demonstrated higher rates of mortality, ADL dependency, and IADL dependency than people without sensory impairment 10 years after collection of the baseline data. Those with dual sensory impairment demonstrated the greatest decline in function and the greatest rates of mortality.

Parminder et al. (2004) reported that individuals with both seeing and hearing disabilities had the greatest IADL restrictions, followed by persons with only seeing or hearing disabilities. Carabellese et al. (1993) reported an independent association between a deficit in hearing or visual modality and an increased risk of low mood level but no interaction between hearing and visual impairment on their depressive score. Crews et al. (2004) investigated the health, activity, and social participation of people aged 70 years or older with vision, hearing or combined impairments. They reported an additive impact of hearing and visual impairments on these modalities.

3. AIMS OF THE STUDY

The aims of this study were:

1) To determine the prevalence of functional visual and/or hearing impairment in the general population aged 75 years and over in Finland, and to evaluate if there is an association between functional sensory impairments and activities of daily living (Substudy I).

2) To study an association between functional sensory impairments and depression (Substudy II).

3) To ascertain reasons for the lack of eye examination in the visually impaired elderly population and to obtain estimates of how many of those with poor vision could be helped by cataract surgery or by provision of new corrected spectacles (Substudy III).

4) To evaluate the use of hearing aids in a population aged 75 years and older in the city of Kuopio in Finland (Substudy IV).

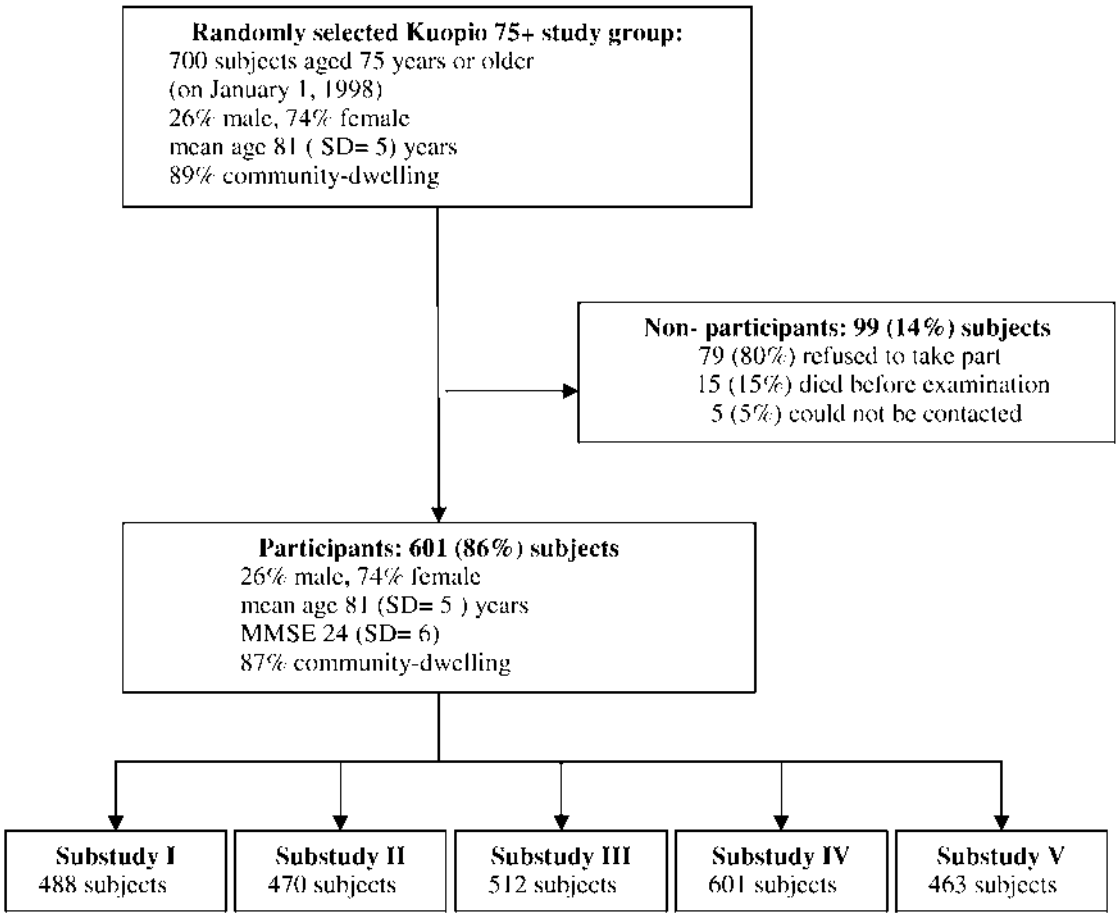
5) To assess the use of home care services among sensory impaired community-dwelling older persons (Substudy V).

4. SUBJECTS AND METHODS

4.1 Study populations

This study was a part of the population based Kuopio 75+ study, which was being carried out in the collaboration between the University of Kuopio and the Social Welfare and Health Center of Kuopio. Kuopio has a population of 86 000 inhabitants; 5.3% of them being 75 years old and older (4518 individuals). Seventy-four percent of these elderly individuals were female and 26% male. The random selection was performed by the computer center of the city of Kuopio. It was done separately for females and males and for different age groups. Thus the sample was representative of the respective age groups and genders. The identification numbers of citizens at least 75 years old in the city of Kuopio were arranged in a random order. Every sixth person was selected to the primary sample. The primary study sample consisted of 700 persons, which was 15.5% of the entire age group (Figure 1). Of those persons eligible, 601 participated in the standardized interview and geriatric assessment between January 1998 and January 1999.

Figure 1. The participants of the Kuopio 75+ study and the number of subjects in each substudies.



Due to different exclusion criteria in each substudy, the study populations in the substudies differed somewhat from each other. The basis of each substudy group was the Kuopio 75+ - study population (congruent to the hearing aid use- study population). The study populations and exclusion criteria in each substudy are seen in Table 4.

Table 4. The populations of the substudies. The basic population was the Kuopio 75+ study population.

Substudy	Subjects (N) - sex - mean age - MMSE (mean) - community-dwelling (%)	Excluded subjects (N)	Exclusion criteria
Functional status: Substudy I	488 -73% female - 81 years - MMSE 26 - 95%	113	unreliable visual or hearing testing
Depression: Substudy II	470 - 73% female - 81 years - MMSE 27 - 96%	131	unreliable visual or hearing testing or incomplete depression status inventory
Eye examination: Substudy III	518 - 73% female - 81 years - MMSE 25 - 92%	83	unreliable visual testing
Hearing aid use: Substudy IV	601 - 74% female - 81 years - MMSE 24 - 87%	0	none
Service use: Substudy V	463 - 73% female - 80 years - MMSE 26 - 100%	138	unreliable visual or hearing testing or institutional care

4.2 Methods

All participants were interviewed and examined by a geriatrician (A.Vatanen, MD) and a trained nurse (L. Pelkonen). The standardized interview and the examination lasted approximately four hours (two separate visits) and were carried out in a primary health care center or at home (nursing home residents and house-bound participants). The interview elicited data regarding the participant's sociodemographic characteristics, general health history and the level of ability in daily activities and mood. The cognitive function was screened by the Finnish translation of the Mini-Mental State Examination (MMSE) (Folstein et al.1975).

4.2.1 Assessment of functional visual acuity

The visual examination consisted of an assessment of binocular visual acuity for both distance and near, corrected with the patient's own spectacles (Appendix). No extra illumination was used during the examination. A Snellen chart with E-letters (Deederer 1970) was used in testing the visual acuity for distance. The test distance was five meters. The visual acuity can be tested from 0.10 - 1.25, which means $\log_{10}$ minimum angle resolvable (logMAR) +1.0 to -0.1 according to the methods recommended by Ferris et al. (1982). The identification of the correct position of at least four of five E´s was necessary to indicate sufficient visual acuity for any given line.

The reading charts designed by the Finnish Center for Visually Impaired were used when testing the visual acuity for near. The test distance was equal to which was recommended in the charts (40 cm). A whole line should be read correctly to be accepted for that visual acuity to be registered for that line. The reading acuity can be tested from 0.10 to 1.00 (logMAR+1.0 to 0.0). These methods for screening were chosen because of their availability in every primary health care center in Finland. The functional visual impairment was registered, if the binocular visual acuity, either in near or distance vision was less than 0.3 (logMAR+0.5). This threshold was employed based on the World Health Organization criteria for visually handicapped (WHO 1973). We could not undertake a more thorough identification of visual handicap because it was not possible to induce a complete eye examination performed by an ophthalmologist. This accounts for our decision to use terminology of "functional visual impairment" in our reports.

4.2.2 Assessment of functional hearing acuity

The survey was not intended to assess the status of absolute hearing acuity, but rather the presence of "functional hearing impairment". A functional hearing impairment was defined in three ways. First of all, it was registered if the interviewed person had a clear difficulty in conversation due to a poor hearing acuity as observed by the nurse (Appendix). The conversation distance was one meter. The hearing impairment of these subjects was confirmed by the reported diagnosis of presbyacusis in the medical records. Secondly, it was registered if the person expressed that his or her main health problem was difficulty in hearing. Thirdly, it was registered if the person had earlier been provided with a hearing aid.

4.2.3 Different groups with functional sensory impairment

Subjects, who had both visual and hearing impairments, were classified as having combined functional sensory impairment. Based on the screening of hearing and visual acuity, the subjects were divided into four groups:

1) Subjects with adequate sensory functions (ASF)
2) Subjects with functional hearing impairment but adequate visual function (FHI)
3) Subjects with functional visual impairment but adequate hearing function (FVI)
4) Subjects with combined functional sensory impairment (CSI)

4.2.4 Assessment of functional capacity

The Activities of Daily Living (ADL) were evaluated by the Barthel-index (Collin et al.1988, Wade et al.1988) and the Instrumental Activities of Daily Living (IADL) by the IADL-scale of Lawton and Brody (Lawton et al.1969). The Barthel-index consists of ten questions about the individual's ability to function in the basic areas of self-care: feeding, moving from wheelchair to bed and return, personal hygiene, getting on and off toilet, bathing, walking on a level surface, ascending and descending stairs, dressing and control of bowels and bladder. The total score can vary from 0 to 100 (help needed in all activities - independent in all activities).

The IADL-score includes eight questions about the person's ability to manage more complex tasks necessary for independent living: shopping, cleaning, cooking, washing clothes, paying bills, using the phone, taking care of personal medication and using public vehicles. Every

question is scored either 0 or 1 point, thus the total score ranges from 0 to 8 points with 8 points meaning that no help is needed.

4.2.5 Assessment of depression

A geriatrician interviewed the subjects and "The fourth edition of the Diagnostic and Statistical Manual of Mental Disorders" (DSM-IV) operationalized criteria were used to determine whether they met the criteria for "major depressive episode", "dysthymic disorder" or "depressive disorder not otherwise specified". The Finnish translation of the Zung Depression Status Inventory (DSI) (Zung 1972) was used to estimate depressive symptoms. The DSI is a semistructured interviewer-rated inventory measuring various psychological and somatic symptoms of depressive illness. It consists of 20 questions; each of these items is rated on a scale of one to four, i.e. the higher the score, the more severe the disturbance. The total DSI scores range from 20 to 80, such that a sum score from 40 to 47 is associated with minimal to mild depressive illness and scores equal to or greater than 48 strongly suggest clinical depression in older populations (Zung 1972, Okimoto et al. 1982).

4.2.6 Assessment of the eye examination

The primary assessment of visual acuity was conducted in 1998. At the beginning of 2002, the patient documents of the visually impaired subjects were reviewed in the local hospital (the University Hospital of Kuopio). After that a list of those visually impaired subjects, who had not been investigated in the local hospital, was sent to all local ophthalmologists. They were inquired if these subjects have been investigated in the private sector. Before that questionnaire, the local ophthalmologists were informed about the study protocol at a professional society meeting. If they did not reply to the questionnaire, they were contacted personally by phone call. It was confirmed whether an ophthalmologist had examined these visually impaired subjects and if their visual acuity had been corrected by cataract surgery or by the provision of new spectacles during the follow-up time.

4.2.7 Assessment of hearing aid (HA) use

Questions concerning the possible provision of a HA, and the use of HAs were included into the standard questionnaire (Appendix). Patient documents in the local hospital and in the primary health care centers were also reviewed and checked from their notes if these Kuopio 75+ study subjects had earlier been provided with a HA. The subjects were asked how often they used their

HAs. If they said, they did not use it at all; they were reported to as non-users. If they used it all the time when they felt the need of amplification; they were reported to as full-time users. Finally if they said, they used the HA only occasionally or sometimes; they were reported to be part-time users. The subjective reasons for the non-use of the HAs were inquired and recorded.

4.2.8 Assessment of home care service use and costs of this service use

Home care services were divided into three different groups: home nursing, home help and meals-on- wheels. Home nursing is organized by the primary health care centers. The purpose of these services is to provide medical care in homes. The number of home nurse visits may vary from daily visits to once monthly visits. In this study, the number of visits was reported as an average number per month. Home help provides personal care in the ADLs and IADLs in homes and is provided by the social service department of the local community. The number of these services can vary from five times per day to one visit per week. In this study we reported the average number of visits per month. The meals-on-wheels service means that a person gets a complete meal delivered to her or his home. The meal service can be arranged daily and is provided by the social service department of the local community. We reported the average number of meal services provided per month.

Each subject had access to home nursing and home help as well as meals-on-wheels services. We used the total amount of these services and costs, which accrue to the community from delivery of these services. We totaled together these costs and in this way estimated the total costs of the service use to every subject per year. The average cost of one home nursing visit was 43 €, of one home help visit 28 €, and of one meal on wheels as 5 €. All costs are presented in Euros. Discount rate analysis was not used, as the follow-up was only one year. A sensitivity analysis was performed. The costs varied by 30% .

4.3 Statistical methods

Variables with normal (Gaussian) distribution descriptive values were expressed by mean and standard deviations (SD); statistical comparison between the groups was made by using t-test or analysis of variance (ANOVA). The normality of variables was evaluated by the Kolmogorov-Smirnov statistics, with Lilliefors significance or Shapiro-Wilk statistics.

If the variables did not have a normal distribution or ordinals, then descriptive values were expressed by the median and interquartile range (IQR) or range; statistical comparison between groups was made by using Mann-Whitney test or Kruskal-Wallis test. Measures with a discrete distribution were expressed as counts (%) and analyzed by Chi-Square, Fischer's exact test or

Fisher-Freeman-Halton exact test. Correlation coefficients were calculated by the Spearman method.

Median regression models (least-absolute value models) determined the relationship between the functional sensory impairment and the ADL-score and the IADL-score in substudy I. Logistic regression models with robust estimates of variance were used to determine adjusted predictive values of depressive symptoms in substudy II and of the use of services in substudy V. Furthermore, univariate and forward stepwise logistic regression analyses were used to identify the predictive effects for the lack of examination of visual impairment in substudy III. Additionally, we used Hommel's adjustments in substudy IV to correct the significance levels for multiple (post hoc) testing between different groups using HAs.

The most important descriptive values were expressed with 95 per cent confidence intervals (95% CI). The α level was set at 0.05 in all tests.

4.4 Ethical considerations

The study was reviewed and approved by the Ethics Committee of the University of Kuopio and University Hospital of Kuopio. The participants and/or their nearest relative provided written informed consent for participation in the study. If the subjects were detected to have untreated health problems they were sent to their family physician or to a specialist for more thorough investigations.

5. RESULTS

5.1 Prevalence of functional sensory impairments (Substudy I)

Ninety-nine (20%) subjects of the sensory study population had a functional hearing impairment (FHI), 62 (13%) exhibited a functional visual impairment (FVI) and 36 (7%) had combined sensory impairment (CSI). Table 5 shows that there was a statistically significant difference in the mean age between the different impairment groups ($p<0.001$) and between those with some kind of functional impairment and the adequate sensory functions groups ($p<0.001$). The mean age was 86.7 years (SD 5.0) in the combined sensory impairment group, 81.5 years (SD 4.8) in the functional visual impairment group, 81.7 years (SD 4.1) in the functional hearing impairment group, and 79.3 years (SD 3.4) in the adequate sensory functions group.

There was a statistically significant difference in the incidence of cardiovascular diseases between the adequate sensory functions and the functional impairment groups ($p=0.02$). The number of institutionalized persons was significantly higher in the functional impairment group compared to the adequate sensory functions group ($p=0.04$) (Table 5).

Table 5. Demographic and clinical data on functional sensory impairment and adequate sensory function groups.

Variables	Functional impairment N=197			p value between different impairment groups	Adequate sensory function N=291	p value between functional impairment and adequate sensory function groups
	Hearing N=99	Visual N=62	Combined N=36			
Number of females (%)	63 (64)	49 (79)	26 (72)	0.11 [a]	218 (75)	0.24 [a]
Mean age, years (SD)	81.7 (4.1)	81.5 (4.8)	86.7 (5.0)	<0.001 [b]	79.3 (3.4)	<0.001 [b]
Diagnosed diseases:						
Cardiovascular, n (%)	82 (83)	54 (87)	28 (78)	0.49 [a]	216 (74)	0.02 [a]
Stroke or TIA, n (%)	21 (21)	7 (11)	11 (31)	0.06 [a]	51 (18)	0.53 [a]
Diabetes, n (%)	17 (17)	11 (18)	8 (22)	0.79 [a]	48 (16)	0.61 [a]
Respiratory, n (%)	13 (13)	12 (19)	3 (8)	0.29 [a]	27 (9)	0.09 [a]
Psychiatric disorders, n (%)	18 (18)	19 (31)	10 (27)	0.16 [a]	55 (19)	0.19 [a]
Number institutionalized, (%)	4 (4)	7 (11)	4 (11)	0.15 [a]	10 (3)	0.04 [a]

[a] Chi-Square or Fisher-Freeman-Halton test.
[b] T-test.

5.2 Associations between functional sensory impairments and activities of daily livings (Substudy I)

Table 6 demonstrates the relationships between sensory impairments and functional status. There was a statistically significant difference in the median of the scale of the ADLs between the functional impairment group and the adequate sensory functions group ($p<0.001$) and also between the different functional impairment groups ($p=0.001$). The median of the scale of the ADLs was 100 (IQR: 95,100) in the functional hearing impairment and the adequate sensory functions groups but only 95 (IQR: 75,100) in the functional visual impairment and the combined sensory impairment groups.

The difference in the median of the scale of IADLs between the functional impairment and the adequate sensory functions ($p<0.001$) groups and between the different functional impairment ($p=0.007$) groups was also statistically significant. The median of the scale of IADLs was 8 (IQR: 6, 8) in the adequate sensory functions group, 7 (IQR: 5, 8) in the functional hearing impairment and the functional visual impairment groups and only 5 (IQR: 4, 7) in the combined sensory impairment group (Table 6)

Table 6. ADL and IADL scale according to functional impairment and adequate sensory function groups.

	Functional impairment			p value between impairment groups	Adequate sensory function	p value between impairment and adequate sensory groups
	Hearing Median (IQR)	Visual Median (IQR)	Combined Median (IQR)		Median (IQR)	
ADL (scale: 0-100) [a]	100 (95 , 100)	95 (75 , 100)	95 (75 , 100)	0.001 [c]	100 (95 , 100)	<0.001 [d]
IADL (scale: 0-8) [b]	7 (5 , 8)	7 (5 , 8)	5 (4 , 7)	0.007 [c]	8 (6 , 8)	<0.001 [d]

IQR= interquartile range; ADL= activities of daily living; IADL= Instrumental activities of daily living.

[a] Barthel index. Maximum value indicates independent in all activities.

[b] Lawton and Brody scale. Maximum value indicates independent in all activities.

[c] Kruskal-Wallis test.

[d] Mann-Whitney test.

Table 7 shows that combined sensory impairment had an independent association with the functional status even after adjustment for age and sex. Functional visual impairment had a significant age and sex adjusted effect on the ADLs (p<0.001), but not on the IADLs (Table 7).

Table 7. Age and sex adjusted effect of functional sensory impairment to the ADL and the IADL score. Regression models were calculated by using the median regression models.

Variable	ADL	p value	IADL	p value
	Coefficient (95% CI)		Coefficient (95% CI)	
Only hearing impairment	0.35 (-0.10 to 0.80)	0.13	0.20 (-.05 to 0.44)	0.12
Only visual impairment	-4.27 (-4.85 to –3.69)	<0.001	-0.12 (-0.43 to 0.18)	0.42
Combined impairment	-1.32 (-2.11 to –0.53)	0.001	-0.71 (-1.06 to -.35)	<0.001

ADL= Activities of daily living; IADL= Instrumental activities of daily living; CI= Confidence interval.

5.3 Association between functional sensory impairments and depression (Substudy II)

Twenty-three percent from the population in the depression substudy (N=470) had "major depressive episode", "dysthymic disorder" or "depressive disorder not otherwise specified" diagnosed according to the DSM-IV criteria. Twenty percent of subjects in the functional hearing impairment group, 33% in the functional visual impairment group, 23% in the combined sensory impairment group and 21% in the adequate sensory functions group had a diagnosis of some form of depression. The difference between these groups was statistically significant (p=0.009; Chi-Square test).

Two hundred and twenty-eight (49%, [95% CI: 44 to 53]) subjects had a total score of DSI 40 points or over. The occurrence rate of the DSI score equal or over 40 points was 50% in the functional hearing impairment group, 53% in the functional visual impairment group, 70% in the combined sensory impairment group compared to 45% in the adequate sensory functions group. The difference between the adequate sensory functions group and the functional sensory impairment group was statistically significant (p=0.03; Mann-Whitney test) but not between the different impairment groups (p=0.14; Kruskall-Wallis test).

5.4 Use of home care services and costs of this service use (Substudy V)

Table 8 shows the association between sensory functions and the use of home care services. There were statistically significant differences between the adequate sensory functions group and functional sensory impairment group in the use of home nursing (p=0.023) and home help (p=0.022). The differences between different sensory impairment groups were also statistically significant in the use of home nursing (p=0.004) and home help (p=0.02). Only 11% of subjects in the adequate sensory function and functional hearing impairment groups were using a home help compared to 25-28% in the functional visual and combined sensory impairment groups. Additionally, 7-9% of subjects in the functional hearing impairment and adequate sensory function groups used home nursing compared to 19-27% in the functional visual and combined sensory impairment groups (Table 8).

Table 8. Use of home care services in the different sensory impairment and adequate sensory function groups.

Service	Functional impairment N=182			p value between impairment groups [a]	Adequate sensory function N=281	p value between impairment and adequate sensory groups [a]
	Hearing (N=95) N (%)	Visual (N=55) N (%)	Combined (N=32) N (%)			
Home help	10 (11)	14 (25)	9 (28)	0.02	30 (11)	0.022
Home nursing	7 (7)	15 (27)	6 (19)	0.004	24 (9)	0.023
Meals on wheels	14 (15)	6 (11)	5 (16)	0.76	23 (8)	0.056
Any service	21 (22)	23 (42)	11 (34)	0.034	44 (16)	<0.001

Home help; personal care in the ADL- and IADL- functions, Home nursing; medical care provided by a nurse, Meals-on-wheels; complete meal delivered to home, Any service; any one of these 3 services being utilized

[a] Chi-Square or Fisher-Freeman-Halton test.

Figure 2 shows the annual costs of the use of services in different groups. Eighty-four percent of subjects in the adequate sensory functions group did not use any services and thus caused no costs at all. Seventy-eight percent in the functional hearing impairment group, 58% in the functional visual impairment group and 66% in the combined sensory impairment group did not use any services and thus caused no costs.

On average, 10% of subjects in the functional visual impairment and combined sensory impairment groups required so much care that their annual service costs were at least 10 000 € (Figure 2).

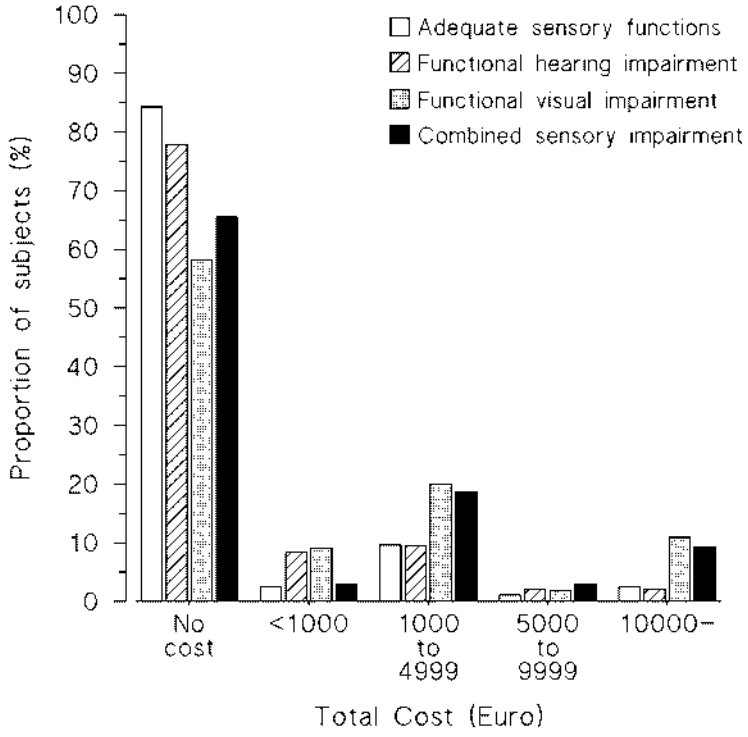


Figure 2. Annual costs of the use of home care services in the different sensory impairment groups.

The mean of the annual costs was 800 € (0 - 20 100 €) in the functional hearing impairment group, 2 800 € (0 - 21 000 €) in the functional visual impairment group, 3 400 € (0 - 38 000 €) in the combined sensory impairment group and 890 € (0 - 32 000 €) in the adequate sensory functions group. There were statistically significant differences in the median of the annual costs between the functional visual impairment and the adequate sensory functions group ($p< 0.001$; Mann-Whitney test) and between the combined sensory impairment and the adequate sensory functions group ($p= 0.03$; Mann-Whitney test).

In the sensitivity analysis, 30 % range in the annual costs was being used. Thus we estimated the annual costs in the FHI group to range from 540 € to1 040 €, in the FVI group from 1 960 € to 3 640 €, in the CSI group from 2 380 € to 4 420 €, and in the ASF group from 623 € to 1 157 €.

5.5 Lack of eye examination among visually impaired elderly persons (Substudy III)

One hundred and twenty-two (24% [95% CI: 20 to 27]) subjects in this study sample had functional visual impairment. Seventy- three (60%) of them had impairment both in near and distance vision, 35 (29%) only in near vision and 14 (11%) only in distance vision. An ophthalmologist had examined fifty- nine (48%) of these 122 persons during the follow-up period (at least two years), 33 (56%) of them had been examined in the local hospital and 26 (35%) in the private sector. The visual acuity of fifteen (25%) of these fifty-nine persons, who had been examined, improved to the level of 'no visual impairment' [visual acuity less than 0.3 (LogMAR + 0.5)] by provision of new spectacles and of thirteen (22%) persons by cataract surgery. An ophthalmologist had examined thirty- three subjects (45%), who had impairment both in near and distance vision, and eleven (33%) of them had experienced an improvement in their visual acuity. Nineteen subjects (54%), who had impairment only in near vision, had been examined by an ophthalmologist during the follow-up period, and eleven (58%) of them now enjoyed improved visual acuity. Furthermore, an ophthalmologist had examined seven subjects (50%), who had impairment only in distance vision and five (71%) of them had better visual acuity either via provision of new spectacles or by cataract surgery.

Fifty-nine persons of the 122 visually impaired subjects were in the group of "examined by an ophthalmologist during the follow-up" and thus 63 persons were classified into the group of "non-examined". There were statistically significant differences between the examined and the non-examined group in terms of the number of institutionalized individuals ($p<0.001$; Chi-Square test), median of the ADL-scale ($p<0.001$; Mann-Whitney test) and the MMSE-score equal or lower than 24 points ($p<0.001$; Mann- Whitney test). One third of the non-examined subjects were in institutional care and almost 80 percent had impaired cognitive functioning as measured by MMSE. The sex, age, hearing impairment or possible depressive mood did not explain the lack of examination of visual impairment. Table 9 shows that the significant univariate predictive effects (odds) for the lack of examination for visual impairment were institutional care, low ADL-score and MMSE ≤ 24. The stepwise logistic regression analysis showed that only the low ADL-score and the MMSE ≤ 24 were both strongly and independently associated with the lack of examination of visual impairment (Table 9).

Table 9. Predictive effect of factors for the lack of examination of visual impairment; results of univariate and forward stepwise logistic regression analysis.

Variable	Model	
	Univariate	Stepwise [a]
	OR (95% CI)	OR (95% CI)
Male sex	1.00 (0.43 to 2.29)	
Age, (years)	1.06 (0.99 to 1.13)	
Living in institution	6.87 (2.19 to 21.54)	
Barthel-index	0.96 (0.94 to 0.98)	0.96 (0.94 to 0.98)
Hearing impairment	0.78 (0.36 to 1.70)	
Mini Mental State Examination ≤ 24	4.44 (2.02 to 9.74)	2.88 (1.19 to 6.96)
Zung depression scale ≥ 40	1.67 (0.79 to 3.55)	

[a] Only entered variables showed.

5.6 Non-use of hearing aids (Substudy IV)

A HA had earlier been provided to 100 persons (16.6% [95% CI: 13.9 to 19.8]) in this study sample (N=601). Sixty- four (14.4%) of the 445 females and 36 (23.1%) of the 156 males had been provided with a HA. We obtained information about the use of HAs from 95 of those 100 subjects: one subject did not communicate at all due to moderate dementia, and four did not report themselves as being HA owners even though the provision of HAs was documented in their medical records.

As is seen in Table 10, one quarter of the subjects never used their HAs. A decline in cognitive or functional capacity and a low income were associated with the non-use of HAs. The post hoc test located statistically significant differences in incomes between the non-user and part-time user groups (p=0.005) and between the non-user and full-time user groups (p=0.001), the income being the lowest in the non-user group. There was also a statistically significant difference in the median of the MMSE-score between the non-users and the part-time users (p=0.017) and between the non-users and the full-time users (p=0.002), the MMSE-score being the lowest in the non-user group. The non-user group also differed statistically significantly from the part-time user group (p=0.019) and from the full-time user group (p=0.005) in the median of the ADL-score. Again the score was the lowest in the non-user group.

Table 10. Use of hearing aids in 95 subjects with provided a hearing aid.

Variables	Hearing aid use			p-value	
	Non-users (N=24)	Part-time users (N=19)	Full-time users (N=52)	Between groups	Post hoc Test
Demographics:					
Number of females (%)	13 (54)	12 (63)	36 (69)	0.44 [a]	-
Mean age (SD)	84 (5)	82 (5)	83 (5)	0.36 [b]	-
Median years of education (IQR)	6 (4, 6)	6 (5, 9)	6 (4, 10)	0.18 [c]	-
Median total income in euros (IQR)	3 908 (2 582, 6 935)	9 566 (7 754, 13 328)	7 702 (5 092, 13 966)	0.002 [c]	N/P, N/F
Number of institutionalized (%)	4 (17)	1 (5)	2 (4)	0.14 [a]	-
Clinical:					
Median MMSE (IQR)	23 (15, 26)	27 (19, 29)	27 (23, 29)	0.006 [c]	N/P, N/F
Median ADL (IQR)	90 (70, 95)	100 (90, 100)	95 (95, 100)	0.011 [c]	N/P, N/F
Median Zung depression scale (IQR)	43 (32, 47)	39 (33, 44)	40 (35, 46)	0.55 [c]	-

Hommel's adjusted post hoc tested only when the difference between the groups was significant. SD; Standard Deviation, IQR; Inter-Quartile-Range, MMSE; Mini-Mental-State-Examination, ADL; Activities of Daily Living, Barthel-index (range from 0 to 100). Maximum value indicates independent in all activities. N; Non-users, P; Part-time users, F; Full-time users.

[a] Chi-Square or Fisher-Freeman-Halton test.
[b] Analysis of variance (ANOVA).
[c] Kruskal-Wallis test.

There were 24 HA non-users in our study sample. Ten of them (42%) stated that they did not feel any need for a HA nor did they obtain any benefit from it. Five (21%) of the 24 non-users claimed that it was too difficult to use and four persons (17%) stated that their HA was broken. One subject said that the reason for non-use was the costs of the batteries, one that the HA was lost and one that the reason was external otitis. Two of the non-users could not give any reason at all for their HA non-use.

6. DISCUSSION

This study was a part of the general population-based Kuopio 75+ study. Since institutional care was not an exclusion criterion in that study, there were also many severely demented persons in the basic population sample. Most of them were excluded from this sensory study, because many measurements became unreliable, if the person could not co-operate or communicate in an adequate way. The exclusion criteria for each substudy are seen in Table 2. The most important criterion was the unreliable assessment of visual or hearing impairment due to communication or co-operation problems. Because of these exclusion criteria, the results are not relevant for elderly persons 75 years or older who have moderate to severe dementia except with respect to the results concerning the use of HAs. Since the prevalence of both dementia diseases and sensory impairments increases with age, the exclusion of subjects with severe dementia disease probably decreased the prevalence rates of sensory impairments among this study population.

Severely demented persons are challenging subjects when one wishes to screen their sensory functions. Many screening tests (whispered voice test, audiometry, Snellen cards with E-letters and reading charts) require concentration and co-operation from the studied subjects. That is the reason for exclusion of severely demented persons also in many earlier published studies. However, many demented persons have visual and hearing problems, which create problems in communication and social life as well as in overall functioning. Furthermore, adaptation to sensory disability and rehabilitation of these impairments are often complicated in demented persons. The fact that the amount of dementia diseases is increasing in the future, means that there is a clear need for further research in this area.

The Snellen cards with E-letters and the reading cards were used in this study when screening functional visual acuity. These screening methods for visual impairment are widely used in many health care centers in Finland. In most previous studies, the best-corrected visual acuity has been measured for each eye separately (Attebo et al. 1996, Rubin et al. 1997, Klaver et al. 1998). In many cases, an elderly person does not have the best-corrected spectacles. That is the reason to measure the vision with person's own spectacles in this study. We also decided to use binocular testing and did not use extra illumination, because we wanted to evaluate the visual capacity in normal living conditions. Both the near and distance visual acuity were tested, since they represent different kinds of ability in day-to-day functioning.

The problems in face-to-face conversation were selected as the first step screening method for hearing impairment as these problems represent a clear loss in auditory function (30-40 dB). In many cases this is the sign, which makes a person aware of suffering a loss in auditory function. The patient records were used to ascertain the observations of hearing difficulties. Patients' own awareness of a hearing problem and the hearing aid provision were the other two criteria used to

classify functional hearing impairment in this study. A documentation of a HA provision was verified from the patient records. Subjects were also asked if they had a HA (Appendix). Furthermore, it was documented if they were wearing a HA during the interview. Subjects were also asked, "What were the main problems with their health?" The subjective observation was verified if they said that it was a hearing problem. With this method we probably identified those persons who were in other way healthy. We were aware that there were probably many other persons in our study sample, who had some minor loss of auditory function, but our method sought only those with significant functional hearing impairment.

6.1 Prevalence and implications of functional sensory impairments

A 20% prevalence rate of visual impairment (functional visual impairment and combined sensory impairment) was reported, which is similar to the rates earlier reported in two large epidemiological studies in this age group (Klein R et al. 1991, Reidy et al. 1998), but it was higher than in many other studies (Attebo et al. 1996, Rubin et al. 1997, Klaver et al. 1998). That is due to the methods and the differences in definitions. The participants of this study used their own spectacles, which mean that we did not obtain the best-corrected visual acuity. A person was also classified as being visually impaired, if she or he had poor visual acuity for near vision. In many other studies, only the visual acuity for distance has been used (Rubin et al 1997, Klaver et al 1998).

Due to the testing methods, the prevalence of hearing impairment (functional hearing impairment and combined sensory impairment) was much lower than values earlier reported, 27% versus 42-50% (Davis 1989, Gates et al. 1990, Cruickshanks et al. 1998, Rees et al. 1999, Cambell et al. 1999, Smeeth et al. 2002). In many previous studies, the auditory function has been measured by using the pure- tone audiometry (Cruickshanks et al. 1998, Reuben et al. 1999) but standardized questionnaires have been used as well (Nondahl et al. 1998). We used both a subjective and an objective evaluation of hearing acuity and in this way hoped to identify these elderly individuals, who had significant functional problems in daily living because of poor hearing.

There was a 7% prevalence rate for combined sensory impairment with that being found especially in persons aged 85 years and over. Only a few community-based studies have evaluated the prevalence of combined sensory impairment (Carabellese et al.1993, Reuben et al.1999, Bergman et al.2001, Crews et al. 2004). Crews et al. (2004) reported an 8.6% prevalence rate of combined sensory impairment among adult ≥70 years, Reuben et al. (1999) found a 4.6% prevalence rate in the study population aged 55 to 74 years, and Carabellese et al. (1993) assessed a 1.6% prevalence rate in their study population aged 70-75 years. Bergman et al. (2001) reported

at least mild combined sensory impairment in 0.5 % of individuals aged 70, 22 % at age 81–82 and 23 % at age 88 years. Also here was detected a clear increase in the prevalence rate of combined sensory impairment with age.

A statistically significant difference was reported between sensory impairments and adequate sensory function groups with respect to the prevalence of cardiovascular diseases, not in the prevalence of other diagnosed diseases (stroke or TIA, diabetes, respiratory or psychiatric disorders). Also Crews et al. (2004) reported an association between hearing or visual impairment and heart diseases. Furthermore, we reported that the number of institutionalized persons was significantly higher in the functional impairment group compared to the adequate sensory functions group. This result was similar to the results of Osterweil et al. (1995) and Wang et al. (2003), who have earlier reported that there was an association between visual or hearing impairment and subsequent risk for nursing home placement.

An association between functional visual impairment and the decline of ADLs (even after adjustment for sex and age) was also reported. West et al. (1997) reported in the SEE - project that visual impairment was significantly related to a decline of functional status. Rudberg et al. (1999) reported in their study, that persons with visual impairment were 1.37 [95% CI: 1.20-1.57] times more likely to show more disability in ADLs than those without visual impairment. However, hearing impairment was not independently related to increased ADL disability in their study. These results concerning ADLs were similar to the previous reports. It is worth noting that the medians of both the ADL-score and the IADL-score in the different study groups were quite high. The reason for this is that many institutionalized, severely demented persons were excluded from this study due to the difficulties encountered in testing these individuals. On the other hand, it may be suspected that these methods are too crude to detect minor changes in functional status.

We found also that elderly persons who had combined sensory impairment experienced a decrease in both the ADL- and the IADL-score. This relationship could still be detected even after adjustment for sex and age. Both Keller et al. (1999) and Reuben et al. (1999) have reported in their studies an association between combined sensory impairment and functional decline. Parminder et al. (2004) reported that individuals with both seeing and hearing disabilities exhibited the greatest IADL restrictions followed by persons with only seeing or hearing disabilities. Also Crews et al. (2004) reported an association between dual sensory impairment and limitations in functioning.

These results concerning combined sensory impairment and ADL and IADL- functions are important. Combined sensory impairment is concentrated especially in persons aged 85 years and over. During this century, the number of very old people (over 85-years) will increase appreciably in the developed countries. Consequently one can predict that there will be more elderly persons

with combined sensory impairment and related ADL - and IADL- dependency who will need extensive assistance and services in the future.

The association between sensory impairment and depression was also studied. The Zung Depression Status Inventory was used as a screening method for depressive symptoms, because it has been used in this age group earlier in many studies also in Finland (Kitchell et al. 1982, Kivelä et al. 1996, Kiljunen et al. 1997), and the cut off points (40 and 48) were previously defined (Zung 1967, Okimoto et al. 1982). Our results concerning single sensory impairment and depression are similar to those earlier reported (Herbst et al. 1980, Mulrow et al. 1990, Carabellese et al. 1993, Ip et al. 2000, Tsuruoka et al. 2001). The occurrence rate of the DSI score equal to or over 40 points was 70% in the combined sensory impairment group. The fact that depressive symptoms are common in elderly persons with combined sensory impairment was demonstrated for the first time in this study, at least to our knowledge. However, this result is not unexpected because a decrease of functional status and isolation are associated with both hearing and visual problems. These results are clinically important because depression in the elderly may have severe consequences including high rates of suicide (Nnadi-Okola et al. 1995, Turvey et al. 2002), impaired recovery from medical illnesses and inappropriate placement in residential care facilities (Wells et al. 1989, Fawcett et al. 1993).

Furthermore, we showed that functional visual impairment and combined sensory impairment had a statistically significant association with the use of home nursing and home help. Wang et al. (1999a,b) and Stoddart et al. (2002) have earlier reported that problems with eyesight were determinants for service use in women, but functional hearing impairment did not increase the use of services despite expectations to the contrary. Also Creen et al. (2001) had reported that hearing impairment did not lead to the extra use of services. Functional visual and combined sensory impairments were associated with a decline of the functional ability of the aged, and this decline for its part triggered the need for home care services. The use of these services increased the annual costs among these impairment groups by three-fold higher compared to the adequate sensory functions group. The associations between sensory impairment and costs of service use have not been earlier reported.

The association between visual and combined sensory impairments and the decline of functional ability offers a possibility to influence this service use and therefore the costs. Attempts should be made to slow this decline of functional capacity by improving diagnostic, treatment and rehabilitation of the diseases behind these impairments. Sufficient resources for the treatment and rehabilitation should also be guaranteed, because untreated sensory impairments will result in increased costs by increasing the use of services. Since elderly persons with sensory impairment require more home care services, there should be an effort made to train local home care personnel to detect persons with sensory impairment. Home care personnel need also guidance on

how to handle technical aids and other rehabilitation interventions (Watson 2001, Heine et al. 2002).

6.2 Lack of eye examination among the aged

We found that 24% of individuals aged 75 years and over in substudy III group had functional visual impairment. An ophthalmologist had examined forty-eight percent of them during the follow-up time with 47% of these individuals achieving better visual acuity either by cataract operation or by provision of new spectacles. Deteriorations in cognitive function and impairment in ADLs were the strongest factors associated with the lack of eye examination for visual impairment.

Thirty-three percent of these subjects who had impairment both in near and distance vision, and who have been examined by an ophthalmologist during the follow-up time, now exhibited better visual acuity after being supplied wit new corrected spectacles or by undergoing cataract operation. The equivalent proportion was 58% among subjects who had impairment only in near vision and 71% among subjects who had impairment only in distance vision. The major proportional improvement observed in these last two groups probably means that these individuals had been wearing "improper spectacles" at the initial research assessment.

The patient documents in the local hospital and in local offices of ophthalmologists in Kuopio were checked. It was determined whether the visually impaired study subjects had been examined in these offices. These subjects were often in institutional care or had cognitive decline, so it is unlikely that they would have sought ophthalmologist services outside the City of Kuopio. The number of subjects, who achieved better visual acuity by new corrected spectacles of by operation, is similar to the values reported earlier (Attebo et al. 1996, Munoz et al. 2000, West et al. 2003). Munoz et al. (2000) reported that one third of those with visual acuity worse than 0.5 (LogMAR + 0.3) improved to 0.5 or better with adequate refractive correction. Also West et al. (2003) reported that the prevalence of visual impairment decreased after refractive correction among nursing home residents (from 38% to 29%). It has also been reported that the cataract operation is effective (Klaver et al. 1998). The efficacy of cataract surgery depends on factors such as the population under study and the availability of the operation. Buch et al. (2004) reported in the Copenhagen City Eye Study that among those aged 65 to 84 years, cataract surgery could reduce visual impairment by one third.

In the present study, half of the visually impaired elderly patients did not seek out an ophthalmologist even though their visual acuity was worse than 0.3 (LogMAR + 0.5). Many of these persons were living in institutional care. One way to promote examination of visual problems would be to emphasize to the personnel working in these institutions the importance of

early diagnoses of visual problems and the possibility to help the visually impaired elderly. The cognitive or functional decline showed an association with the lack of eye examination in this age group. For these reasons the visually impaired elderly person probably need help from their relatives or from home care personnel to arrange these examinations (time reservation, being transported to an ophthalmologist etc). Often they are also adapted to their visual impairment and for that reason they need special motivation to attend these examinations.

In the Rotterdam study, Klaver et al. (1998) evaluated the general characteristics of subjects who did not participate in their ophthalmologic examination, which was part of their study protocol. They found that older age (study subjects were older than 55 years), female sex, institutional care, visual and other health problems and lower score of MMSE were explanations for nonparticipation. Our results are parallel to that except that gender did not seem to be a contributing factor in this study.

6.3 Non-use of hearing aids

Seventeen percent of this study population had earlier been provided with a HA, and 25% of those never used it. The decline in cognitive or functional capacity and low income associated with the non-use of HAs. The most common subjective reasons for the non-use of HAs were the difficulty to use it or its ineffectiveness.

Hearing impairment among the aged is a chronic condition that shows a negative correlation with communication, social integration, well-being, and cognition (Weinstein et al. 1982, Uhlman et al. 1989, Jerger et al. 1995, Carabellese et al. 1993). Since the most common reason for hearing impairment in this age group in the Western Countries is presbyacusis, a condition for which there is no curative treatment, there is a need for management strategies. These should include - when appropriate - also a fitting of HAs (Davis et al. 1987). The use of HAs among subjects with hearing impairment improves their quality of life and is helpful in communication (Mulrow et al. 1990, Appollinio et al. 1996, Tesch-Römer 1997).

The prevalence of fitting of HAs in various age groups increases as a function of age. It is estimated, that at least 30% of those aged over 65 years have such severe hearing impairment, that they would benefit from a fitting of hearing aid (Rudin et al. 1988, Davis 1989). In Germany, 9% of those between 70 and 75 years (Plath 1990) and in Sweden 12% of those aged 70 years and over have been fitted with HAs (Karlsson et al. 1998). Davis (1989, 1995) reported 18-20% prevalence rate of provision of HA in the aged 75+ in Great Britain that is similar to our finding (17%). Johansson et al. (2003) reported in their study sample (aged from 20 to 80 years) that while 7.7% of subjects were estimated to benefit from a hearing aid, the actual prevalence of hearing aid users was only 2.4%. Gussekloo et al. (2003) reported in their population based study

that 66% of participants with severe hearing problems did not actually use a HA. Three out of four declined to participate in the auditory rehabilitation programme. The most common reason was the feeling that they could cope with their disabilities and considered a HA to be unnecessary. Hietanen et al. (2004) reported previously that in Finland over 75% of those (people aged over 80 years) who had moderate hearing impairment did not use HAs.

Many earlier published studies have reported from 20% up to 57% non-usage of HAs (Ward 1993, Popelka et al. 1998, Gianapoulus et al. 2002,a). Our rate of HA non-use is similar to a value earlier reported (25% non-use rate). Already in 1984 Sorri et al. reported a 23% non-use rate for HAs in Finland. They commented that efforts should be directed to make more effective the use of limited resources available for rehabilitation. The provision of HAs which are subsequently unused represents a huge waste of health resources, and Ward (1993) has claimed that there is evidence that those who did not use an aid had increased use of community support services.

Financial costs, low quality of sound amplification, lack of support from health care providers, stigmatization and handling problems are mentioned as being the main problems in the use of HAs among the aged (Upfold et al. 1990, Kochklin et al. 1993, Gartestecki et al. 1998). Wu et al. (2004) reported that the willingness to use HA was correlated to patients' functional status, but not to the severity of hearing impairment. Gianopoulos et al. (2002b) reported that the patients' preference for the bilateral fitting of hearing aids was a better predictor of long-term use than the actual degree of hearing impairment. One reason for that result could be the more conscientious fitting of bilateral HAs. Unfortunately, in Finland individuals in this older age group are usually fitted with only one HA. In this study, the decline in functional or cognitive capacity and low income was explanatory factors for the non-use of HAs. This result is clinically important, since both the dementia diseases and hearing impairment are age-associated. In the future, there will be many demented persons who at the same time have hearing impairment. They need not only HA provision but also special attention in counseling to guarantee the effective use of their HAs.

There are some special challenges concerning the HA provision and use in Finland. The HA itself is free provided of charge but in most municipalities patients have to purchase the batteries themselves. Some patients complain that these costs are excessive. Thus patients with hearing impairment may be given an expensive HA, but it is left unused in a drawer due to the battery costs. The other problem is the long queuing time for HA provision. Sometimes elderly patients have to wait as long as 12 to 18 months before they actually obtain the HA (Sorri et al.2001b). Furthermore, awareness of this long waiting time may be one reason why some elderly persons do not seek out help for their hearing problems.

It has been reported earlier that hearing impairment is more common in men than women. One important finding in this study was that even though the prevalence rate of persons provided a HA was higher in men (23%) than women (14%), in the population which has been provided a HA

there were actually more women (N=64) than men (N=36). This is due the over representation of women in this age group. Mededith et al. (1993) reported that among women with hearing difficulties, HA non-use was not associated with age, cognitive status or subjective health, but in subjects over the age of 75-years the major reason was the handling problems. In this study, the difficulties encountered in using the HA was one subjective reason for the non-use of HA. Five persons (21%) from these 24 non-users stated that it was too difficult to use these devices and four of them were females. It must be realized that in the future many HA users in this age group will be women and this should be taken into consideration when developing these technical devices. Usually women are not as comfortable as men with handling technological equipments.

When the decision to prescribe a HA has been made, the patient needs counseling and motivation to use the device. Adapting to the hearing aid is not easy, and a patient must be assured that the ability to use hearing aid-processed sound will improves over time. In many cases, elderly persons will also need support from other people (relatives, local heath care personnel) in handling their HAs. It is not sufficient that the patients themselves are given advice on how to handle their HA, more attention should be paid to training their relatives and home care personnel about the problems related to the use of these aids.

7. CONCLUSIONS

1. Forty percent of the elderly aged 75 years or older has some kind of functional sensory impairment. Combined sensory impairment is common, especially in the age group of over 85-year-olds. Combined sensory impairment and functional visual impairment is associated with a decrease of functional capacity in the aged.

2. Combined sensory impairment is connected to the risk to suffer depressive symptoms.

3. One in every four or five of the subjects in this age group suffers functional visual impairment: many of these could be helped by cataract operation or by provision of new spectacles. Dementia disease or decreased functional capacity increases the risk to receive inadequate treatment for visual impairment.

4. The non-use of hearing aids is still a serious problem. Decline in cognitive or functional capacity and low income are explanatory factors for the non-use of hearing aids.

5. Visual impairment and combined sensory impairment are associated with the use of services, and therefore extra costs. The annual costs of this service use can be greatly elevated (3400 € compared to 800 € among subjects with adequate sensory functions) if an elderly person has visual or combined sensory impairment.

8. CLINICAL RECOMMENDATIONS

In the future, sensory problems can be expected to become even more prevalent and more attention should be paid to the early diagnosis of specific diseases behind these problems. Screening of hearing and visual loss is practical, because there are many possibilities to offer effective treatment and rehabilitation for these problems. What are needed are some straightforward and rapid screening methods for the use in primary health care centers and seamless co-operation between family physician, geriatricians and specialists in ophthalmology and audiology. More attention should also be paid to educating local health care personnel to detect persons with sensory impairment and to refer them for assessment for fitting technical aids and/or other rehabilitation interventions. The high number of sensory impaired elderly people should also be taken into consideration in environmental planning.

Sufficient resources for the treatment and rehabilitation should be guaranteed; untreated sensory impairments result in costs by increasing the use of services. The waiting time to cataract operation or to HA provision should be shortened to guarantee the timely treatment and rehabilitation of these impairments. The efficiency and cost impact of early diagnostic and treatment of these diseases as well as more active rehabilitation should be stressed.

Furthermore, we should be aware that elderly persons who need assistance in ADLs or who have dementia might suffer a hidden visual impairment. Many of these persons live in institutional care. The personnel of these institutions should be educated to understand the importance of early diagnoses of visual problems and the possibility to help the visually impaired elderly. We need also timely HAs provision, patient motivation, counseling and follow up as well as training of local health care personnel. A new generation of easy-to-use and convenient HAs for use by the elderly is urgently needed. We should also remember that an elderly person, who needs a HA to hear properly, and who then experiences cognitive or functional decline is at risk to become a non-user of the HA. These persons need special attention in the HA fitting procedure.

Furthermore, more geriatric research is required in this area. Even though the prevalence rates of sensory impairment are quite high and the consequences of these impairments are serious, very little geriatrics research has been done on these topics. One probable reason is that visual and hearing problems are traditionally examined by specialist in ophthalmology or audiology, who tends to concentrate on the diagnostic procedures and treatment. However, the main interest from the geriatric point may well be how these impairments influence an elderly individual's activity of daily livings, quality of life and service use. In the future, research protocols should entail joint efforts by specialists in audiology and ophthalmology as well as gerontology to guarantee a holistic approach solving these problems.

9. SUMMARY IN FINNISH – SUOMENKIELINEN YHTEENVETO

Seniorikansalaisten määrän kasvaminen seuraavina vuosikymmeninä muodostaa merkittävän haasteen terveys- ja sosiaalipalveluiden tuottajille. Tarvitaan yhä tarkempaa tietoa ikääntyneiden sairastavuudesta sekä fyysiseen että psyykkiseen toimintakykyyn ja myös palveluiden tarpeeseen vaikuttavista tekijöistä.

Ikääntyessä näkökyky heikkenee. Osittain kyseessä on normaali ikääntymiseen liittyvä ilmiö; merkittävä näön heikkeneminen liittyy kuitenkin aina johonkin silmän sairauteen. Länsimaissa ikääntyneillä yleisimmät heikkonäköisyyttä aiheuttavat sairaudet ovat silmänpohjarappeuma, silmänpainetauti ja harmaakaihi. Viimeaikaisissa ulkomaisissa tutkimuksissa on yllättäen todettu, että seniorikansalaisilla yleisin heikkonäköisyyden syy on kuitenkin hoitamaton taittovirhe (eli sopimattomat silmälasit), ja että jopa 70 % näkövammaisuudesta olisi potentiaalisesti hoidettavissa joko kaihileikkauksella tai lasien uusinnalla. Myös kuulo heikkenee iän myötä. Suurin osa huonokuuloisuudesta johtuu sisäkorvan ikärappeumasta. Ikäkuulon aiheuttamaa haittaa pyritään kompensoimaan kuulokojeen avulla. Ongelmana on kuulokojeiden vähäinen käyttö.

Näkö- ja kuulo-ongelmat ovat erittäin yleisiä ikääntyneillä. Eräiden tutkimusten mukaan jopa 22 prosentilla yli 75-vuotiaista on näköongelmia ja peräti 50 prosentilla kuulo-ongelmia. Usein nämä ongelmat on riittämättömästi tutkittu ja hoidettu. Ikääntyneiden näkö- ja kuulo-ongelmat altistavat laitoshoitoon joutumiselle sekä aiheuttavat toimintakyvyn laskua ja lisäävät depression riskiä. Kun sekä näkökykyä heikentävien sairauksien että ikähuonokuuloisuuden esiintyvyys lisääntyy iän myötä, yhä useammalla ikääntyneellä on samanaikaisesti sekä huono kuulo että huono näkö. Tästä yhteisvammasta on julkaistu aikaisemmin vain muutama kansainvälinen tutkimusartikkeli. Tämän tutkimuksen tarkoituksena oli selvittää näkö- ja kuulohaitan, erityisesti yhdistetyn kuulo-näköhaitan, esiintyvyyttä yli 75-vuotiailla suomalaisilla, sekä näiden aistihaittojen vaikutusta ikääntyneiden toimintakykyyn ja palvelutarpeeseen. Tutkimuksessa etsittiin myös tekijöitä, jotka selittävät näköhaitan hoitamattomuutta tässä ikäluokassa. Lisäksi tutkimus selvitti kuulokojeiden käyttöä ja syitä käyttämättömyyteen.

Tutkimus oli osa Kuopio 75+ vanhustutkimusta, jossa selvitettiin väestörekisteristä satunnaisesti valitun 601 kuopiolaisen terveydentilaa, toimintakykyä, palveluiden käyttöä sekä sosiaalisia taustatekijöitä. Tutkituilta testattiin sekä kaukonäkö (E-Taulu) että lähinäkö (Lukutaulu) omilla silmälaseilla korjattuna. Jos näkökyky oli heikompi kuin 0.3, katsottiin tutkittavalla olevan ns. toiminnallinen näköhaitta. Alkuperäinen tutkimus tehtiin vuonna 1998. Vuoden 2002 alussa selvitettiin Kuopion yliopistollisen sairaalan sekä yksityisten silmälääkäriasemien potilasarkistoista, olivatko kyseiset "tutkitut, joilla oli toiminnallinen näkö-

haitta" olleet hoidettavina näissä. Erityisesti kiinnitettiin huomioita siihen, oliko heille tehty kaihileikkausta tai oliko näkökykyä parannettu lasikorjauksella.

Toiminnallinen kuulohaitta tutkitulla todettiin, jos tutkimushoitaja havaitsi hänellä olevan selviä ongelmia kuulemisessa testaustilanteissa, tutkittu itse ilmoitti keskeisimmäksi terveysongelmakseen kuulohaitan tai hänelle oli aiemmin määrätty kuulokoje. Kuulokojeen käyttö/käyttämättömyys kirjattiin sekä kysyttiin syitä käyttämättömyyteen. Varsinaisen kuulo- tai näkövamma diagnoosin tekemiseksi olisi tarvittu silmä- ja korvalääkärin tutkimusta, joten raportissa päädyttiin käyttämään toiminnallisen haitan termiä. Toiminnallinen kuulo-näköhaitta tutkitulla todettiin, jos hänellä oli molemmat yllämainitut aistihaitat.

Peräti 40 %:la tutkituista todettiin toiminnallinen aistihaitta: 7 %:la yhdistetty kuulo-näköhaitta, 13 %:la toiminnallinen näköhaitta ja 20 %:la toiminnallinen kuulohaitta. Yhdistettyä kuulo-näköhaittaa todettiin erityisesti yli 85-vuotiailla. Yhdistettyyn kuulo-näköhaittaan liittyi ongelmia sekä henkilökohtaisissa päivittäisissä toiminnoissa (mm. pukeutuminen, peseytyminen, ateriointi) että ns. välineellisissä toiminnoissa (mm. ruuan valmistus, kaupassa käynti, siivoaminen), toiminnalliseen näköhaittaan vain välineellisissä toiminnoissa. Lisääntynyt avun tarve näkyi lisääntyneenä palveluiden käyttönä, sekä tämän myötä palveluita tuottavalle kunnalle muodostuvina lisääntyneinä kustannuksina. Palveluiden käytöstä muodostuvat kustannukset olivat jopa kolmenkertaiset tutkituilla, joilla todettiin kuulo-näköhaitta tai näköhaitta verrattuna tutkittuihin, joilla ei ollut aistiongelmia. Tutkituilla, joilla oli toiminnallinen aistihaitta, oli tilastollisesti merkitsevästi useammin depressioon viittaavia oireita ($p=0.03$) kuin tutkituilla, joilla ei ollut aistiongelmia.

Vain noin puolet tutkittavista, joilla oli todettu toiminnallinen näköhaitta, oli ollut silmälääkärin hoidossa seuranta-aikana. Näistä noin puolelle oli saatu merkittävä näkökyvyn korjaus joko kaihileikkauksella tai uusimalla silmälasit. "Ei-tutkittujen" ryhmässä esiintyi tilastollisesti merkitsevästi enemmän dementiaa ($p<0.001$) ja toimintakyvyn laskua ($p<0.001$) verrattuna "tutkittuihin". Lisäksi jopa kolmannes heistä asui laitoksessa. Kuulokoje oli määrätty 17 % tutkittavista, heistä noin 25 % ei käyttänyt sitä lainkaan ja vain noin puolet käytti sitä säännöllisesti. "Ei-käyttäjillä" oli tilastollisesti merkitsevästi matalampi tulotaso ($p=0.002$), ja heikentynyt kognitiivinen ($p=0.006$) tai fyysinen toimintakyky ($p=0.011$) verrattuna "käyttäjiin".

Yhteenvetona voidaan todeta, että aistiongelmat ovat yleisiä yli 75-vuotiailla, ja yhdistetty kuulo-näköhaitta on oletettua yleisempää. Ikääntyneillä tutkituilla, joilla oli näkö- ja/tai kuulohaitta oli "ei-aistiongelmaisia" enemmän toimintakyvyn laskua, depressioon viittaavia oireita sekä palveluiden käyttöä ja sen seurauksena kustannuksia. Ikääntyneiden näkö- ja kuulo-ongelmien tutkimisessa, hoidossa ja kuntoutuksessa on edelleen toivomisen varaa. Erityisesti dementoituneet ja fyysisesti huonokuntoiset ikääntyneet ovat riskissä jäädä ilman asianmukaista hoitoa. Vanhusten määrä lisääntyy merkittävästi seuraavina vuosikymmeninä. Täten myös aistivammaisten vanhusten määrä tulee kasvamaan. Kuntien tiukentuneen taloustilanteen myötä

on lääketieteen eri aloilla jouduttu toteuttamaan säästöjä, jotka ovat osaltaan johtaneet esim. kaihileikkausjonojen kasvuun, kuulokojeen saannin jonotusajan pidentymiseen sekä kuntoutusmäärärahojen karsimiseen näkö- ja kuuloapuvälineiden osalta. On tärkeää laajemminkin keskustella näiden säästötoimenpiteiden mahdollisesti aiheuttamista inhimillisistä kärsimyksistä (mielialaongelmat) ja suoranaisista lisäkustannuksista - palvelutarpeen lisääntymisen muodossa - ikääntyneiden aistiongelmaisten ryhmässä.

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11. APPENDIX

3.Onko Teillä kuulokoje?
0 ei
1 kyllä
99 ei tietoa

4.Kuinka säännöllisesti käytätte kuulokojetta?
1 ei koskaan tai erittäin harvoin
2 joskus
3 usein
4 enimmäkseen tai aina
99 ei tietoa
Jos 1 – 3, miksi ei
käytä?_____

5.Onko Teillä muita kuuloon liittyviä apuvälineitä?
0 ei
1 kyllä,
mitä?_____
99 ei tietoa

6.Käytättekö silmälaseja?
0 ei
1 vain lukiessa
2 vain muulloin kuin lukiessa
3 jatkuvasti
4 muu,
mitä?_____
99 ei tietoa

7.Jos Teillä on silmälasit, ovatko silmälasinne
1 lukulasit
2 kaukolasit
3 kaksiteholasit
4 piilolasit

8. Milloin kävitte viimeksi näön/lasien tarkastuksessa?
99 ei tietoa
_____

9. Onko Teillä muita näönhuoltoon liittyviä apuvälineitä kuin silmälasit?
1 ei
2 kyllä,
mitä?_____
99 ei tietoa

KAUKONÄKÖ

Kaukonäkö tutkittiin 0 ei
1 kyllä

Jos ei, niin
miksi?_____

99 ei tietoa

Kaukolasit 0 ei
1 kyllä
99 ei tietoa

Onko mukana 0 ei
1 kyllä
99 ei tietoa

nääntarkkuus : |__|, |__|__|

Testitulokseen vaikutti:

LÄHINÄKÖ

Lähinäkö tutkittiin 0 ei
1 kyllä

Jos ei, niin miksi?

---

99 ei tietoa

Lukulasit: 0 ei
1 kyllä
99 ei tietoa

Onko mukana
0 ei
1 kyllä
99 ei tietoa

nääntarkkuus: |__|, |__|__|

KUULO: (Tutkimushoitajan arvio)

1 Kuulee tavallisen puheen vaikeuksitta tai pienin vaikeuksin
2 Kuulee puheen vaikeuksitta tai pienin vaikeuksin, kun ääntä korotetaan
3 Keskustelussa huomattavia vaikeuksia
4 Järkevä keskustelu mahdotonta

Käyttikö kuulokojetta tutkimuksen ajan?
0 ei
1 kyllä

ORIGINAL ARTICLES

ARTICLE I

Blackwell Synergy

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Combined functional visual and hearing impairment in a population aged 75 and older in Finland and its influence on activities of daily living

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To the Editor: Various studies have described a significant increase in the prevalence of impaired vision and hearing with age (1-4). Diminished vision has been associated with disability in activities of daily living (ADLs) (5-6) and in instrumental ADLs (IADLs) (6-9), and an association between hearing impairment and dependency in IADL functions has been found in at least two studies (7,9). Despite our knowledge about single sensory impairment, little is known about the double sensory impairment and its association with functional dependency. Keller et al. (7) noted that subjects seen in outpatient geriatric clinic with dual sensory impairment had mean IADL and ADL scores significantly lower than those with no impairment, and dual impairment had a greater effect on function than single sensory impairment (7).

In this population-based study, we wanted to determine the age-adjusted effect of functional visual and hearing impairment, especially double sensory impairment, to ADL.

METHODS

This study was part of the population-based Kuopio 75+ study in Finland. Of the 700 persons (aged ≥75) eligible, 601 (85.9%) participated in the standardized interview and geriatric assessment between January 1998 and January 1999. Fifteen (2.1%) died before being seen, 79 (11.3%) refused to participate, and five (0.7%) could not be contacted at all. Because of their inability for adequate cooperation in the investigative procedures, 113 demented persons were excluded from the sensory study. Thus the sensory study group included 488 persons.

The ADL functions were evaluated using the Barthel Index and the IADL functions using the IADL scale of Lawton and Brody. The total score of the Barthel Index ranges from 0 to 100 points (help needed in all activities to independent in all activities), and the IADL scale ranges from 0 to 8 points, with 8 points meaning that no help is need. Functional hearing impairment was registered if the interviewed person had a clear difficulty in conversation due to poor hearing acuity observed by the nurse, the person expressed that his or her main health problem was difficulty in hearing, or the person had earlier been ordered a hearing aid.

The visual examination consisted of an assessment of binocular visual acuity for distance (Snellen charts with E-letters) and near (the reading charts) corrected with the patient's spectacles. Functional visual impairment was registered if visual acuity was less than 20/60 by Snellen equivalent (logMAR + 0.5, the logarithm of the minimum angle of resolution). Based on the screening of hearing and vision, the subjects were divided into four groups: (1) with adequate sensory functions (ASF), (2) with functional hearing impairment (FHI), (3) with functional visual impairment (FVI), or (4) with combined functional sensory impairment (CSI).

The descriptive values of the Barthel Index and the IADL scale were expressed using the median and interquartile range; statistical comparison between groups was made using the Mann-Whitney test or the Kruskal-Wallis test. Median regression models determined the age-adjusted effect of the functional sensory impairment to the Barthel Index and the IADL scale.

RESULTS

Ninety-nine (20%) subjects of the sensory study population had FHI, 62 (13%) FVI, and 36 (7%) CSI. There was a statistically significant difference in the mean age between the different impairment groups ($P< .001$) and between the functional impairment (FHI, FVI, and CSI) and ASF groups ($P< .001$). The mean age ± standard deviation was 86.7 ± 5.0 in the CSI group, 81.5 ± 4.8 in the FVI group, 81.7 ± 4.1 in the FHI group, and 79.3 ± 3.4 in the ASF group. Table 1. shows the statistically significant difference between the ASF and functional impairment groups and between the functional impairment groups in the unadjusted Barthel Index and IADL scale but only between different functional impairment groups in the age-adjusted Barthel Index.

CONCLUSIONS

We determined that 7% of our study population had CSI. It was found especially in persons aged 85 and older. CSI had an independent effect on the Barthel index even after adjustment for age.
It is important to be aware of sensory problems and pay more attention to early diagnosis of specific diseases causing these problems. We must also pay more attention to educating local healthcare personnel to detect persons with sensory impairment and to refer them for consideration of technical aids and other rehabilitation maneuvers (10). The high number of older people with sensory impairments should also be taken into consideration in environmental planning. It remains to be determined whether early observation and treatment of sensory impairments could prevent long-term functional decline.

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Table 1. ADL and IADL Scale According to Functional Impairment and Adequate Sensory Function Groups

Measurement	Functional Impairment			*P*-value Between Impairment Groups		Adequate Sensory Function	*P*-value Between Impairment and Adequate Sensory Groups	
	Hearing	Visual	Combined					
	Median (IQR)			Un adjusted	Age adjusted	Median (IQR)	Un adjusted	Age adjusted
ADL*	100 (95-100)	95 (75-100)	95 (75-100)	.001	.001	100 (95-100)	<.001	.15
IADL†	7 (5-8)	7 (5-8)	5 (4-7)	.007	.12	8 (6-8)	<.001	.42

*Range 0-100; Barthel index. Maximum value indicates independent in all activities.

†Range 0-8; Lawton and Brody scale. Maximum value indicates independent in all activities.

IQR = interquartile range; ADL = activities of daily living; IADL = instrumental activities of daily living.

ARTICLE II

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Combined hearing and visual impairment and depression in a population aged 75 years and older

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SUMMARY

Background Depression is associated with both visual and hearing impairment. Little is known about the relationship between combined hearing and visual impairment and mood in this age group. The aim of this population-based study was to investigate the association between functional sensory impairment, especially combined sensory impairment and depressive symptoms and depression diagnosed according to the DSM-IV criteria.

Method The study group consisted of 470 adults, population-based sample, aged 75 years or older. We used the Snellen eye charts with E-letters and reading charts to evaluate the functional visual acuity. The ability to conduct a face-to-face conversation, the hearing aid use and the self-reported hearing problems were used to assess the functional hearing acuity. Depression was identified with two different methods. A geriatrician interviewed the subjects and the DSM-IV checklist was used to determine whether they met the criteria for major depression. The Zung Depression Status Inventory (DSI) was used to identify depressive symptoms. The cut off points of 40/80 and 48/80 in the DSI-score was used.

Results Seventy-two persons (15%) of the study population had depression diagnosed according to the DSM-IV criteria. Twelve per cent of subjects in the Functional Hearing Impairment (FHI) group, twenty per cent in the Functional Visual Impairment (FVI) group, eighteen per cent in the Combined Sensory Impairment (CSI) group and fifteen per cent in the Adequate Sensory Function (ASF) group suffered major depression. The differences between these groups were insignificant. The occurrence rates of the DSI score equal or over 40 points was 50% in the FHI group, 53% in the FVI group, 70% in the CSI group and 45% in the ASF group. The difference between the ASF group and sensory impairment group including FHI, FVI and CSI groups was statistically significant ($p = 0.03$).

Conclusions Depressive symptoms, but not major depression, were common if elderly persons had combined sensory impairment. Copyright © 2002 John Wiley & Sons, Ltd.

KEY WORDS — depression; functional sensory impairment; combined sensory impairment; aged

INTRODUCTION

Depression is the most prevalent mental health problem in the elderly. Several studies indicate that at least 10% of persons age 65 and older suffer from significant depressive symptoms (Mulsant and Ganguli, 1999; Newman *et al.*, 1998). In many cases depression remains unrecognized and untreated. Physicians have been recommended to use standardized screening instruments to improve the diagnose of depression (Almeida *et al.*, 1999; Galaria *et al.*, 2000; Pomerey *et al.*, 2001).

Visual and hearing impairment are also among the most common conditions affecting older persons. Additionally, many investigations have noted a relationship between hearing impairment and depressive symptoms (Herbst and Humphrey, 1980; Carabellese *et al.*, 1993; Tsuruoka *et al.*, 2001), as well as between

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visual impairment and depression (Carabellese *et al.*, 1993; Rovner and Ganguli, 1998; Ip *et al.*, 2000). Depression and sensory impairment in the elderly may have severe consequences including excess disability (Lenze *et al.*, 2001; Wallhagen *et al.*, 2001) and the wish to die (Jorm *et al.*, 1995).

Since the prevalence of hearing and visual impairment increases with age some elderly persons have both visual and hearing impairment. This double sensory impairment leads to considerable sensory deprivation. Many studies have been published about single sensory impairment. Little is known about double sensory impairment, its prevalence or its association to functional dependency or mood in the aged. Keller *et al.* (1993) and Reuben *et al.*, 1999 documented in their studies an association between double sensory impairment and functional decline and Carabellese *et al.* (1993) reported also the association between double sensory impairment and mood.

In the present study we have examined the association between functional sensory impairment, especially combined sensory impairment and depression in our study population aged 75 or over. We used simple screening methods, which are available in primary care centers in Finland, to test the visual and hearing acuity.

METHODS

Depression study population

This study is part of the Kuopio 75– study, which is being carried out in collaboration between the University of Kuopio and the Social Welfare and Health Center of Kuopio. The purpose of that survey was to clarify the diseases, functional capacity and use of services for senior citizens in the city of Kuopio in eastern Finland. Kuopio has a population of 86 000 inhabitants, 5.3% of them being 75 years old and older. The Kuopio 75+ study population consisted of 700 persons aged more than 75 years (on 1 January 1998), which was 15.5% of the entire age group. They were randomly selected from the population register and representative of their respective age groups and gender. Of those 700 persons eligible, 601 (85.9%) participated in the standardized interview and geriatric assessment between January 1998 and January 1999. Fifteen (2.1%) died prior to being seen, 79 (11.3%) refused to participate and five (0.7%) could not be contacted at all.

Due to their inability for adequate cooperation in the investigative procedures 131 persons were excluded from the depression study. Thus the depression study group included 470 persons. The study was reviewed and approved by the Ethics Committee of the University of Kuopio and University Hospital of Kuopio and the participants and/or their nearest relative provided written informed consent for the study.

Measures

All participants were interviewed and examined by a geriatrician and a trained nurse. The standardized interview and examination lasted approximately four hours (two separate visits) and were carried out in a primary health care center, in an institution or at home (nursing home residents and house-bound participants). The interview elicited data regarding the participant's sociodemographic characteristic, medical and common health history, the level of ability in daily activities and the mood. The Physical Activities of Daily Living (PADL) was evaluated by the Barthel-index (Collin *et al.*, 1988; Wade and Collin, 1988) and the Instrumental Activities of Daily Living (IADL) by the IADL-scale of Lawton and Brody (1969).

The assessment of depression

A geriatrician interviewed the subjects and the DSM-IV checklist was used to determine whether they met the criteria for major depression. The Finnish translation of the Zung Depression Status Inventory (DSI) (Zung, 1972) was used to estimate depressive symptoms. DSI is a semistructured interviewer-rated inventory measuring various psychological and somatic symptoms of depressive illness (Zung, 1972). It consists of 20 items, many of them are also included in the DSM-IV criteria for major depressive disorders (American Psychiatric Association, 1994). Each of these items is rated on a scale of one to four. The higher the score was the more severe disturbance. The total DSI scores range from 20 to 80, such that a sum score from 40 to 47 is associated with minimal to mild depressive illness and scores equal to or greater than 48 strongly suggest clinical depression in older populations (Zung, 1972; Okimoto *et al.*, 1982).

Functional sensory impairments

The survey was not intended to assess the status of the absolute hearing acuity but the presence of the functional hearing acuity. Functional hearing impairment was registered, if the interviewed person had a clear difficulty in conversation due to poor hearing acuity, the person him/herself expressed that his/her main health problem was difficulty in hearing or the person had earlier been ordered a hearing aid.

The visual examination consisted of an assessment of binocular visual acuity for both distance and near, corrected with the patient's own spectacles. A Snellen chart with E-letters (Gabriels, 1969) was used in testing the visual acuity for distance. The visual acuity can be tested from 20/200 to 20/15 on the American scale, which means $\log_{10}$ minimum angle resolvable (logMAR) +1.0 to −0.1 according to the methods recommended by Ferris *et al.* (1982). The identification of the correct position of at least four of five E's was necessary to indicate sufficient visual acuity for each given line. In testing the visual acuity for near vision the reading charts designed by the Finnish Center for Visually Impaired were used. The whole line should be read correctly to accept that visual acuity be registered for that line. The reading acuity can be tested from 20/200 to 20/20 (logMAR + 1.0 to 0.0).

Functional visual impairment was registered, if the binocular visual acuity, either for near or distance vision, was less than 20/60 (logMAR + 0.5). This threshold was employed based on the World Health Organization criteria (World Health Organization, 1973).

Subjects, who had both visual and hearing impairments, were classified as having combined functional sensory impairment. Based on the screening of hearing and vision, the subjects were divided into four groups: (1) those with functional hearing impairment but adequate visual function (FHI); (2) those with functional visual impairment but adequate hearing function (FVI); (3) those with combined functional sensory impairment (CSI) and (4) those with adequate sensory functions (ASF).

Statistical methods

Mean and standard deviations (SD) expressed variables with normal (Gaussian) distribution descriptive values. Statistical comparison between the groups was made by using the *t*-test or the analysis of variance (ANOVA). If the variables did not have a normal distribution or ordinal, then descriptive values were expressed by median and interquartile range (IQR) or range. Statistical comparison between groups was made by using the Mann–Whitney test or the Kruskal–Wallis test. Measures with a discrete distribution are expressed as counts (%) and analysed by the Chi-Square, the Fischer's exact test or the Fisher–Freeman–Halton exact test. Logistic regression models with robust estimate of variance were used to determine adjusted predictive values of depressive symptoms. The normality of variables was evaluated by the Kolmogorov–Smirnov statistics, with a Lilliefors significance or Shapiro–Wilk statistics. Correlation coefficients were calculated by the Spearman method. The most important descriptive values were expressed with 95% confidence intervals (CI). The α level was set at 0.05 for all tests.

RESULTS

94 (20%) subjects of the study population had FHI, 60 (13%) had FVI and 33 (7%) had CSI. 72 subjects (15%, 95% CI: 12–19) had depression diagnosed according to the DSM-IV criteria. 228 (49%, 95% CI: 44–53) subjects had a total score of DSI 40 points or over.

Table 1 summarizes the differences in the age, in the institutional care and in the functional capacity between these groups. The differences between these groups were statistically significant ($p < 0.001$) in the mean age. Persons in the functional sensory impairment group (includes FHI, FVI and CSI groups) were more often institutionalized than persons in the ASF group, the difference between these groups was statistically significant ($p = 0.034$). The median of the

Table 1. Demographic and clinical data on functional sensory impairment and adequate sensory function groups

Variables	Functional impairment ($n = 187$)			*p*-value between impairment groups	Adequate sensory function ($n = 283$)	*p*-value between impairment and adequate sensory groups
	Hearing ($n = 94$)	Visual ($n = 60$)	Combined ($n = 33$)			
Number of females (%)	59 (57)	47(78)	24 (73)	0.11	212 (75)	0.20
Mean age, years (SD)	82 (4)	82 (5)	86 (4)	< 0.001	79 (3)	< 0.001
Number institutionalized, (%)	3 (3)	7 (12)	3 (9)	0.085	8 (3)	0.034
Median Barthel-index*, (IQR)	100 (95, 100)	95 (80, 100)	95 (80, 100)	0.002	100 (95, 100)	< 0.001
Median IADL†, (IQR)	7 (5, 8)	7 (5, 8)	5 (4, 7)	0.009	8 (6, 8)	< 0.001

*Maximum value indicate independent in all activities, scale from 0 to 100.
†Maximum value indicate independent in all activities, scale from 0 to 8.

Table 2. Depression in functional sensory impairment and adequate sensory function groups

Criteria	Functional impairment ($n = 187$)			p-value between impairment groups	Adequate sensory function ($n = 283$)	p-value between impairment and adequate sensory groups
	Hearing ($n = 94$) n (%) [95% CI]	Visual ($n = 60$) n (%) [95% CI]	Combined ($n = 33$) n (%) [95% CI]		n (%) [95% CI]	
DSM-IV depression	11 (12) [7 to 20]	12 (20) [12 to 32]	6 (18) [9 to 34]	0.34	43 (15) [11 to 20]	0.93
Zung depression scale						
> 40	47 (50) [40 to 60]	32 (53) [41 to 65]	23 (70) [53 to 83]	0.14	126 (45) [39 to 50]	0.03
> 48	15 (16) [10 to 25]	16 (27) [17 to 39]	10 (30) [17 to 47]	0.13	48 (17) [13 to 22]	0.18

Barthel-index and the IADL-scale was statistically significantly lower in the functional impairment group compared to ASF group ($p < 0.001$). These scores were the lowest in the CSI group.

Table 2 demonstrates the relationship between functional sensory impairment and depression. Twelve per cent of subjects in the FHI group, 20% in the FVI group, 18% in the CSI group and 15% in the ASF group had depression diagnosed according to the DSM-IV criteria. There were not statistically significant differences between these groups. The occurrence rate of the DSI score equal or over 40 points was 50% in the FHI group, 53% in the FVI group, 70% in the CSI group and 45% in the ASF group. The difference between the ASF group and the functional sensory impairment group was statistically significant ($p = 0.03$) but not between the different impairment groups ($p = 0.14$). The results concerning the DSI score equal or over 48 points were similar to depression diagnosed according to the DSM-IV criteria.

The age, gender and institutionalization adjusted risk ratio for total score of DSI 40 points or over in the sensory impaired subjects was 1.15 (95% CI: 0.77–1.72).

DISCUSSION

In this population-based study we have shown that depressive symptoms were common if elderly persons had CSI. The occurrence rate of the DSI score equal to or over 40 points was 70% in the CSI group. The difference of this occurrence rate was statistically significant between the functional sensory impairment group and the ASF group. But even though subjects with CSI had depressive symptoms they did not meet the criteria of major depression according to DSM-IV more often than other subjects in this age group.

This study is part of the population-based Kuopio 75+ study. There were also many demented persons in the population sample. Most of them were excluded from this depression study for unreliable sensory measurements. Due to these exclusion criteria our results cannot be extrapolated to elderly person who have moderate to severe dementia.

The methods used in this study for screening visual and hearing impairment are available in the primary care. The prevalence of FVI was similar to that earlier documented in one large epidemiological study in north London (Reidy *et al.*, 1998), but it was higher than in many other studies (Attebo *et al.*, 1996; Klaver *et al.*, 1998; West *et al.*, 1997). This was due to our methods and the differences in definition.

We selected the problems in face-to-face conversation as our first step screening method for the hearing acuity, because it is usually the first sign of hearing problem encountered in a primary health care center. We also used self-reported problems in hearing as one defining criterion. Subjects with a hearing aid were also included in the FHI group. With those methods we did not identify persons with only mild hearing problems. For that reason the prevalence of FHI was lower than earlier reported: 30% versus 42–45% (Cruickshanks *et al.*, 1998; Mosicki *et al.*, 1985).

We wished to evaluate depression with a variety of methods, which represented different approaches to this common condition. We used the DSM-IV criteria to determine major depression. Since depression is often under-estimated among elderly persons we also wanted to find depressive symptoms and used the Zung Depression Status Inventory (DSI) for screening

of depressive symptoms. The DSI has been used in this age group earlier in many studies (Kitchell *et al.*, 1982; Kivelä *et al.*, 1996; Kiljunen *et al.*, 1997) and the cut off points (40 and 48) were previously defined (Zung, 1967; Okimoto *et al.*, 1982).

Individuals in the CSI group were older than those in the other groups (Table 1). That result was quite expected since both the visual problems and hearing problems increase with age. They also needed more often assistance in the PADL and the IADL activities compared to persons who did not have problems with the hearing or visual acuity or who had either the visual or hearing problems. The association between sensory impairment and increased physical disability has been documented earlier in many studies (Carabellese *et al.*, 1993; Keller *et al.*, 1999; Reuben *et al.*, 1999; Wallhagen *et al.*, 2001). Probably due their need for assistance in the PADL and the IADL functions, persons in the impairment group were more often institutionalized compared to persons in the ASF group. Institutional care and also the functional decline have been associated with depression in earlier studies (Ip *et al.*, 2000; Lenze *et al.*, 2001). Since age, institutional care, functional decline and sensory impairment are highly associated with each other it is difficult to demonstrate their individual effects on the mood.

Depressive symptoms were common if elderly persons had sensory impairment, especially combined sensory impairment (Table 2). Our results concerning single sensory impairment are similar to those earlier documented (Herbst and Humphrey, 1980; Mulrow *et al.*, 1990; Carabellese *et al.*, 1993; Ip *et al.*, 2000; Tsuruoka *et al.*, 2001). Carabellese *et al.* (1993) documented in their study a clear association between single sensory impairment and depressive mood, but no interaction of double sensory impairment on depressive mood was detectable. In their study there were 1191 non-institutionalized elderly subjects (age 70 to 75 years) and the double sensory impairment group consisted of only 20 subjects. Other studies concerning double sensory impairment have, at least to our knowledge, concentrated on physical capacity, not on mood.

We can conclude that depressive mood was common condition if elderly persons suffered sensory problems. The risk of depressive symptoms was more obvious if they had at the same time problems in the hearing and visual acuity. We must be aware in future planning of social and health services that elderly persons often will suffer sensory problems that predispose them also to depressive symptoms.

KEY POINTS

- Depressive symptoms were common if an elderly person had double sensory impairment.
- Although they had great extensive depressive symptoms they did not have major depression more often than other persons in this age group.

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ARTICLE III

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Decrease Of Functional Or Cognitive Capacity Explains The Lack Of Eye Examination In Visually Impaired Older Persons

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To the Editor: The decline of visual function with age is well known (1, 2). Vision loss has been ranked behind arthritis and heart disease as the third-most-common chronic condition that forces older persons to require assistance with activities of daily living (3). It is associated with depressive mood (4); functional decline (5); and increased risk of falls, hip fracture, and mortality. Decreased vision also appears to increase the risk of becoming institutionalized (6). As with many other health problems encountered in older people, visual impairment is often undiagnosed and untreated (1, 7, 8). Recently, it was reported that adequate implementation of surgery to treat cataract could reduce visual impairment by one-third (2) and that uncorrected refractive error is the most common cause of bilateral visual impairment across all decades of life, but especially in those aged 80 and older (9).

The purpose of this study was to ascertain reasons for the lack of eye examination in the visually impaired older population and to obtain estimates of how many of those with poor vision have been helped with cataract surgery or with new corrected eyeglasses.

METHODS

This study is a part of the population-based Kuopio 75+ study. The design of that study has been previously reported (10). This study group consisted of 518 persons. They all had reliable information about visual acuity measured with screening methods.

The visual examination consisted of an assessment of binocular visual acuity for distance (Snellen chart with E-letters) and near (reading charts designed by the Finnish Center for Visually Impaired) vision, corrected with the patient's own eyeglasses. Visual impairment was registered if the binocular visual acuity was less than 20/60 (logMAR +0.5). The primary research was conducted in 1998. At the beginning of 2002, patient documents in the local university hospital and in the offices of local ophthalmologists were reviewed. The investigations verified whether an ophthalmologist had examined these visually impaired subjects during the follow-up time and whether cataract surgery or provision of new eyeglasses had corrected their visual acuity.

Physical, psychological, and cognitive functions and functional hearing acuity were also measured during the examination of these study subjects. Activities of daily living (ADLs) were evaluated using the Barthel index and mood using the Finnish translation of the Zung Depression Status Inventory. Cognitive function was screened using the Finnish translation of the Mini-Mental State Examination (MMSE).

RESULTS

Visual impairment was found in 122 (24%, 95% confidence interval (CI) = 20-27) of the 518 study subjects. An ophthalmologist had examined 59 (48%) of them during the follow-up period: 17 (29%) of these had received new eyeglasses, and 13 (22%) had undergone cataract surgery. With these actions, their visual acuity had improved to the level of "no visual impairment."

Table 1 shows statistically significant differences between the examined and nonexamined groups in the number of institutionalized individuals, median of the Barthel index, and MMSE score of 24 points or less. Sex, age, hearing impairment, and possible depressive mood did not explain the lack of examination of visual impairment. The significant univariate predictive effect for the lack of examination for visual impairment was institutional care (odds ratio (OR) = 6.87, 95% CI = 2.19-21.54), Barthel index (OR = 0.96, 95% CI = 0.94-0.98), and MMSE $\leq$24 (OR = 4.44, 95% CI = 2.02-9.74). The forward stepwise logistic regression analysis entered the Barthel index (OR = 0.96, 95% CI = 0.94-0.98) and MMSE $\leq$24 (OR = 2.88, 95% CI = 1.19-6.96).

Table 1. Characteristics of Visually Impaired Subjects Who Were Examined or Not Examined by an Ophthalmologist

Characteristic	Examined	Not Examined	*P*-value
Female, n (%)	45 (76)	48 (76)	.99
Age, mean ± standard deviation	83 ± 5	84 ± 5	.11
Institutionalized, n (%)	4 (7)	21 (33)	<.001
Barthel Index, median (interquartile range)*	95 (90-100)	75 (55-95)	<.001
Hearing impairment, n (%)	19 (32)	17 (27)	.53
Mini-Mental State Examination $\leq$24, (%)	26 (44)	49 (78)	<.001
Zung depression scale $\geq$40, (%)	32 (55)	39 (67)	.18

*Maximum value indicates independent in all activities.

CONCLUSIONS

Impairment of vision is common in this age group. An ophthalmologist had examined 48% of visually impaired subjects during the follow-up time, and half of these achieved better visual acuity from cataract operation or provision of new eyeglasses. Deteriorated cognitive function and impairment in ADL functions were the strongest factors associated with lack of eye examination for visual impairment.

Many of these visually impaired persons live in institutional care. To promote examination of visual problems, the staff of these institutions should understand the importance of early diagnoses of visual problems and the possibility of helping visually impaired older people. In addition, physicians should be aware that older persons who need assistance in ADL functions or who have dementia might also have a hidden visual impairment.

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ARTICLE IV

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Audiology

The non-use of hearing aids in people aged 75 years and over in the city of Kuopio in Finland

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Abstract: Hearing loss is one of the most prevalent chronic conditions affecting the health of the aged. It is typically medically non-treatable, and hearing aid (HA) use remains the treatment of choice. However, only 15–30% of older adults with hearing impairment possess an HA. Many of them never use it. The purpose of our study was to investigate the use of provided HAs and reasons for the non-use of HAs. This population-based survey was set in the city of Kuopio in eastern Finland. A total of 601 people aged 75 years or older participated in this study. A geriatrician and a trained nurse examined the subjects. Their functional and cognitive capacity was evaluated. A questionnaire about participants' socioeconomic characteristics and the use of HAs were included in the study protocol. The subjects who had an HA were assigned to three groups on the basis of HA use: full-time users, part-time users and non-users. Inquiries were made about the subjective reasons for the non-use of HAs. An HA had been prescribed earlier to 16.6% of the study group. Fourteen percent of the females and 23% of the males had been provided with an HA. The HA owners were older than persons who had not been provided with an HA. Twenty-five percent of the HA owners were non-users, and 55% were full-time users. A decline in cognitive or functional capacity and low income explained the non-use of HAs. The most common subjective reasons for the non-use of HAs were that the use did not help at all (10/24), the HA was broken (4/24) or it was too complicated to use (5/24). The non-use of HAs is still common among the aged. Elderly people who have been provided with an HA and who have a cognitive or functional decline are at risk to be a non-user of an HA. Therefore, they need special attention in counseling.

Keywords: Elderly - Hearing aids - Non-use of hearing aids

Introduction

The prevalence of hearing problems among the elderly aged at least 75 years is estimated to be about 50% [1, 2]. Hearing impairment has been associated with poorer quality of life [3], depressive symptoms [4] and also with a decrease of functional capacity [3, 5]. Furthermore, hearing impairment correlates with a higher subsequent risk for nursing home placement [6] and cognitive decline [7].

Typically, age-related hearing loss is not medically curable. The treatment strategy depends on the patient's communications needs. The treatment of presbyacusis includes emotional support from family members and health care professionals, environmental modification and the use of various types of assisting listening devices (e.g., telephone and television amplifiers and hard-wired communication devices) or HAs. Use of HAs among subjects with hearing impairment improves their quality of life [8] and is helpful in communication [9]. Also, dementia patients benefit from HA use [10, 11]. Only 15–30% of older adults with hearing impairment possess an HA [12, 13]. Furthermore, too often the treatment compliance (hearing-aid use) is poor in this age group [2, 13, 14].

The purpose of this study was to examine HA use in a population aged 75 years and over in Finland. The four main questions of the present study were: (1) What were the demographic characteristics of these elderly persons who had previously been prescribed an HA? (2) To what extent were the prescribed HAs being used? (3) Were there any explanations for the non-use of HAs? (4) What were the subjective reasons for the non-use of HAs?

Subjects and methods

Study population

This study was a part of the Kuopio 75+ study, which was carried out as collaboration between the University of Kuopio and the Social Welfare and Health Center of Kuopio. The purpose of this survey was to clarify the diseases, functional capacity and use of services for senior citizens in the city of Kuopio in eastern Finland. Kuopio has a population of 86,000 inhabitants, with 5.3% of them being 75 years and older.

The Kuopio 75+ study population consisted of 700 persons aged more than 75 years (on 1 January 1998), which was 15.5% of the entire age group. They were randomly selected from the population register and representative of their respective age groups and gender. Seventy-nine (11.3%) of them were living in long-term institutionalized care (care provided also at night). The proportion of people in institutionalized care is representative of the Finnish population. Of those 700 persons eligible, 601 (85.9%) participated in the standardized interview and geriatric assessment between January 1998 and January 1999. Fifteen (2.1%) died prior to being seen, 79 (11.3%) refused to participate and 5 (0.7%) could not be contacted at all. The mean age of the Kuopio 75+ study population was 81.3 years (SD=5), and 74.1% of them were female. The study was reviewed and approved by the Ethics Committee of the University of Kuopio and University

Hospital of Kuopio, and the participants and/or their nearest relative provided a written informed consent for the study.

Methods

Measures

All participants were interviewed and examined by a geriatrician and a trained nurse. The interview elicited data regarding the participant's sociodemographic characteristics, the extent of their education and financial status as well as the medical history. Information about their financial status was based on their latest account taxation, which is in the public domain in Finland. The Activities of Daily Living (ADLs) were evaluated by the Barthel index [*15*]. The total score can range from 0 to 100 ("help needed in all activities" to "independent in all activities"). The cognitive function was screened by the Mini-Mental State Examination (MMSE) [*16*]. The Finnish translation of the Zung Depression Status Inventory (DSI) was used to estimate depressive symptoms [*17*].

Questions concerning the prescription and the use of HAs were included in the medical history questionnaire conducted by the nurse. The subjects were asked how often they used their HAs. If they said they did not use it at all, they were documented as non-users. If they used it all the time, they felt the need of amplification, they were documented as full-time users. And if they said they used it only occasionally or sometimes, they were documented as part-time users. Because in this age group the subjective need to use amplification depends greatly on the living situation (alone or institutionalized) and social activity, we did not want to use hours as a specification method. Inquiries were made about the subjective reasons for the non-use of HAs.

Statistical methods

Variables with normal distribution descriptive values were expressed by mean and standard deviations (SD); statistical comparison between the groups was made using the *t*-test or analysis of variance (ANOVA). Variables with ordinal descriptive values were expressed by median and interquartile range (IQR). Statistical comparison between groups was made using the Mann-Whitney test or Kruskal-Wallis test. Measures with a discrete distribution were expressed as counts (%) and analyzed by the chi-square test, Fischer's exact test or Fisher-Freeman-Halton exact test. We used Hommel's adjustments to correct significance levels for multiple (post hoc) testing. The normality of variables was evaluated by Shapiro-Wilk statistics. The most important descriptive values were expressed with a 95% confidence interval (95% CI). The α level was set at 0.05 for all tests.

Results

A hearing aid had been prescribed previously to 100 persons [16.6% (95% CI: 13.9 to 19.8)] in the study group. Sixty-four (14.4%) of the 445 females and 36 (23.1%) of the 156 males had been provided with an HA. There was no statistically significant difference in the mean age between females and males who has been provided with an HA (P=0.49). The mean age was 83±5 years among females and 82±5 years among males.

Sixty-four percent of the people who had been provided with hearing aids and 76 percent of the people who had not been provided with hearing aids were females. There was a statistically

significant difference in the number of females (P=0.012) between these groups (Table 1). There was also statistically significant difference in the mean age (P<0.001) between these two groups. The mean age in the HA group was 83±5 years; in the other group it was 81±4 years. No significant differences between these two groups were found in the median duration of education, the median income, the number of institutionalized subjects, the MMSE score, the ADL score or Zung depression score.

Table 1 Demographics and clinical data in the subjects provided with hearing aids.

Variables	**Hearing aid provision**		***P* value**
	Yes	**No**	
	(*n*=100)	**(*n*=501)**	
Demographics			
Number of females (%)	64 (64)	381 (76)	0.012
Mean age (SD)	83 (5)	81 (4)	<0.001
Median years of education (IQR)	6 (4, 8)	6 (4, 8)	0.65
Median total income in dollars (IQR)	9,472 (5,598, 16,512)	9,147 (4,900, 14,479)	0.38
Number of institutionalized (%)	8 (8)	70 (14)	0.10
Clinical			
Median MMSE (IQR)	26 (20, 28)	25 (20, 28)	0.55
Median ADL (IQR)	95 (90, 100)	95 (85, 100)	0.58
Median Zung depression scale (IQR)	40 (35, 45)	39 (33, 45)	0.36

SD standard deviation, *IQR* inter-quartile range, *MMSE* mini mental-state examination, *ADL* activities of daily living, Barthel-index (range from 0 to 100). Maximum value indicates independent in all activities.

We obtained information about the use of their HAs from 95 of the 100 subjects. One subject did not communicate at all because of moderate dementia, and four did not report to be HA owners even though the prescription of an HA was documented in the medical records. Table 2 shows demographic and clinical data from these 95 subjects. Fifty-two subjects (55%) were full-time users, 19 (20%) part-time users and 24 (25%) non-users. There was not a statistically significant difference in hearing aid use between females and males.

Table 2 Demographics and clinical data in 95 subjects provided with hearing aids; comparison between the non-users, the part-time user and full-time user groups. Hommel's adjusted post hoc tested only when the difference between the groups was significant.

Variables	**Hearing aid use**			***P* value**	
	Non-users	**Part-time users**	**Full-time users**	**Between groups**	**Post hoc test**
	(*n*=24)	**(*n*=19)**	**(*n*=52)**		
Demographics					
Number of females (%)	13 (54)	12 (63)	36 (69)	0.44	-
Mean age (SD)	84 (5)	82 (5)	83 (5)	0.36	-
Median years of education (IQR)	6 (4, 6)	6 (5, 9)	6 (4, 10)	0.18	-
Median total income in dollars (IQR)	4,808 (3,176, 8,530)	11,766 (9,538, 16,393)	9,474 (6,263, 17,178)	0.002	N/P, N/F
Number of institutionalized (%)	4 (17)	1 (5)	2 (4)	0.14	-
Clinical					
Median MMSE (IQR)	23 (15, 26)	27 (19, 29)	27 (23, 29)	0.006	N/P, N/F
Median ADL (IQR)	90 (70, 95)	100 (90, 100)	95 (95, 100)	0.011	N/P, N/F
Median Zung depression scale (IQR)	43 (32, 47)	39 (33, 44)	40 (35, 46)	0.55	-

SD standard deviation, *IQR* inter-quartile range, *MMSE* mini mental-state examination, *ADL* activities of daily livings, Barthel-index, *N* non-users, *P* part-time users, *F* full-time users

There were statistically significant differences between these groups in the median of incomes (P=0.002), the MMSE score (P=0.006) and the ADL score (P=0.011). The median of incomes was 4,808 (IQR 3,176 to 8,539) dollars in the non-users group, 11,766 (IQR 9,538 to 16,393) dollars in the part-time users group and 9,474 (IQR 6,263 to 17,178) dollars in the full-times users group. The post hoc test localized statistically significant differences in incomes between the non-user and part-time user groups (P=0.005) and between the non-user and full-time user groups (P=0.001). There was also a statistically significant difference in the median of the MMSE scores between the non-user and part-time user groups (P=0.017) and between the non-user and the full-time user groups (P=0.002). The MMSE score was 23 (IQR 15 to 26) in the non-user group, 27 (IQR 19 to 29) in the part-time user group and 27 (IQR 23 to 29) in the full-time user group. The non-user group also differed statistically significantly from the part-time user group (P=0.019) and from the full-time user group (P=0.005) in the median of the ADL score. The median of the ADL score was 90 (IQR 70 to 95) in the non-users group, 100 (IQR 90 to 100) in the part-time user group and 95 (IQR 95 to100) in the full-time user group.

There were 24 HA non-users in our study group. The subjective reasons for the non-use of HAs are documented in Table 3. Ten of them (42%) expressed that they did not feel any need for an HA, nor did they obtain any benefit from their use. Five of them were females and five males. Five (21%) of the 24 non-users expressed that it was too difficult to use and four of them were females. Four persons (17%) stated that their HA was broken.

Table 3 Subjective reasons for the 24 cases of non-use of hearing aids. *HA* hearing aid

Subjective reasons	**Male**	**Female**	**Total**
	***n*=11**	***n*=13**	***n*=24**
No need or no perceived benefit from HA use	5	5	10
Too difficult to use	1	4	5
The HA was broken	2	2	4
Costs too much to replace batteries	1	0	1
The HA was lost	1	0	1
Cannot use due to external otitis	1	0	1
No reasons documented	0	2	2

Discussion

In this population-based study, 17% of the study population had been provided previously with an HA, but 25% of them never used it. The decline in cognitive or functional capacity and low income was associated with HA use. The most common subjective reasons for the non-use of HAs were the difficulty to use it or its ineffectiveness.

It has previously been reported that hearing impairment is more common among men than women. One interesting finding in our study was that even though 23% of males and only 14% of females were HA owners, actually most of the HA owners were females (64 versus 36). This is due to the over representation of women in this age group. Furthermore, the HA owners were older than persons who had not been provided with an HA. Because the number of very old people will increase appreciably in the developed countries in the next years, this probably means there will be extensive need of aural rehabilitation and also HA provision in the future. It should be taken into consideration that these older HA owners will be females, who are not as experienced in the use of technical devises as males.

The prevalence of HA provision in various age groups increases as a function of age. It is estimated that at least 30% of those aged 65 years or over have such severe hearing impairment that they would benefit from a hearing aid [1, 18]. In Sweden, 12% of those aged 70 years and over have been equipped with HAs [12]. Davis (1989) reported an 18–20% prevalence rate of provision of HAs in those aged 75 and older in Great Britain [1], which is similar to our finding. Tolson et al. (1995) reported that residents in long-stay wards are more than four times as likely to need an HA prescription as their cotemporaries in the general population [19]. In our study, we did not find significant differences in the HA prescription between the institutionalized and community-dwelling subjects.

Only a part of the HAs that have been provided are being used effectively. Popelka et al. (1998), reporting from a Wisconsin community in the USA [*13*], found that 29% of HA owners no longer

used their HAs. Gianapoulus et al. (2002) reported that in Wales 57% of HA owners were not using their HAs [*20*]. Sorri et al. documented that in Finland 23% of the HAs were never used, whereas 57% were used regularly every day [*14*], which is similar to our findings. The use rates in Finland have not changed in the last decades.

The age, severity of loss, education, word recognition scores, Hearing Handicap Inventory for the Elderly score and presence of self-reported hearing loss have been reported to be significant factors associated with the use of HAs [*13*]. However, financial costs, low quality of sound amplification, lack of support from heath care providers, stigmatization and handling problems are mentioned as being the main problems in the use of HAs among the aged [*21*, *22*, *23*, *24*].

In our study, the decline in functional capacity was one explanatory factor for the non-use of HAs. This is logical, because a person needs manual dexterity when handling HAs. In many cases, elderly persons need support of other persons (relatives, local heath care personnel, etc.) in handling their HAs. Boisen et al. (1997) have previously documented that cooperation between audiology and geriatric departments as well home care services were valuable to older patients [*25*]. Nursing home residents have been reported to use their HAs consistently [*26*]. Our result was similar to that. We did not find significant differences in the number of institutionalized patients between the groups of non-users, full-time users and part-time users.

The decline in cognitive capacity and low income was explanatory factors for the non-use of HAs. In Finland, the HA itself is free, but patients have to purchase the batteries themselves. Some patients complain that these costs are excessive. Thus, they may be given an expensive HA, but it is left unused in a drawer due to the cost of batteries.

The association between the cognitive decline and the non-use of HAs has not been reported previously, at least to our knowledge. Our result is clinically important, since both dementia diseases and hearing impairment are associated with age. In the future, there will be many demented persons who at the same time have hearing impairment. They also need HA provision and special attention in counseling to guarantee the efficient use of their HAs.

Even though demographic and psychological factors for the non-use of HAs have been documented previously in many studies, the common subjective reasons for this non-use of the HAs in this age group have not been obvious. In our study, one subjective reason for the non-use of HAs was the feeling that the HAs did not benefit the users. Sometimes, the HA is probably prescribed too early, and the user really does not benefit from its use. Often, it may be prescribed too late, and it does not help any more. Thus, the correct timing of HA provision is important. In Finland, the waiting time to the provision of an HA is as long as 6 to 18 months. Awareness of this long waiting time may also be one reason why some elderly persons do not seek help for their poor hearing.

Technical problems and difficulties in actually using the HAs were also reported to be subjective reasons for the non-use of HAs in our study. Manufacturers of these devices should design convenient, user-friendly HAs for the elderly. However, there will always be a need for counseling and follow up, since elderly subjects still must be trained and motivated to use their HAs.

Conclusion

We conclude that the non-use of HAs is still a serious problem and to a great extent an unaddressed problem to which more attention needs to be focused. The provision of these unused HAs represents a huge waste of health resources. We need timely prescription of HAs, patient motivation and counseling and follow-up as well as training of local health care personnel. New generations of easy-to-use and convenient HAs for the elderly are urgently needed. We should also remember that an elderly person who needs an HA to hear properly and who experiences cognitive or functional decline is at risk to become a non-user of the HA. These persons need special attention in HA counseling programs.

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ARTICLE V

Visual impairment and the costs of the use of home care services among community- dwelling people aged 75 years and over in Finland.

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Abbreviated title: Visual impairments and the costs of the use of home care services

Abstract:

Purpose: The purpose of this population-based survey was to evaluate the association between the functional visual (FVI) or combined sensory impairment (CSI) and the use of home care services and the costs of these services among community-dwelling elderly persons aged 75 years or older in Finland.
Methods: We used the Snellen eye charts with E-letters and reading charts to evaluate the functional visual acuity. The ability to conduct a face-to-face conversation, the hearing aid use and the self-reported hearing problems were used to assess the functional hearing acuity. Home care services were divided into three different groups: home nursing, home help and meals on wheels. We evaluated the annual costs of the use of these services per subject.
Results: Functional visual and combined sensory impairment had a statistically significant association with the use of home nursing and home help. The mean of the total costs for this service use was three-fold higher in the FVI and the CSI groups compared to the adequate sensory function (ASF) group.
Conclusion: Visual impairment and combined sensory impairment trigger the use of services, which leads to increased costs.

Key words: Sensory impairment, visual impairment, home care services, costs, elderly

Introduction

The number of elderly people has increased appreciably in recent decades in the western countries. If we want to design and organize appropriate services for elderly, we need knowledge about those diseases and defects which can influence the social, psychological, and physical capabilities of the elderly and increase the need for services in this age group.

Visual and hearing impairment are among the most common conditions affecting older persons. In the Blue Mountain Eye Study, the prevalence of at least mild visual impairment (visual acuity worse than 20/40) was 22% in individuals aged 75 to 84 years (Attebo et al., 1996). It is estimated that even 46 % of those over the age 75 years suffer from hearing impairment (Cruickshanks et al., 1998). Some elderly individuals have at the same time both visual and hearing impairment. The prevalence of this combined sensory impairment has ranged from 1.6 % to values as high as

11 % in persons aged 70 years and over (Carabellese et al., 1993; Bergman & Rosenhall 2001; Lupsakko et al., 2002).

Sensory impairments have serious consequences in this age group. Visual impairment has been associated with a greater rate of hip fractures (Felson et al., 1989; Cummings et al., 1995), depression (Carabellese et al., 1993; Lupsakko et al., 2001) and mortality (Thompson et al., 1989, Reidy et al., 2002). In addition, hearing impairment has been associated with a poorer quality of life (Mulrow et al., 1990) and depression (Carabellese et al., 1993; Tsuruoka et al., 2001). An association between disability in functional capacity and visual impairment (Keller et al., 1999; Lupsakko et al., 2002; Rudberg et al., 1993; Wallhagen et al., 2001) as well as hearing impairment (Keller et al., 1999) has also been reported. Furthermore the double sensory impairment is associated with a decrease in the capacity of the activities of daily living (Keller et al., 1999; Lupsakko et al., 2002) and depressive mood (Lupsakko et al., 2002).
The aim of this study was to evaluate the association between sensory impairment and the use of home care services among community-dwelling elderly persons aged 75 years and over. We also determined the annual costs of these services.

Subjects

This study was a part of the Kuopio 75 +study. The purpose of that survey was to clarify the diseases, functional capacity and use of services for senior citizens in the city of Kuopio in eastern Finland. The Kuopio 75+ study population consisted of 700 persons aged more than 75 years (on January 1, 1998), which represented 15.5% of the entire age group. They were randomly sampled from the population register and representative of their respective age groups and gender. Of those 700 persons eligible, 601 (85.9%) participated in the standardized interview and geriatric assessment. Fifteen (2.1%) died prior to being seen, 79 (11.3%) refused to participate and 5 (0.7%) could not be contacted at all.

A total of 138 persons were excluded from this study due to their inability for adequate co-operation in the investigative procedures (severe demented) or due to the fact that they were in institutional care. Thus the final study group included 463 persons.
The study was reviewed and approved by the Ethics Committee of the University of Kuopio and University Hospital of Kuopio and the participants and/or their nearest relative provided written informed consent for the study.

Methods

Measures

All participants were interviewed and examined by a geriatrician and a trained nurse. The interview elicited data regarding the participant's sociodemographic characteristics, medical history and the use of home care services. The Activities of Daily Living (ADLs) was evaluated by the Barthel-index (Collin et al., 1988). The cognitive function was screened by the Mini-Mental State Examination (MMSE) (Folstein et al., 1975). The Finnish translation of the Zung Depression Status Inventory (DSI) was used to estimate depressive symptoms (Zung WWK, 1972).

Functional sensory impairments

We used simple screening methods available in the primary health care centers. Functional hearing impairment was registered if the interviewed person had a clear difficulty in conversation due to poor hearing acuity as observed by the nurse, the person expressed that her or his main health problem was difficulty in hearing, or the person had earlier been provided a hearing aid.

The visual examination consisted of an assessment of binocular visual acuity for both distance (Snellen chart with E-letters) and near (reading charts) corrected with the patient's own spectacles (Gabriels, 1969). Functional visual impairment was registered if visual acuity, either for near or distance vision was less than 20/60 (logMAR+0.5) (Ferris et al., 1982). This threshold was employed based on the World Health Organization criteria for visually handicapped (1973).

Based on the screening of hearing and vision, the subjects were divided into four groups: 1) those with functional hearing impairment (FHI); 2) those with functional visual impairment (FVI); 3) those with combined functional sensory impairment (CSI); 4) those with adequate sensory functions (ASF).

The assessment of the use of home care services

Home care services were divided into three different groups: home nursing, home help and meals on wheels. Home nursing is organized by the primary heath care centers. The purpose of home nursing is to provide medical care in home. The number of home nurse visits can vary from daily visits to one visit a month.

Home help provides support in the Activities of the Daily Living (ADL) - and Instrumental Activities of the Daily Living (IADL) - functions and are organized from the municipal service department of the local community. The number of visits can vary from five times per day to one visit per week.
The meals on wheels service means that a person receives a complete meal delivered to her or his home. This service can be arranged everyday and is organized from the municipal service department of the local community.

Cost analysis

A subject could be using home nursing plus the service of home help as well as delivery of meals on wheels. We calculated the total amount of each services and costs to the community to produce these services in one year. We counted together these costs and in this way reached the annual costs of the use of services for every subject. The average cost of one home nursing visit was 43 €, a home help visit 28 €, and to one meal 5 €. The costs of services range huge between countries and communes depending on the service systems and the formation of the costs. In this study we used the costs of services in the city of Kuopio.
No discount rate analysis was used, as the follow-up was only one year. A sensitivity analysis was performed. The costs were varied by 30%.

Statistical methods

Statistical comparison between the groups was made by using the t-test, analysis of variance (ANOVA), Mann-Whitney test or the Kruskal-Wallis test with the Monte Carlo estimate of p-value. Measures with a discrete distribution analyzed by the Chi-Square, the Fischer's exact test or the Fisher-Freeman-Halton exact test. Logistic regression models with robust estimate of variance were used to determine adjusted predictive values of the use of services. The normality of variables was evaluated by Shapiro-Wilk statistics. Results were expressed as mean or median, standard deviation (SD) or interquartile range (IQR), and 95% confidence intervals (95% CI). The α level was set at 0.05 for all tests.

Results

Individuals in the functional sensory impairment group (consists the FHI, FVI and CSI groups) were statistically significantly ($P< 0.001$) older than in the ASF group (Table 1). There were statistically significant differences between the ASF and the sensory impairment group also in the median of the MMSE score ($P=0.014$), ADL score ($P< 0.001$) and DSI scale ($P=0.034$). There

were no significant differences in the prevalence of common diseases, in the number of females or in the living situation (living alone) between these groups.

Table 2 shows the statistically significant differences between the ASF group and functional sensory impairment group in the use of home nursing (P=0.023) and home help (P=0.022). There were also statistically significant differences in the use of home nursing (P=0.004) and home help services (P=0.02) between different sensory impairment groups. More subjects in the FVI and the CSI groups used these services than in the FHI group. The median number of home nursing visits per one month was 2 (IQR 1 to 2) in the FHI group, 2 (IQR 1 to 2) in the FVI group, 1.5 (IQR 1 to 2) in the CSI group and 1(IQR 1 to 2) in the ASF group. The median number of home help visits per one month was 12 (IQR 7 to 22) in the FHI group, 16 (IQR 8 to 57) in the FVI group, 12 (IQR 8 to 61) in the CSI group, and 8 (IQR 4 to 25) in the ASF group.

We used logistic regression models to determine the effect of the age, gender, living situation, sensory impairments, cognition, depressive mood and ADL-functions to the use of any services. Table 3 shows that the age (OR=1.15 [95% CI: 1.07 to1.24]), living alone (OR=4.12 [95% CI: 1.78 to 9.53]) and the low ADL score (OR=0.90 [95% CI: 0.86 to 0.94]) explained independently the use of services. However after adjustment for age, sex and living alone (not with the ADL score) there were still statistically significant (P=0.013) differences between the FVI and other groups in the estimated proportion of the use of any services.

Figure 1 shows the annual costs of the use of services in the different groups. Eighty-four percent of subjects in the ASF group did not use any services and thus incurred no costs at all. Seventy-eight percent in the FHI group, 58 % in the FVI group and 66 % in the CSI group did not use any services. An average of 10 % of subjects in the FVI and CSI groups made such extensive use of services that the costs amounted to over 10 000 € each year.

The mean of annual costs were 800 € (maximum costs 20 100 €) in the FHI group, 2 800 € (maximum costs 21 000 €) in the FVI group, 3 400 € (maximum costs 38 000 €) and 890 € (maximum costs 32 000 €) in the ASF group. There were statistically significant differences in the mean annual costs between the FVI and the ASF group (P< 0.001) and between the CSI and the ASF group (P= 0.03).

In the sensitivity analysis, we used 30% variation of the annual costs. This resulted in the mean annual costs in the FHI group ranging from 540 € to1 040 € (maximum costs 26 130 €), in the FVI group from 1 960 € to 3 640 € (maximum costs 27 300 €), in the CSI group from 2 380 € to 4 420 € (maximum costs 49 400 €) and in the ASF group from 623 € to 1 157 € (maximum costs 41 600 €).

Discussion

We reported that functional sensory impairment, especially functional visual impairment (FVI) and combined sensory impairment (CSI) had a statistically significant association with the use of home nursing and home help. Only 11% of subjects in the adequate sensory function (ASF) and functional hearing impairment (FHI) groups used home help compared to 25-28% in the FVI and CSI groups. Additionally 7-9% of subjects in the FHI and ASF groups used home nursing compared to 19-27% in the FVI and CSI groups. The mean annual costs for this service use were three-fold higher in FVI and CSI groups compared to the ASF group.

It is obvious that the need of services in the CSI group is connected to the practical problems due to the loss of vision. Functional hearing impairment did not increase the use of services. This result is reasonable because the needs rising from hearing impairment are mainly social and communicative, which cannot be met by the home care services. Also Creen & Pope (2001) had earlier reported that hearing impairment did not lead to use of services despite expectations to the contrary.

Most of persons, also in the impairment groups, were not associated with any expenses. One explanation to this result is probably the fact that these expenses signify only the use of these services not the real need of services. In Finland the elderly must pay themselves for its part of home care services and this probably influences to the use of services. The connection between the age and living alone and the use of services is reasonable. Older age is often associated with diseases and decline of functioning that increase the need of services. As long as there are other relatives (spouse or children) with the elderly in home, they do not need so much help from officinal home-care personnel.
Sensory impairments decrease the functional ability of the aged (Carabellese et al., 1993; Lupsakko et al., 2002; Keller et al., 1999; Wallhagen et al., 2001), and the decline in the ADL-functions has an independent effect on the use of home care services. This connection actually explained the need for home care services in these impairment groups but also offers the possibility to influence this service use and therefore the costs. We should try to slow the rate of decline in ADL-functions of sensory impaired elderly by improving the diagnosis, treatment and rehabilitation of the diseases, which are responsible for these impairments. Visual and hearing impairment is still often undiagnosed and untreated (Davis & Mueller 1987; Attebo et al., 1996; Karlsson & Rosenhall 1998; Reidy et al., 1998; Muñoz et al., 2000) in this age group. An uncorrected refractive error is one of the most common cause of bilateral visual impairment across all decades of life but especially for those aged 80 years or older (Weih et al., 2000, West et al. 2003), and adequate implementation of surgery to treat cataract could reduce visual impairment by one third (Klaver et al., 1998). Age-related hearing loss typically is medically non-treatable, and the use of hearing aid (HA) remains the treatment of choice. However, only 15-30% of older adults with hearing impairment actually possess a HA (Davis et al., 1987; Karlson & Rosenhall 1998).

Sufficient resources for the cure and rehabilitation should be guaranteed since untreated sensory impairments anyway result in costs by increasing the use of services. For example, in Finland the elderly have to wait a cataract operation for one to two years and the queue for a hearing aid is around one to one and half years. Because elderly persons with sensory impairment use much home care services, we must also pay more attention to educating local home care personnel to detect persons with sensory impairment and to refer them for consideration of technical aids and other rehabilitation maneuvers (Watson 2001).

We conclude that sensory impairments are common in this age group. Visual impairment and combined sensory impairment trigger the use of services, which leads to increased costs. We must try to influence these costs by finding efficient treatment strategies and improving the rehabilitation of these impairments. The cost effect of early diagnostic and care of these diseases and also of more active rehabilitation should be observed.

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Table 1. Demographic and clinical data on functional sensory impairment and adequate sensory function groups.

Variables	Functional impairment N (%) N=182(39%)			P value between impairment groups	Adequate sensory function N=281(61%)	P value between impairment and adequate sensory groups
	Hearing N=95(52%)	Visual N=55(30%)	Combined N=32(18%)			
Demographics:						
Number of females (%)	60 (63)	44 (80)	24 (75)	0.077	210 (75)	0.30
Mean age, years (SD)	81.7 (4.1)	81.3 (4.7)	86.2 (5.0)	<0.001	79.2 (3.4)	<0.001
Living alone	59 (62)	38 (69)	17 (53)	0.33	170 (60)	0.64
Clinical:						
Diagnosed diseases:						
Cardiovascular, n (%)	19 (20)	12 (22)	3 (9)	0.31	41 (15)	0.25
Stroke, n (%)	12 (13)	3 (5)	7 (22)	0.075	26 (9)	0.33
Diabetes, n (%)	19 (20)	11 (20)	8 (25)	0.82	56 (20)	0.80
Respiratory, n (%)	7 (8)	2 (4)	2 (6)	0.66	16 (6)	0.81
Median MMSE (IQR)	27 (24 , 29)	25 (23 , 29)	25 (20 , 27)	0.070	27 (25 , 29)	0.014
Median ADL (IQR)	100 (95 , 100)	95 (85 , 100)	95 (90 ,100)	0.009	100 (95 , 100)	<0.001
Median Zung depression scale (IQR)	39 (34 , 45)	40 (35 , 45)	42 (37 , 47)	0.13	38 (32 , 44)	0.034

SD; Standard deviation, IQR; Interquartile range, MMSE; Mini mental state examination, ADL; Activities of daily livings.

Table 2. The use of home care services in the sensory impairment and adequate sensory function groups

Service	Functional impairment N=182			P value between impairment groups	Adequate sensory function N=281	P value between impairment and adequate sensory groups
	Hearing(N=95) N (%)	Visual(N=55) N (%)	Combined(N=32) N (%)			
Home help	10 (11)	14 (25)	9 (28)	0.02	30 (11)	0.022
Home nursing	7 (7)	15 (27)	6 (19)	0.004	24 (9)	0.023
Meals on wheels	14 (15)	6 (11)	5 (16)	0.76	23 (8)	0.056
Any service	21 (22)	23 (42)	11 (34)	0.034	44 (16)	<0.001

Home help; personal care in the ADL- and IADL- functions, Home nursing; medical care provided by a nurse, Meals on wheels; complete meal delivered to home, Any service; any one of these 3 services being utilized.

Table 3. Explanatory variables of the use of municipal services to the elderly using logistic regression models.

Variables	OR (95% CI)	P-value
Gender (male)	1.79 (0.85 to 3.78)	0.13
Age (years)	1.15 (1.07 to 1.24)	<0.001
Living alone	4.12 (1.78 to 9.53)	<0.001
Hearing impairment	0.68 (0.33 to 1.42)	0.30
Visual impairment	1.29 (0.61 to 2.73)	0.50
MMSE <24	1.47 (0.71 to 3.02)	0.30
ADL-scale	0.90 (0.86 to 0.94)	<0.001
Zung depression scale	1.00 (0.96 to 1.04)	0.89

MMSE; Mini mental state examination, ADL; Activities of daily livings, OR; Odds ratio

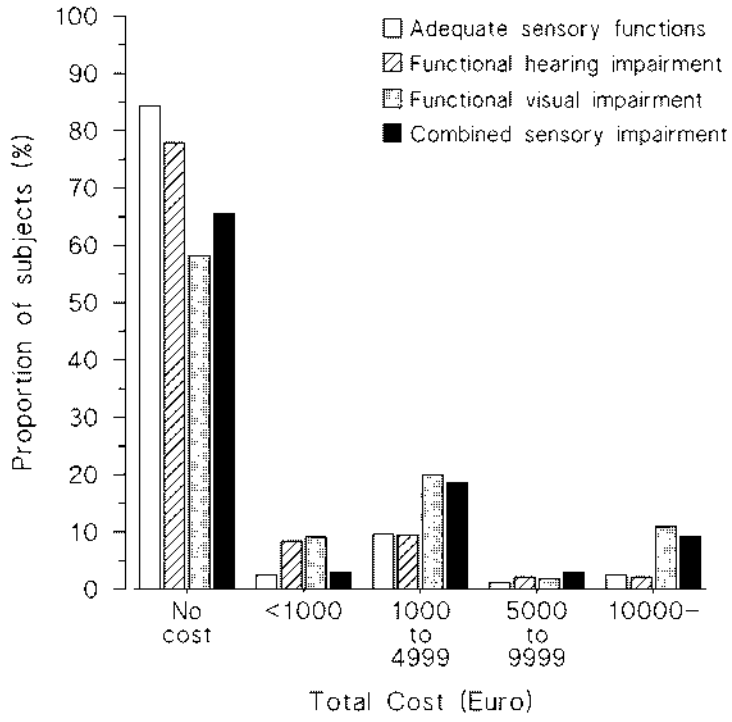

Figure 1. The annual costs of the use of home care services in the different sensory impairment groups.

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