Age and Ageing 1996;25:89–96

Effects of Sensory Aids on the Quality of Life and Mortality of Elderly People: A Multivariate Analysis

ILDEBRANDO APPOLLONIO, CORRADO CARABELLESE, LODOVICO FRATTOLA, MARCO TRABUCCHI

Summary

The present study aimed at clarifying the relationships between the use of sensory aids and the quality of life (QOL) and mortality of elderly people suffering from sensory deprivation. We carried out a cross-sectional survey on the QOL and the sensory status of an elderly cohort and a 6-year longitudinal follow-up of mortality rates among 1192 non-institutionalized people aged 70–75 years in a North Italian town. We classified respondents into three groups: those with functionally adequate visual and hearing acuity (n = 275); those with sensory impairment, corrected by the use of sensory aids (n = 680), and those with uncorrected sensory impairment (n = 245). In the whole sample, multiple logistic regression analyses showed that an uncorrected sensory deprivation was associated with a significant and independent impairment of mood, self-sufficiency in instrumental activities of daily living and social relationships. Such impairments were not apparent in the subjects with sensory impairments who were using sensory aids. In men with uncorrected sensory impairment the unadjusted 6-year mortality rate was almost twice that of the other two groups, which did not differ from each other. No corresponding differences were detected in women. Multivariate analysis showed that the effect of the sensory aid status on mortality was indirect and mediated through the global physical health status and the social relationships.

We conclude that our cross-sectional data demonstrate an association between uncorrected sensory deprivation and a low QOL; such an association was not present in subjects with corrected sensory deprivation.

Introduction

Various studies have consistently demonstrated that impairment of vision and/or hearing acuities (sensory deprivation) of older people, when functionally relevant, is associated with an enhanced risk of impaired quality of life (QOL) [1–8]. There is also evidence of an effect of sensory impairment on function [9–16]. Sensory deprivation might also represent an adjunctive risk factor for mortality, and available data suggest a possible indirect effect through QOL variables [17, 18]. This effect is apparent at medium- or long- rather than short-term follow-up. Furthermore, it appears to be restricted to specific subgroups of the elderly population such as men [19], although the reasons for such a sex difference are not known.

Few studies have taken into consideration the possible benefits of sensory aids on the consequences of sensory deprivation. Available data suggest that treatment of sensory deprivation, when feasible, can restore sensory acuity even in the very old [20–22]. The consequent improvement in sensory acuity exerts positive effects on quality of life [23–28], but the studies on this topic have been subject to various methodological limitations on the generalizability of their results. Specifically, previous studies are usually limited either to a single sensory modality, or to a single functional dimension. Moreover, it is still not clear which of the components of QOL are directly affected by modification of sensory performance and also not clear is the relationship between sensory deprivation, sensory aids and mortality.

With this background in mind, our study was carried out on a homogeneous population of non-institutionalized elderly subjects in a town in Northern Italy. Both the QOL indexes and the mortality rates in subjects whose sensory impairment (vision and/or hearing) had been restored by sensory aids were compared with those detected in subjects with uncorrected sensory impairment and in subjects without sensory impairment.

Subjects and Methods

Subjects: The study was carried out in two phases. During the first phase (February–June 1986), a cohort of community-dwelling elderly people aged 70–75 years, living in Brescia, was identified. Among all eligible subjects (n = 1303), data could be collected for 91.5% (n = 1192) using a multidimensional questionnaire and a standardized physical examination, including sensory screening tests. Data collection was undertaken using a door-to-door method by ten specifically trained general practitioners. Further details about this phase of the study have already been reported [29–31].

For the second phase of the study (June 1992), the Government Registry Office was utilized to identify subjects who had died up to 31 May 1992. Fifty-two of the subjects who had been included in the cross-sectional phase could not be located and were excluded from the second phase analysis; thus 1140 (371 men, 769 women) were entered in the mortality database. Those lost to follow-up were not statistically different from the studied sample in terms of age, sex, functional or mental status. The analyses related to the quality of life profile take into account the whole sample of 1192 subjects, whereas the analysis of mortality considers only the 1140 subjects, for whom both baseline and follow-up information was available [19].

Questionnaire; During the first phase, demographic information (age, sex, years of education, economic status) and the various aspects of QOL were obtained by questionnaire. Details of the questionnaire are available from previously published material [30, 31]. Briefly, the affective domain was evaluated through a scale comprising a revised version of the Beck's Depression Inventory (BDI) plus the Anxiety and Personal Well-being Scale [32]. Cognitive function was quantified by the Mental Status Questionnaire (MSQ) [33]. In a parallel study of the same population, both these variables have shown only weak association with mortality [29].

Functional status was assessed by the Instrumental Activities of Daily Living (IADL) scale [34]; impairment was evaluated in terms of the number of functions lost, corrected for family structure. Social relationships were scored with Linn's SELF scale [35]. Both these variables were strong predictors of mortality in the overall population; in particular, the IADL score emerged as a stronger predictor than the more elementary ADL scores, impairments in the latter being hardly compatible with living at home and less sensitive to small changes in function. Thus, ADL score was not examined in the present study.

The assessment of global physical health status was achieved through a scale quantifying health services utilization and somatic complaints during the month preceding interview [36]. The assessment of physical health status based on use of medical services is considered reliable in a uniform and restricted environment; the population sampled in the present study belonged to the same health district where a single general hospital with one geriatric department was located. This index is one of the most important predictors of mortality [29, 37].

Sensory assessment: The examination was focused upon functional assessment, in order to reveal ecologically relevant impairments [8]. Performance in each sensory function was tested on both eyes or ears simultaneously. In addition, subjects were tested with their sensory aids, if they usually used them.

Visual evaluation was based on visual acuity for distance (4 m) using an E chart and followed a standard procedure [38]. Binocular vision impairment was defined as an acuity of less than 20/50 [39].

For auditory evaluation, the free-field whispered voice testing was used [40]. Binaural hearing impairment was

Table I. Summary data of the three sensory-defined subgroups

	Group A (n = 275) No. (%)	Group B (n = 680) No. (%)	Group C (n = 245) No. (%)	χ^2
Sex:				
Men	103 (37.5)	208 (30.6)	78 (31.8)	
Women	172 (62.5)	472 (69.4)	167 (68.2)	NS
Living situation:				
Alone	170 (61.8)	345 (50.7)	122 (49.8)	
With others	105 (38.2)	335 (49.3)	123 (50.2)	11.3**
Years of schooling:				
<5 years	168 (61.1)	437 (64.3)	175 (71.4)	
>5 years	107 (38.9)	243 (35.7)	70 (28.6)	NS
Financial status:				
Good	90 (32.8)	106 (15.8)	37 (15.1)	
Sufficient	96 (35.0)	329 (49.0)	112 (45.7)	
Insufficient	88 (32.1)	236 (35.2)	96 (39.2)	42.3***
Physical health index:				
Good (0–5)	192 (69.8)	462 (67.9)	143 (58.4)	
Borderline (6–10)	76 (27.6)	188 (27.6)	86 (35.1)	
Poor (>10)	7 (2.5)	30 (4.4)	16 (6.5)	11.5*

Group A = Subjects with adequate sensory functions.
Group B = Subjects with adequate sensory functions thanks to the use of one or two sensory aids.
Group C = Subjects with either one or two sensory dysfunctions.
Financial status was self-related.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. NS = not significant at χ^2 test.

defined as the inability to repeat correctly the three numbers pronounced by the examiner or to achieve greater than 50% success over three triplets of numbers [41].

Further details on the methodological aspects of the sensory assessment can be found elsewhere [8].

On the basis of performance on the sensory tests, the 1192 subjects were categorized into three groups:

1. Subjects whose hearing and visual functions were adequate without the use of sensory aids (group A);
2. Subjects with impaired vision and/or hearing but with adequate sensory function due to the use of sensory aids (group B);
3. Subjects with hearing and/or visual deficits which had not been successfully corrected by their sensory aid(s) or who did not use sensory aids and so had a functionally relevant impairment in at least one sensory modality (group C).

Statistical analysis: The SPSS package was employed [42] in data analysis. Comparisons among the groups were computed using contingency tables and χ^2 statistics for ordinal and continuous non-normally distributed variables. One-way analysis of variance (ANOVA) of the means was used for other continuous variables, followed by *post-hoc* Student's *t* test, when appropriate. Baseline variables which differed significantly between groups on univariate analysis were entered into multivariate regression models in order to identify those significantly and independently associated with the presence or absence of sensory aids. A backward stepwise method was adopted to create the models.

Because the follow-up period of 6 years was the same for all study subjects, and the outcome variable was a dichotomous measure, univariate logistic regression analyses were used to estimate the odds ratios of death for the three groups.

The mortality rate subtended by each sensory condition was initially quantified by computing the (non-corrected) odds ratios with the corresponding confidence intervals. The point estimates were subsequently controlled using a bivariate logistic regression model in order to adjust for the effects of possible confounders. The iterative maximum likelihood method was employed. Baseline variables that were significant predictors of mortality and the sensory variables which survived the bivariate logistic regression were finally entered into a multivariate logistic regression model. The backward stepwise method was adopted again in order to identify the variables which were independently associated with mortality.

Results

Examination of sensory status and sensory aids: The sensory examination carried out during the first phase of the study detected 275 subjects (23.1%) who had adequate visual and auditory function without using any sensory aid (group A); 673 subjects (56.5%) who had functionally adequate vision and hearing when using at least one sensory aid (group B); and 244 (20.5%) subjects with at least one uncorrected functional sensory deficit (group C). More precisely, group B comprised 651 (96.7%) subjects wearing spectacles and 22 (3.3%) subjects using hearing aids; group C comprised 20 subjects who had a non-corrected deficit in both sensory modalities, 106 subjects with non-corrected hearing impairment but adequate vision and 118 subjects who had non-corrected visual impairment but adequate hearing. Summary data for the three groups are presented in Table I: sex, economic situation (self-rated), and living condition (self-rated) were differently distributed among the three groups. χ^2 tests showed a significantly higher proportion of men in group A than group C, and a significantly higher prevalence of subjects living with other family members and with better economic conditions in group A than in groups B and C. Groups B and C did not differ significantly in any of the demographic variables, and the three groups did not differ in global physical health status.

Quality of life—Univariate analysis: Table II shows that there are significant differences among the three groups in all functional variables for each of which scores are worse in group C than in the other two groups. Post-hoc *t* tests confirmed that group C scored significantly worse than either group A or B, in all indices of QOL with lower social relationships and cognitive performance, worse mood level and poorer

Table II. Comparison of the quality of life characteristics in the three sensory-defined subgroups

Scale	Mean scores (95% confidence intervals) Group A (n = 275)	Group B (n = 680)	Group C (n = 245)	F (df = 2,1198)
IADL	0.4 (0.28–0.52)	0.4 (0.32–0.47)	0.8 (0.57–1.02)	13.1*
SELF	19.9 (18.88–20.92)	18.1 (17.51–18.69)	15.4 (14.38–16.41)	19.7**
mBDI	15.2 (13.88–16.52)	17.5 (16.50–18.50)	22.8 (20.93–24.67)	22.6**
MSQ	0.6 (0.49–0.71)	0.6 (0.52–0.67)	0.9 (0.76–1.04)	5.9*

The groups are defined in Table I.
IADL = Instrumental Activities of Daily Living (scores are mean number of functions lost).
SELF = Self Evaluation of Life Function (higher scores indicate better social relationships).
mBDI = modified Beck's Depression Inventory (higher scores indicate worse mood state).
MSQ = Mental Status Questionnaire (scores are mean number of errors).
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ at the F statistic; df = degrees of freedom.

performance in IADL. On the other hand, although there were statistically significant differences between groups A and B in some of the functional variables (social relationships and mood levels), the corresponding mean values for both groups remained well within the normal ranges (Table II). The substantial similarity (in clinical terms) between the QOL profile in groups A and B was further confirmed by the absence of any significant difference between the two groups when the QOL indices were analysed as discrete variables (using appropriate cut-off values) and subjected to non-parametric tests of frequency distribution (data not shown).

Quality of Life—Multivariate analysis: The univariate results for the QOL indices were obtained without controlling for the possible confounding effects due to the demographic differences (at least, between groups A and C). Since it would be of great interest to identify which of the QOL measures are significantly and independently associated with the use and non-use of sensory aids and which are only indirectly associated with such use, we built up two multiple regression models, using the backward stepwise method. The first model (Table III, upper half) considers groups A and B and shows that the variables remaining significantly and independently different between the two groups are sex, economic situation and social relationships. The second model (Table III, lower half) takes into account groups B and C and shows that social relationships, mood level and performance in IADL remain significantly and independently different between the two groups, even after controlling for demographic characteristics.

Mortality—Univariate analysis: Six-year mortality rates are set out in Table IV. Overall, 6-year mortality was 25.5% (n = 291); the computed univariate logistic regression did not reveal any significant association with the sensory aid status for the whole sample (χ^2: 3.54, df = 2, p = 0.17). However, a significant interaction between sex and sensory status was apparent [Exp (B) = 0.86, $p < 0.002$], and a significant difference in the mortality rate of the two sexes was also detectable ($\chi^2 = 41.2$, $p < 0.0001$). These data prompted us to perform separate analyses for men and women.

Among women, neither the presence of an uncorrected sensory deficit nor the presence of a sensory aid were associated with a significant increased risk for 6-year mortality in comparison with group A ($\chi^2 = 0.78$, df = 2, p = 0.67). The corresponding ORs (together with the 95% CI) are as follows: group A vs. group B: 1.23 (0.78–1.95); group A vs. group C: 1.15 (0.65–2.03); group B vs. group C: 0.93 (0.59–1.48).

As shown by Table IV, the mortality rate differs between the three subgroups of men ($\chi^2 = 9.42$, df = 2, $p < 0.01$); in particular, those belonging to group C have a significantly higher mortality rate than both group A ($\chi^2 = 4.96$, $p < 0.03$) and group B ($\chi^2 = 9.18$, $p < 0.01$), whereas the mortality rate for

Table III. Multivariate logistic regression in the whole population for quality of life indices adjusted for the demographic variables

Variables	B	SE	Exp (B)	Wald Statistic	p value
Groups A and B		*Variables in the equation*			
Sex	0.338	0.15	1.40	4.88	0.03
Economic condition	0.210	0.10	1.23	4.21	0.04
Social relationships	−0.002	0.01	0.98	5.21	0.02
Constant	0.332	0.39		0.71	0.40
		Variables not entered in the final equation			
Residual χ^2 0.73 (2 df)					0.69
		Score			
Living condition		0.005			0.94
Mood level		0.72			0.39
Groups B and C		*Variables in the equation*			
Social relationships	−0.023	0.01	0.98	4.69	0.03
Mood level	0.018	0.01	1.02	10.66	0.001
Self-sufficiency	0.202	0.06	1.22	10.00	0.002
Constant	−1.119	0.26		18.88	0.00
		Variables not entered in the final equation			
Residual χ^2 2.16 (5 df)					0.83
		Score			
Sex		0.84			0.36
Living condition		0.34			0.56
Economic situation		0.13			0.72
Cognitive level		0.33			0.56
Global physical health		0.16			0.69

The groups are defined in Table I.

Table IV. Six-year mortality by sex and functional group

Group	Men (n = 371) No. dead	(%)	Women (n = 769) No. dead	(%)	All (n = 1140) No. dead	(%)
A	103	(35.7)	172	(17.5)	275	(24.2)
B	208	(32.7)	472	(20.7)	680	(24.3)
C	78	(52.7)	167	(19.6)	245	(30.4)
All	139	(37.5)	152	(19.8)	291	(25.5)

The groups are defined in Table I.

the latter two groups does not differ significantly ($\chi^2 = 0.27$, p = NS). Again, the corresponding ORs are as follows: group A vs. group B: 0.87 (0.52–1.45); group A vs. group C: 2.01 (1.08–3.71); group B vs. group C: 2.29 (1.33–3.95).

Mortality—Multivariate analysis: In addition to mortality, the three groups of men differed in terms of general demographic and functional variables (data not shown) and each of these might account, at least in part, for the apparent effects of the non-corrected sensory deprivation. Hence, the next step was to control in the men for the effects of possible confounders in the association of non-corrected sensory impairment with mortality rate by means of logistic regression. After adjusting for economic status and global physical health index (age, education and living condition were not differently distributed among the three male groups), the mortality rate remained significantly higher for the men with an uncorrected sensory impairment in comparison both with those without sensory dysfunction [B = 0.31, SE = 0.16; Exp (B) = 1.37, p = 0.05] and with those with corrected sensory deprivation [B = 0.71, SE = 0.28, Exp (B) = 2.04, p = 0.01].

At this point, sensory aid status was allowed to enter a multiple logistic regression model together with the demographic and functional variables (Table V). Within this model, the sensory aid status was no longer an independent predictor of mortality. More precisely, in groups B and C, only the social relationships and the global physical health status remained significant and independent predictors of mortality (at the 0.05 level).

Discussion

Our study confirms that sensory deprivation has to be included among the factors associated with frail ageing; as in the great majority of previous literature [1–8] this condition was correlated with the impairment of several QOL indices.

A more original result concerns the effective role of sensory aids in counteracting the negative effect of sensory dysfunction on QOL: subjects using sensory aids showed a higher mood level, richer social relationships and better performance in the activities of daily living than subjects with non-corrected sensory impairments. Furthermore, their QOL profile was substantially similar to that of subjects without any kind of sensory impairment: the differences detected at univariate analyses had more a statistical than a clinical value and were mostly related to the demographic variables, as shown by the multivariate approach.

Obvious limitations of these conclusions should be borne in mind, mainly in relation to methodological aspects. All subjects belonged to the same age cohort

Table V. Multivariate logistic regression for male mortality adjusted for demographic and functional variables

Variables	B	SE	Exp (B)	Wald Statistic	p value
Groups B and C		*Variables in the equation*			
Sensory aid use	0.541	0.30	1.72	3.27	0.07
Global physical health	0.134	0.06	1.14	4.53	0.03
Social relationships	−0.044	0.02	0.96	7.34	0.007
Self-sufficiency	1.137	0.64	3.12	3.15	0.08
Constant	−2.003	0.85		5.55	0.02
		Variables not entered in the final equation			
Residual χ^2 1.58 (1 df)					0.21
		Score			
Mood level		1.58			0.21

The groups are defined in Table I.

(70–75 year-olds), and were living at home in an urban setting. Moreover, a cross-sectional study does not allow inferences about the existence of a causal relationship between the variables under study. Nevertheless, recognition of these associations can be relevant and valuable. Our results represent a substantial progress in comparison with the existing literature [23–28] given the multidimensional approach adopted for the sensory and for the QOL assessments. The longitudinal component of our study focused on mortality; in a previous analysis [19] we demonstrated a significant increase of mortality risk due to sensory deprivation, at least in men. The findings presented here suggest that sensory aids might play a protective role even at this level in that the men using sensory aids had an unadjusted mortality rate similar to those with adequate sensory functions and lower than those with uncorrected sensory impairments.

However, the univariate analysis should be interpreted with caution because the three male groups were unbalanced in various demographic and functional variables. The multivariate models suggest that the protective role of sensory aids is, at most, indirect and mediated through other factors, such as quality of health and the level of social relationships. A simpler hypothesis might be that men with uncorrected sensory deprivation are also in poorer health and therefore a higher mortality rate should be expected. In any case, it is intriguing that the sensory aid status remained a significant predictor of mortality in the first multivariate model, i.e. after adjusting for the demographic variables *and* the global physical health index. By contrast, the sensory aid status did not survive the second multivariate approach when the functional variables were also fitted into the model. These results suggest that poor health *per se*, although very important, does not fully explain the differences in the mortality rates of the three sensory-defined male groups. They seem rather to favour an indirect role of sensory status in mortality, mediated through influences on functional variables (in particular the social one).

Overall, these data give grounds for extensive sensory screening of elderly people, as recommended by the World Health Organization [43], and also for encouraging the intensive use of sensory aids. It has been shown that first-level sensory screening can be performed in several settings, for example during routine examination by general practitioners as well as during the multidimensional assessment of the geriatrician and even, on an opportunistic basis, in an emergency department [44, 45].

With regard to sensory aids, it is well known that, above and beyond the difficulties related to the choice and the monitoring of the optimal treatment in the single subject, there is also the problem of its acceptance and continuous use by elderly people. This is particularly true for the hearing aids [46–52]. Various studies have shown highly variable, often low, rates for the use of sensory aids in different settings, especially for hearing aids [53–60]. Other studies have shown different satisfaction rates among elderly users of different types of aids, with the lowest percentages for those wearing hearing aids [61]. Two hypotheses, not necessarily mutually exclusive, have been advanced to explain the high percentage of non-use and misuse of sensory aids. First is insufficient monitoring during the follow-up after the acquisition of the sensory aid; second is the possibility of a limited impact of the sensory aid on the overall QOL of the wearer, above and beyond simple improvement in sensory performance. Although not definitive, the results obtained in the present study make the second hypothesis no less likely.

Finally, a discussion has recently arisen in the literature, centred on factors to be taken into account in the evaluation of the cost/benefit ratios before the introduction of extensive screening programmes and rehabilitation treatments for sensory dysfunction in elderly people [52, 54, 62]. Some studies suggest that possible predictors of a successful sensory aid provision might include the level of the initial sensory deficit, the age of the subject, the type of sensory deficit and the subject's economic status [22, 54, 63]. Other studies have been unable to replicate these results and to find any correlates of successful hearing aid use, apart, perhaps, from the severity of the hearing deficit [64]. Our data stress the importance of considering not only the sensory deficits, but also QOL indices as fundamental variables to be used in any algorithm regarding successful or unsuccessful sensory aid provision for elderly people.

References

1. Weinstein BE, Ventry IM. Hearing impairment and social isolation in the elderly. *J Speech Hear Res* 1982;**25**: 593–9.
2. Thomas PD, Hunt WC, Garry PJ, Hood RB, Goodwin JM, Goodwin JS. Hearing acuity in an healthy elderly population: effects on emotional, cognitive and social status. *J Gerontol* 1983;**38**:321–5.
3. Bess FH, Lichtenstein M, Logan SA. The eyes and ears of the world of function: in reply [Letter]. *J Am Geriatr Soc* 1989;**37**:1100.
4. Bess FH, Lichtenstein MJ, Logan SA, Burger MC, Nelson E. Hearing impairment as a determinant of function in the elderly. *J Am Geriatr Soc* 1989;**37**:123–8.
5. Appollonio I, Carabellese C, Rozzini R, Frattola L, Trabucchi M. The eyes and ears of the world of function. *J Am Geriatr Soc* 1989;**37**:1099–100.
6. Branch LG, Horowitz A, Carr C. The implications for everyday life of incident self-reported visual decline among people over age 65 living in the community. *Gerontologist* 1989;**29**:359–65.
7. Mulrow CD, Aguilar C, Endicott JE *et al.* Association between hearing impairment and the quality of life of elderly individuals. *J Am Geriatr Soc* 1990;**38**:45–50.
8. Carabellese C, Appollonio I, Rozzini R, *et al.* Sensory impairment and quality of life in a community elderly population. *J Am Geriatr Soc* 1993;**41**:401–7.
9. Granick S, Kleban MM, Weiss AD. Relationship between hearing loss and cognition in normally hearing aged persons. *J Gerontol* 1971;**31**:434–40.

10. Herbst KG, Humphrey E. Hearing impairment and mental state in the elderly living at home. *Br Med J* 1981;**281**:903–5.
11. Weinstein BE, Amsell L. Hearing loss and senile dementia in the institutionalized elderly. *Clin Gerontol* 1986;**4**:3–15.
12. Uhlman RF, Larsson EB, Koepsell TD. Hearing impairment and cognitive decline in senile dementia of the Alzheimer's type. *J Am Geriatr Soc* 1986;**34**:207–10.
13. Peters CA, Potter JP. Hearing and visual impairment as predictors of cognitive decline in dementia. *J Am Geriatr Soc* 1987;**35**:905.
14. Peters CA, Potter JF, Scholer SG. Hearing impairment as a predictor of cognitive decline in dementia. *J Am Geriatr Soc* 1988;**36**:981–6.
15. Eastwood MR, Corbin-Rifat SL. Is the hearing-impairment/dementia relationship impaired? *J Am Geriatr Soc* 1989; **37**:489–90.
16. Uhlmann RF, Larson EB, Rees TS. Relationship of hearing impairment to dementia and cognitive dysfunction in older adults. *J Am Med Assoc* 1989;**261**:1916.
17. Thompson JR, Gibson JM, Jagger C. The association between visual impairment and mortality in elderly people. *Age Ageing* 1989;**18**:83–8.
18. Laforge R. Spector WD, Sternberg J. The relationship of vision and hearing impairment to one-year mortality and functional decline. *J Aging Health* 1992;**4**:126–48.
19. Appollonio I, Carabellese C, Magni E, Frattola L, Trabucchi M. Sensory impairments and mortality in an elderly community population: a six-year follow-up study. *Age Ageing* 1995;**24**:30–6.
20. Corrado OJ. Hearing aids. *Br Med J* 1988;**296**:33–4.
21. Hillman JS. Aids for low vision in the elderly. *Br Med J* 1988;**296**:102–3.
22. Parving A, Philip B. Use and benefit of hearing aids in tenth decade and beyond. *Audiology* 1991;**30**:61–9.
23. Plomp R. Auditory handicap of hearing impairment and limited benefit of hearing aids. *J Acoustical Soc Am* 1978; **63**:533–49.
24. Welzl-Muller K, Stephan K. The benefit of hearing aids: influence of hearing loss and age. *Scand Audiol* 1986;**15**: 115–19.
25. Kricos PB, Lesner SA, Sandridge SA, Yanke RB. Perceived benefits of amplification as a function of central auditory status in the elderly. *Ear Earing* 1987;**8**:337–42.
26. Brenner MH, Curbow B, Javitt JC, Legro MW, Sommer A. Vision change and quality of life in the elderly: response to cataract surgery and treatment of other chronic ocular conditions. *Arch Ophthalmol* 1993;**111**: 680–5.
27. Mulrow CD, Aguilar C, Endicott JE, *et al.* Quality-of-life changes and hearing impairment: a randomized trial. *Ann Intern Med* 1990;**113**:188–94.
28. Appollonio I, Carabellese C, Rozzini R, Frattola L, Trabucchi M. Sensorial aids and the quality of life in the elderly. *Rev Espanol Geriatr Gerontol* 1991;**26(suppl 1)**: 144.
29. Rozzini R, Bianchetti A, Franzoni S, Zanetti O, Trabucchi M. Social, functional and health status influences on mortality: consideration of a multidimensional inquiry in a large elderly population. *J Cross Cultural Gerontol* 1991;**3**:83–90.
30. Rozzini R, Bianchetti A, Carabellese C, Inzoli MR, Trabucchi M. Depression, life events and somatic symptoms. *Gerontologist* 1988;**28**:229–32.
31. Bianchetti A, Rozzini R, Carabellese C, Zanetti O, Trabucchi M. Nutritional intake, socioeconomic conditions and health status in a large elderly population. *J Am Geriatr Soc* 1990;**38**:521–7.
32. Kane R, Bell R, Riegher A, Wilson A, Kane RA. Assessing the outcomes of nursing home patients. *J Gerontol* 1983;**38**:385–93.
33. Kahn R, Goldfarb A, Pollock M, Peck A. Brief objective measure for the determination of mental status in the aged. *Am J Psychiatry* 1960;**117**:326–8.
34. Lawton M, Brody E. Assessment of older people: self-maintaining and instrumental activities of daily living. *Gerontologist* 1969;**9**:176–86.
35. Linn M, Linn B. Self-evaluation of Life Function (Self) scale: a short comprehensive self-report of health for elderly adults. *J Gerontol* 1984;**39**:603–12.
36. Fillenbaum G. *The well-being of the elderly: approaches to multidimensional assessment* (Offset Publication No. 84). Geneva: World Health Organization, 1985.
37. Ferrucci L, Guralnik JM, Baroni A, Tesi G, Antonini E, Marchionni N. Value of combined assessment of physical health and functional status in community dwelling aged: a prospective study in Florence, Italy. *J Gerontol* 1991;**46**: M52–6.
38. National Research Council Committee on Vision. Recommended standard procedures for the clinical measurement and specification of visual acuity. *Adv Ophthalmol* 1980;**41**:103–48.
39. Walsh J, Gold A. *Physicians' desk reference for ophthalmology*. Oradell NJ: Medical Economics Company Inc., 1988.
40. Swan I, Browning G. The whispered voice as a screening test for hearing impairment. *J R Coll Gen Pract* 1985;**35**:197.
41. Macphee GJA, Crowther JA, McAlpine CH. A simple screening test for hearing impairment in elderly patients. *Age Ageing* 1988;**17**:347–51.
42. Norusis M. *Statistical package for the social sciences, v.4.0.* Chicago, IL: SPSS Inc., 1990.
43. World Health Organization. *The prevention of blindness. WHO Tech Rep Ser* No. 518, Geneva: WHO, 1973.
44. Long CA, Holden R, Mulkerrin E, Sykes D. Opportunistic screening of visual acuity of elderly patients attending outpatient clinics. *Age Ageing* 1991;**20**:392–5.
45. Reinstein DZ, Dorward NL, Wormald RP, *et al.* 'Correctable undetected visual acuity deficit' in patients aged 65 and over attending an accident and emergency department. *Br J Ophthalmol* 1993;**77**:293–6.
46. Wheeler-Leff M. Special problem of amplication in the elderly. *J Otolaryngol* 1986;**15**:253–5.
47. George J, Binns VE, Clayden AD, Mulley GP. Aids and adaptations for the elderly at home: underprovided, underused and undermaintained. *Br Med J* 1988;**296**: 1365.
48. Pollack MD. Electroacoustic characteristics. In: Pollack MC, ed. *Amplification of hearing impaired.* 1st edn. New York: Grund & Stratton, 1975.
49. Dudley NY. Aids for visual impairments. *Br Med J* 1990; **301**:1151–3.
50. Golabek W, Nowakowska M, Siwiiec H. Degree of utilization of hearing aids by adults. *Otolaryngol Pol* 1991;**45**:381–5.
51. Von Wedel H, Von Wedel UC, Streppel M. Monitoring the efficiency of hearing aid fitting in the aged by the social hearing handicap index. *Acta Otolaryngol* [*Suppl*] (*Stockh*) 1990;**476**:270–6.

52. Weinstein BE. The quantification of hearing aid benefit in the elderly: the role of self assessment measures. *Acta Otolaryngol [Suppl] (Stockh)* 1990;**476**:257–61.
53. Newman CW, Hug GA, Wharton JA, Jacobson GP. The influence of hearing aid cost on perceived benefit in older adults. *Ear Hear* 1993;**14**:285–9.
54. Davis A, Stephens D, Rayement A, Thomas K. Hearing impairments in middle age: the acceptability, benefit and cost of detection. *Br J Audiol* 1992;**26**:1–14.
55. Stach BA, Loiselle LH, Jerger JF. Special hearing aid considerations in elderly patients with auditory processing disorders. *Ear Hear* 1991;**12(suppl 6)**:131–8S.
56. Newman CW, Jacobson GP, Hug GA, Weinstein BE, Malinoff RL. Practical method for quantifying hearing aid benefit in older adults. *J Am Acoust Audiol* 1991;**2**: 70–5.
57. Bade PF. Hearing impairment and the elderly patient. *Wis Med J* 1991;**90**:516–19.
58. Nabelek AK, Tucker FM, Letowski TR. Toleration of background noises: relationship with patterns of hearing aid use by elderly persons. *J Speech Hear Res* 1991;**34**: 679–85.
59. Parving A, Boisen G. In the canal hearing aids: their use by and benefit for the younger and elderly hearing impaired. *Scand Audiol* 1990;**19**:25–30.
60. Gates GA, Cooper JC, Kannel WB, Miller NJ. Hearing in the elderly: the Framingham cohort, 1983–1985: Part I. Basic audiometric test results. *Ear Hear* 1990;**11**:247–56.
61. Smedley TC. Self-assessed satisfaction levels in elderly hearing aid, eyeglass, and denture wearers: a cross-modality comparison. *Ear Hear* 1990;**11(suppl 5)**:41–7S.
62. De Nino LA, Mulrow CD, Gerety MB, Averty EC. Problems in interpreting cost effectiveness in clinical trials: experimental versus implementation cost. *Online J Curr Clin Trials*. 1993;Doc. No 44.
63. Lafon JC, Clavier I, Dornier L, Chaurand A. Hearing in the elderly and hearing aids. *Rev Laryngol Otol Rhinol Bord* 1990;**111**:325–32.
64. Mulrow CD, Tuley MR, Aguilar C. Correlates of successful hearing aid use in older adults. *Ear Hear* 1992;**13**:108–13.

Authors' addresses
I. Appollonio, L. Frattola
Clinica Neurologica, Università di Milano,
Ospedale San Gerardo, Monza, Italy

C. Carabellese*, M. Trabucchi
Gruppo di Ricerca Geriatrica,
Via Romanino 1, 25123 Brescia, Italy

*Address correspondence to Dr C. Carabellese

Received in revised form 24 July 1995