The impact of visual impairment on health, function and mortality

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*ABSTRACT. **Background and aims:** Our aim was to determine the impact of visual impairment on self-rated health, function and mortality amongst a community-dwelling elderly cohort. **Methods:** The study design was prospective and longitudinal, subjects being taken from an age-homogeneous, community-dwelling cohort comprising 452 subjects aged 70 in 1990 and 839 subjects aged 77 in 1998. Comprehensive data were collected by structured interviews and medical examinations carried out during home visits. Data included each subject's demographic and socio-economic profile, medical history, physical findings, functional status and self-rated health status. Visual acuity was measured using a Snellen chart and visual impairment was defined as best-eye corrected visual acuity of 20/40 or worse on Snellen chart testing. **Results:** Measured and self-reported visual impairment correlated closely, and were significantly more prevalent amongst subjects with low education and poor financial status. Visually impaired subjects showed significantly greater dependence in ADL and IADL, poor self-rated health, less ability to rely on friends, increased loneliness and, in men aged 77, increased visits to the emergency room and hospital admissions. Visual impairment at age 70 significantly predicted poor self-rated health (p=0.029, OR 2.36, 95% CI 1.09-5.10), dependence in ADL (p=0.007, OR 2.91, 95% CI 1.34-6.33), general tiredness (p=0.037, OR 2.40, 95% CI 1.06-5.44), and mortality, with a two-and-a-half-fold increase in risk of death at seven years (p=0.0017, OR 2.84, 95% CI 1.48-5.46). **Conclusions:** Visual impairment in the elderly increases the risk of social, functional and medical decline.
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INTRODUCTION

Visual impairment has long been recognized as an important factor in the aging process, and there is growing awareness of its significant influence on health and functional status. More recent findings indicate that visual impairment in the elderly has prognostic value as an independent predictor of mortality (1-4). Other studies have found evidence that visual impairment increases the risk of falls (5, 6), fractures (7, 8), use of community services (9), institutionalization (10, 11), and a decline in the ability to perform basic and instrumental activities of daily living (12, 13), as well as significant affective (14, 15) and cognitive morbidity (16). The vast majority of research has been based upon cross-sectional studies with study populations covering a wide range of different age groups, sampled from clinic- or hospital-based populations. Very few studies have analyzed the impact of diminished vision in the context of comprehensive assessment (4, 13), thus adjusting for the numerous comorbid factors present in an aging population. In the only previous investigation that did follow subjects longitudinally (4), the population studied was heterogeneous in age, ranging from 55 to 74 years old at baseline.

The objective of our study was to determine the impact of visual impairment on self-rated health, function and mortality among community-dwelling elderly. Its uniqueness is that, in addition to being longitudinal in design, the data collected on vision form part of a comprehensive geriatric assessment and the study population is an age-homogeneous cohort of 70-year olds, representative of the entire age stratum in Jerusalem.

METHODS

The methodology of the Jerusalem Longitudinal Study has been described in detail (17, 18). The study was initiated in 1990 and has followed a cohort of West Jerusalem

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residents born between June 1920 and May 1921. Subjects were identified using the Interior Ministry Register for national elections. At each phase of data collection, subjects were interviewed and examined, providing information from sociodemographic, medical, functional and cultural domains. The Helsinki Committee approved the study design. The first phase of data collection took place in 1990 and the second in 1998. The only difference in data collection at the second phase was that both interviews and examinations were carried out in the subject's home, whereas previously the examinations had been performed in a hospital ambulatory care setting.

The subjects of the 1990 sample group have been proved to be representative of the total age stratum of the Jerusalem population, as shown by identical three-year mortality and disease specific hospital morbidity (18). Showing that the sample group was representative of the total age stratum, enabled the enrolment of additional subjects into the cohort at the second stage of data collection, at age 78. Of the 452 subjects examined at age 70, 70 (15.5%) had died at the time of follow-up, 78 (17.3%) refused to participate, 21 (4.7%) had left Jerusalem, and a further 22 (4.9%) could not be traced. Thus, from the 382 surviving subjects, a total of 261 (68.3%) subjects were examined twice, forming the longitudinal group in the study, and 121 (31.7%) subjects were lost to follow-up. In order to maintain sample size and to ensure the subsequent phases of longitudinal data collection, a further 578 new subjects of the same age cohort were enrolled at the second stage of data collection.

Data are presented here from three groups: 1) Cross-sectional analysis of 452 subjects aged 70 in 1990; 2) Cross-sectional analysis of 839 subjects aged 77 in 1998; and 3) Longitudinal findings from 261 subjects examined in 1990 and 1998.

Analysis

Data storage and analysis were performed using the SAS package. Cohorts were examined both cross-sectionally and longitudinally. Cross-sectional analysis of each cohort at age 70 (452 subjects) and 77 (839 subjects) was performed using Chi-square analysis of variables. Multiple logistic regression analysis was performed on the 261 subjects for whom data was available from both phases of the study, to identify the impact of visual impairment over seven years. Odds ratio and confidence intervals were determined. The Log rank test was performed to determine seven-year mortality.

MEASURES
Visual impairment

Subjects were asked if they had difficulty in seeing according to the following question: "Do any problems with vision restrict or interfere with your personal or social life?" and examined by a specially trained nurse who tested visual acuity in Snellen equivalent values. Subjects who normally wore glasses were tested with corrected vision. Measured visual impairment was defined as best corrected visual acuity in the best eye of 20/40 or worse. This cut-off is widely recognized in research concerning function and mortality (2, 4, 8, 19, 20) and conforms to the definition of mild visual impairment of the American Academy of Ophthalmology (21). Several states within the USA also use this cut-off for issuing unrestricted drivers' licenses.

Comprehensive assessment

At each phase of data collection, subjects were systematically asked about their medical history, including a battery of questions concerning social, demographic, cultural and psychological factors, health habits, Emer-

Table 1 - *Comparison of subjects with good and impaired measured vision: social factors (%).*

| | Age 70 | | | | Age 77 | | | |
| | Women | | Men | | Women | | Men | |
	Good vision	Poor vision	Good vision	Poor vision	Good vision	Poor vision	Good vision	Poor vision
Total	153	54	194	51	356	71	344	68
Married	52.3	46.3	83.5	88.2	41.4	34.8	79	85.9
Living with spouse	52.3	40.5	85.6	86.3	38.1	33.3	77.9	79.7
Living alone	35.4	34.6	7.5	10	42.8	40.3	14.3	11.1
Living with child	6.5	11.3	19.1	20	9.4	17.4*	10.3	12.5
Education (>10 years)	75.8	51.9***	81.4	66.7*	73	45.1***	76.2	57.3**
Few/no money problems	80	65.4*	80.2	72.6	83.7	64.4***	89.6	71.7***
Relies on family	87	84	91.1	91.5	92	83*	89.4	85.7
Relies on friends	52	29.6**	47.9	33.3	20.7	8.9*	22.6	10.3*

*<0.05; **<0.01; ***<0.001.

Table 2 - *Comparison of subjects with good and impaired measured vision: Health-related findings at age 70 (%).*

	Women			Men		
	Good vision	**Poor vision**	***p*-value**	**Good vision**	**Poor vision**	***p*-value**
Number of subjects	153	54		194	51	
Generally feels tired	30.7	46.3	0.04	23.7	35.3	0.09
Good self-related health compared with others	63	42	0.009	66	50	0.04
Feels healthy	72.4	55.6	0.02	75.5	68.8	0.3
Feels lonely	38.7	71.7	<0.001	20	26	0.4
Independent ADL	66.4	43.4	<0.001	79.1	57.5	0.02
Independent IADL	77.1	54.7	0.05	69.4	70	0.7
Physical activity	52.9	49.0	0.6	56.2	54	0.8
Heart disease	52.3	48.1	0.6	54.6	54.9	0.9
Diabetes	13.7	9.3	0.4	14.4	29.4	0.01
Hypertension	41.2	51.9	0.2	36.6	29.4	0.3
Falls	36.6	42.3	0.5	18	20	0.8
Emergency room	22	20.7	0.8	20.8	29.4	0.2
Hospitalization	15.5	18.9	0.6	23.2	17.7	0.4

gency Room utilization, hospitalizations, falls in the preceding year, fractures in the prior seven years, and physical activity (as defined as going for a walk at least 4 times a week). Self-rated health was measured in both absolute terms and in relation to others of the same age.

Four Activities of Daily Living (ADL), transfer, dress, bathing and hygiene in the toilet, were taken from the Katz scale, whereas the Instrumental Activities of Daily Living (IADL) were cleaning the home, laundry, cooking, shopping and telephone use (22). Independence for each function was determined by direct observation. Comprehensive physical examination was performed including vital signs, neurologic examination, and cognitive and affective assessement. Dependence in ADL was defined as requiring assistance from another person in any activity tested; dependence in IADL was defined as requiring assistance from another person in more than one of the activities tested. Depression was identified by the Brief Symptoms Inventory (23).

Mortality data were obtained from a comprehensive review of all death certificates issued in Israel through the Ministry of the Interior, and are complete for all subjects remaining in Israel.

RESULTS

The basic demographic and social characteristics of the cohorts at ages 70 and 77 according to visual impairment are listed in Table 1. Visual impairment was significantly associated with low educational and financial status, at both ages 70 and 77. Amongst men aged 70, the association with financial status failed to achieve significance. Visually impaired subjects reported significantly diminished ability to rely on friends.

There was a close correspondence between measured visual impairment and the complaint that visual problems disturbed daily life. In subjects with measured impairment, 61% at age 70 (p=0.004) and 75% at age 77 (p=0.001) reported difficulty because of visual problems. In accordance with accepted norms in current research (24), measured visual impairment alone was used for data analysis.

The overall prevalence of measured visual impairment at ages 70 and 77 was 23.2% and 16.6% respectively. Of the visually impaired, those with measured impairment between 20/40 up to and including 20/70 formed the majority (76 and 72% at ages 70 and 77 respectively).

The association of decreased visual acuity with other health variables at ages 70 and 77 is listed in Tables 2 and 3 respectively. Visual impairment was significantly associated with poor absolute and relative self-rated health, and dependence in ADL and IADL. Visually impaired subjects reported more fatigue, a finding which achieved statistical significance in women aged 70.

Visually impaired women aged 70 and men aged 77 felt significantly more lonely. Health service use revealed that, of the 77-year-old men, visually impaired subjects had significantly more emergency room visits and hospital admissions. Falls were significantly increased amongst visually impaired 77-year olds. Although declining function was found with increased age across most domains, dependence still remained significantly greater in visually impaired subjects.

Diabetes was significantly associated with impaired vision (with the exception of 70-year-old women), as was hypertension in 77-year old women.

Table 3 - *Comparison of subjects with good and impaired measured vision: Health-related findings at age 77 (%).*

	Women				Men		
	Good vision	Poor vision	*p*-value		Good vision	Poor vision	*p*-value
Number of subjects	356	71			344	68	
Good self-related health compared with others	50.9	33.3	0.01		59.5	46.4	0.07
Feels healthy	55.4	40.6	0.02		66.8	40.6	<0.001
Feels lonely	41.1	45.6	0.5		22.9	39.7	0.007
Independent ADL	61.1	30.3	<0.001		77.3	52.4	<0.001
Independent IADL	64.7	36.7	<0.001		48.7	29.6	0.03
Physical activity	71.3	61.4	0.1		90.2	89.7	0.9
Heart disease	69.1	63.4	0.3		72.1	64.7	0.2
Diabetes	15.2	28.2	0.008		18.9	29.4	0.05
Hypertension	57.9	70.4	0.05		46.2	44.1	0.7
Falls	32.3	46.2	0.03		21.1	32.3	0.05
Fractures	33	30.8	0.8		15.6	8.6	0.3
Emergency room	19.9	26.2	0.2		15.7	35.6	<0.001
Hospitalization	11.6	14.5	0.5		9.7	21.9	0.005

Longitudinal findings

In order to examine the influence of impaired vision at age 70 on a number of health-related outcomes at age 77, data from subjects examined at both ages 70 and 77 were analyzed by multiple logistic regression. The dependent variables examined at age 77 were self-rated health relative to others, general tiredness, independence in ADL, level of physical activities, falls, fractures, emergency room visits, hospital admissions, loneliness, and depression. The independent variables at age 70 included in the regression model were visual impairment, self-rated health relative to others, general tiredness, independence in ADL, level of physical activity, falls, loneliness, depression, hearing ability, financial difficulties, and gender. The self-reported diagnoses of diabetes, hypertension and heart disease at age 70 were also included as confounding, comorbid variables. For each dependent variable measured in 1998, the same variable in 1990 was also included as an independent variable in the regression model, to compensate for the influence of baseline deficiencies

at age 70 by the factor being analysed. The results, listed in Table 4, show that impaired vision at age 70 contributes significantly and independently to poor self-rated health relative to others (OR 2.36, 95% CI 1.09-5.10), general tiredness (OR 2.40, 95% CI 1.06-5.44) and dependence in ADL (OR 2.91, 95% CI 1.34-6.33).

Mortality

Amongst subjects without measured visual impairment, 7-year mortality was 12.5%, whereas visually impaired subjects had a mortality rate of 26.7% (*p*=0.0007) (data not shown). A multiple logistic regression model was used to determine the influence of visual impairment at age 70 on 7-year mortality. Independent variables were visual impairment at age 70, self-rated health relative to others, independence in ADL, hypertension, diabetes, ischemic heart disease, cerebrovascular disease, anemia, respiratory disease, malignancy, kidney disease, cigarette smoking, financial difficulties, and gender. Visual impairment at age 70 was found to be a highly significant

Table 4 - *Effect of visual impairment at age 70 on health findings at age 77: regression analysis on longitudinal data.*

Dependent variable at age 77	*p*-value	Odds ratio	95% confidence interval
Good self-rated health compared with others	0.029	2.36	1.09-5.10
General tiredness	0.037	2.40	1.06-5.44
Dependence in ADL	0.007	2.91	1.34-6.33
Physical activities	0.66	2.63	0.94-7.36
Loneliness	0.18	1.89	0.75-4.77
Falls	0.58	1.25	0.56-2.75
Fractures	0.087	2.50	0.88-7.14

predictor of 7-year mortality (p=0.0017, OR 2.84, 95% CI 1.48-5.46).

DISCUSSION

This study clearly shows the widespread impact of visual impairment amongst a population-based cohort of 70-year olds over a follow-up period of 7 years. The comprehensive nature of the data permitted analysis of numerous variables, including a large number of confounding comorbid factors.

Despite the well-established fact that low self-rated health is an independent predictor of mortality (25, 26), extremely few studies have investigated its relationship to visual impairment. A recent study which addressed this issue (27) was based on an age-heterogeneous group and lacked longitudinal evaluation. Multivariate analysis failed directly to include ADL, a factor known to contribute significantly to self-rated health. Visual impairment was found to be significantly associated with poor self-rated health only in younger subjects. Our study found two separate measures of self-rated health to be highly associated with visual impairment at ages 70 and 77, and visual impairment at age 70 turned out to be a significant prognostic factor for poor self-rated health at age 77. Our data showed that visual impairment continues to erode self-rated health with advancing age, a finding to be extended at the next phase of data collection.

Although the prevalence of measured visual impairment decreased slightly with advancing age, there was an increase in the proportion of self-rated visual impairment in those with measured visual impairment. The findings are complementary, since greater mortality amongst visually impaired subjects explains the reduced survival and lower prevalence over time, whereas the increase in self-rated visual impairment supports the fact that the impairment does become a greater burden and a more meaningful barrier with increasing age.

With respect to functional status, the results of our study strengthen the growing consensus that visual impairment substantially affects the level of function, whether measured by ADL, IADL, or the need for community support services (4, 9, 13, 27, 28). In our population, visual impairment was significantly associated with functional decline in both ADL and IADL in both age groups. More importantly, this study confirms the long-term predictive value of visual impairment in identifying subjects at risk for subsequent functional decline.

Previous studies found a small to moderate impact of visual impairment on mortality (4, 29), and our results, which incorporated numerous comorbid factors, confirmed and strengthened these findings. Mild visual impairment at age 70 was associated with significantly increased mortality at age 77, carrying a two-and-a-half-fold greater risk of death.

The mechanisms of increased mortality in visually impaired people are probably both indirect and multifactorial. Perhaps less effective access to health services is partly due to a decreased social network and support (9), a six-fold lower likelihood of leaving their homes (1), increased falls and mishaps (5-8), functional decline (12, 13) and diminished psychological wellbeing (14-16), which all seem to be plausible factors contributing to a spiral of increasing frailty and vulnerability, themselves the harbingers of illness and death.

There are several limitations to this study. The known inaccuracy of death certificates, exacerbated by the extremely low number of autopsies performed in Israel, precluded reliable ascertainment of the cause of death, thus denying a more detailed insight into specific mechanisms of mortality.

Similarly, the individual causes of visual impairment were not evaluated, as self-reported data in this area are imprecise. The definition of visual impairment based upon Snellen chart acuity has traditionally been an accepted standard, although some recent reports have favored more comprehensive tests, such as the visual-function index (30) and activities of daily vision (31). These newer tools are themselves being assessed for validity. It should be emphasized that they attempt to refine rather than replace Snellen acuity, still the cornerstone in assessing visual function.

With regard to the loss to follow-up of subjects from longitudinal analysis, 121 (31.7%) of surviving subjects were lost to follow-up. Comparison of baseline characteristics revealed that those subjects who were followed up were more highly educated and had fewer financial difficulties – a finding common to longitudinal studies. More importantly, however, there was little difference between the groups in terms of visual impairment at baseline – visually impaired subjects formed 19 and 24% of those followed up and those lost to follow-up respectively.

Taken together, these results show the far-reaching negative consequences of even mild visual impairment in the elderly population, be it on self-related health, functional status or mortality. Far greater awareness of the significance of visual impairment in geriatric care and improved outreach services are necessary, aimed at improved detection, diagnosis and correction of visual problems.

ACKNOWLEDGEMENTS

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