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CLINICAL STUDY

Age-specific changes in the prevalence and management of optically correctable visual impairment between 1988 and 2000: the Ponza Eye Study

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Abstract

Purpose **To obtain age-specific data on changes in the prevalence and management of optically correctable visual impairments (OCVIs) in Ponza, Italy.**
Methods **Ophthalmologic examinations were carried out to 1000 Ponzans aged 40–87 years in 1988 and to 836 persons in 2000. Visual acuity (VA) was evaluated under uncorrected (VA_{UC}), presenting (VA_{PR}), and best-corrected (VA_{BC}) conditions. We calculated the prevalence of total OCVIs (subjects with $VA_{UC} > 0.5$ logMAR and $VA_{BC} \leqslant 0.5$ logMAR in the better eye), uncorrected OCVIs ($VA_{PR} > 0.5$ logMAR), and corrected OCVIs ($VA_{PR} \leqslant 0.5$ logMAR) as well as the OCVI correction rate ((corrected OCVI/total OCVI) $\times$ 100). Subjects with uncorrected OCVIs were compared to those with corrected OCVIs to evaluate possible associations with some risk factors.**
Results **Among 52- to 63-year olds there were increases in the prevalence of total OCVI (from 15.7 to 22.7%, $P = 0.051$), corrected OCVI (from 10.9 to 19.9%, $P = 0.005$), and OCVI correction rate (from 69.2 to 87.8%, $P = 0.045$). Among 64- to 75-year olds decreases were observed in the prevalence of total OCVI (from 28.5 to 20.0%, $P = 0.029$) and uncorrected OCVI (from 12.6 to 4.8%, $P = 0.003$) while the OCVI correction rate increased from 55.9 to 76.1% ($P = 0.033$). The overall prevalence of uncorrected OCVIs dropped from 7.5 to 4.1%. In 2000, uncorrected OCVI was associated with limited education, very advanced age, retirement, and refractive error associated with eye diseases.**
Conclusions **Refractive error management has improved in Ponza since 1988, and these changes may be, in part, due to higher education levels, increased frequency of cataract surgery, and slower progression of cataract-related disability.**
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Keywords: optically correctable visual impairment; prevalence; age; changes

Introduction

Throughout the world (in industrialized and non-industrialized countries alike), adult population-based studies have highlighted uncorrected refractive errors as an important cause of presenting visual impairment (VI).[1–18] The World Health Organization (WHO) estimated that in 2004, there were 153 million people in the world who were visually impaired by uncorrected refractive errors.[19] For this reason, refractive errors are among the conditions targeted by Vision 2020: The Right to Sight, a global initiative organized by the WHO and the International Agency for the Prevention of Blindness with the aim of eliminating avoidable forms of blindness.[20,21]

Most of the studies published thus far have investigated rates of presenting VI that can be eliminated with the use of corrective lenses. Whether and to what extent these impairments are actually being corrected is a question that has received much less attention. Spectacle utilization rates are an important indicator of

the availability of refractive services in a population and of subjects' compliance with prescriptions, but this parameter has been investigated in relatively few studies.[11,13,15,16]

In addition, there is no information on how these rates are changing, which is an important reflection of the success or failure of strategies for eliminating refractive errors. The Blue Mountains Eye Study is the only study that has assessed temporal changes in the rates of correctable VI in an industrialized Western population.[22]

The present study was designed to investigate age-specific correction rates for optically correctable visual impairments (OCVIs) and their temporal trends among the population aged 40–87 years of a small town in central Italy.

Materials and methods

The Ponza Eye Study was conducted in a small island municipality located 18 miles off the coast of the Latium region in central Italy. Ethical approval for the study was obtained from the Italian Ministry of Education, and informed written consent was obtained from all participants. The protocol complied with the tenets of the Declaration of Helsinki. The recruitment methods used have been fully described elsewhere.[23–25]

The study began in 1988, when standardized ophthalmologic examinations were offered to all legal residents of Ponza aged 40 years and over who actually lived in the community for at least 9 months of the year (eligible population). In the spring of 2000, a follow-up study was conducted to determine the incidence of VI; the results have been reported elsewhere.[23] Although the incidence study was naturally limited to the same subjects who had been examined in 1988, we did not limit enrolment in the 2000 study to citizens who had been examined in 1988. To increase the population's acceptance of the study, we again offered ophthalmologic examinations to all legal residents of Ponza aged 40 years and over who resided on the island 9 or more months a year. Therefore, the total population examined in 2000 included some citizens who for various reasons had not participated in the original study, and data obtained in these subjects have been subjected to various analyses (including those described in this report).

Identical methods, standardized examination procedure, and classification criteria were used in the 1988 and 2000 studies.[23–25] Visual acuity (VA), which is the specific focus of the present analysis, was evaluated separately for each eye with a standard 10-letter logarithmic chart at a distance of 4 m.[26] Near and distant VA was evaluated under uncorrected (VA_{UC}), presenting (VA_{PR}), ie with any corrective lenses (spectacles or contact lenses) being used by the subject (information elicited by specific questioning), and best-corrected (VA_{BC}) conditions. The latter evaluation was based on automated measurement of refraction and the results of trial correction using spherical and cylindrical lenses, the red-green duochrome test, and the dynamic cross-cylinder test in natural accommodation.

For the purposes of the present analysis, the term VA refers exclusively to distance VA. We defined VI as a VA of >0.5 logMAR (the equivalent of $<6/18$ or $<3/10$ or $<20/60$), in accordance with WHO recommendations.[27] Slightly different definitions have been used in other studies of this type,[11,13,15,16] and to facilitate comparisons, we also re-elaborated our data using these cutoffs. As in previous studies,[11,13,15,16] we classified subjects based exclusively on the VA of the better eye.

In each study population, we calculated the total rate of OCVIs, which was defined as the number of subjects with VI that could be completely eliminated with the use of corrective lenses (ie subjects with a VA_{UC} of >0.5 logMAR and a VA_{BC} of $\leqslant 0.5$ logMAR). The OCVIs were classified as pure refractive errors or refractive errors associated with other eye diseases, specifically cataract, diabetic retinopathy, or age-related macular degeneration. From a practical point of view, the OCVI rate corresponds to the variable referred to as 'total need for spectacles' in previous studies.[11,13,15,16] It is important to note, however, that the subjects analysed in the latter studies (and in our study as well) do not represent all those in the study population who need or might benefit from refractive correction. Notable exclusions include subjects with impaired near vision, those with milder distance impairments that fail to satisfy the pre-established criterion for impairment, and those whose VI might be improved with corrective lenses without achieving the normal VA cutoff established by the study protocol. For this reason, we preferred to use the term 'OCVI'.

Subjects with OCVIs were then divided into two broad groups based on the VA_{PR}: (1) those with corrected OCVIs, ie subjects who wore spectacles or contact lenses that resulted in a VA_{PR} of $\leqslant 0.5$ logMAR, and (2) those with uncorrected OCVIs, ie subjects with a VA_{PR} of >0.5 logMAR, including those who did not use any type of corrective lenses and those who wore spectacles or contact lenses that provided inappropriate correction. These groups correspond to the groups with met and unmet needs for spectacles in the studies cited above.[11,13,15,16]

Almost half the participants examined in 2000 were members of the original 1988 cohort. To avoid comparison of partially dependant samples, we divided both populations into non-conventional age groups (40–51, 52–63, 64–75, and 76–87 years) based on intervals of 12 years, ie the interval between the two studies, and

statistical analyses were carried out separately for each age group. In this manner, none of the participants who were examined twice were included in the same age group in both studies, and all comparisons involved populations that were completely independent.

For each of the four age groups, we calculated prevalence rates for total OCVIs, corrected OCVIs, and uncorrected OCVIs (based on the total number of subjects in each age group who completed the ophthalmologic examination), as well as the OCVI correction rate, ie the percentage of subjects with OCVIs whose impairment was fully corrected with the corrective lenses being used ((corrected OCVI/total OCVI) $\times$ 100). This variable corresponds to the 'spectacle coverage rate' reported by other investigators.[11,13,15,16] Differences between 1988 and 2000 rates were all assessed with the *z*-test.

We also evaluated possible associations between uncorrected OCVI and the following variables: age (40–51 years *vs* other age groups), gender (female *vs* male), marital status (married *vs* single), educational level (8 years of schooling or more *vs* 5 years of schooling or no education), occupation (non-manual labour *vs* manual labour, housewife, or retired), and type of refractive error (pure *vs* associated with other ocular disorders). For this analysis, the populations with uncorrected OCVIs were compared with those who had corrected OCVIs. Variables that emerged from this analysis as significant were then evaluated in a multivariate step-wise logistic regression model.

Results

In 1988 and 2000, the populations in Ponza that were eligible for enrolment in our studies numbered 1255 and 1216 respectively. The eligible population in 2000 consisted in 590 of the 1000 participants in the 1988 study plus 626 others who were not examined in 1988.[25] The majority of the subjects in the latter group (443 of 626, 71%) were residents aged 40–50 years in 2000 who had been too young to take part in the 1988 study.

In 1988, 1023 of the 1255 eligible citizens were actually examined, but complete data series were obtained for only 1000 (participation rate 79.7%). In 2000, 840 of 1216 eligible citizens were examined, and complete data series were collected for 836 (participation rate 68.8%). A total of 405 of these 836 subjects (48.4%) had also been examined in the 1988 study. Among the various factors that might have contributed to the appreciable drop in the participation rate in 2000 is the 'influx' of 40-year olds into the eligible population described above. This increased the number of subjects in the 40- to 51-year-old group, where job responsibilities made it difficult to take part in the study. There was also a substantial increase in the number of 76- to 87-year olds who were eligible for enrolment in 2000 (159 *vs* 139 in 1988), and non-participation for health problems (65 *vs* 46 in 1988) was common among these subjects.

Table 1 shows the age-specific changes in the prevalence of total, corrected and uncorrected OCVIs, and in OCVI correction rates between 1988 and 2000. The prevalence of total OCVI decreased significantly among 64- to 75-year olds (from 28.5 to 20.0%, $P = 0.029$) and increased among those aged 52–63 years (from 15.7 to 22.7%), although this change displayed only borderline significance ($P = 0.051$). The prevalence of corrected OCVIs in the latter age group also increased significantly (from 10.9 to 19.9%, $P = 0.005$). This change was accompanied by a significant improvement in the OCVI correction rate: the percentage of subjects with OCVIs who were using optimally corrective lenses rose from 69.2 to 87.5% ($P = 0.045$). The prevalence of uncorrected OCVIs in the 64- to 75-year age group dropped from 12.6 to 4.8% ($P = 0.003$), and this improvement was reflected in an increase in the OCVI correction rate from 55.9 to 76.1% ($P = 0.033$).

More detailed analysis of the subgroups with uncorrected OCVIs (75 subjects in 1998, 34 in 2000) revealed that 9 (12%) in 1988, but none in 2000, were blind. The percentage of subjects with uncorrected OCVIs who denied having had an eye examination prior to our studies decreased from 32% (24 of 75) in 1988 to 6% (2 of 34) in 2000. Almost half of those reporting previous eye examinations stated that no corrective lenses had been prescribed by the examiner (1988, 32 of 75 = 43%; 2000, 15 of 34 = 44%). Therefore, the percentage of subjects with uncorrected OCVIs who did not use corrective lenses at all decreased from 75% (56 of 75) in 1988 to 50% (17 of 34) in 2000, while there was an increase in the rate of subjects with inappropriate lenses (from 25% in 1988 (19 of 75) to 50% (17 of 34) in 2000). Over 60% of the uncorrected OCVI cases in both study populations (1988, 47 of 75 = 63%; 2000, 21 of 34 = 62%) had refractive errors associated with other eye diseases, mainly cataract (1988, 46 of 47; 2000, 19 of 21).

To determine whether and to what extent our 1988 study contributed to this improvement, we analysed the sample of 405 subjects who were examined in both studies (Table 2). Because this sample aged 12 years between the two examinations (mean age increased from 55.3 to 67.3 years), the percentage of subjects with no VIs ($VA_{UC} \leqslant 0.5$ logMAR) decreased from almost 88 to 72%; the incidence rates of uncorrected OCVI and nOCVI were 4.8 (17 of 355) and 3.1% (11 of 355) respectively. Of the 33 subjects with corrected OCVIs in 1988, 9 had a worse status in 2000 (two presented nOCVI and seven uncorrected OCVI). On the other hand, 11 of the 12 subjects with uncorrected OCVIs in 1988 had an

Table 1 Age-specific prevalence of total OCVIs, corrected OCVIs, uncorrected OCVIs, and OCVI correction rate in the Ponza Eye Studies

Age (years)	*Ponza 1988*					*Ponza 2000*				
	Examined no.	*Total OCVIs*[a] *no. (%)*	*Corrected OCVIs*[b] *no. (%)*	*Uncorrected OCVIs*[c] *no. (%)*	*OCVI correction rate*[d]	*Examined no.*	*Total OCVIs*[a] *no. (%)*	*Corrected OCVIs*[b] *no. (%)*	*Uncorrected OCVIs*[c] *no. (%)*	*OCVI correction rate*[d]
40–51	250	24 (9.6)	18 (7.2)	6 (2.4)	75.0%	296	32 (10.8)	28 (9.4)	4 (1.4)	87.5%
52–63	331	52 (15.7)*	36 (10.9)**	16 (4.8)	69.2%***	216	49 (22.7)*	43 (19.9)**	6 (2.8)	87.8%***
64–75	326	93 (28.5)§	52 (16.0)	41 (12.6)§§	55.9%§§§	230	46 (20.0)§	35 (15.2)	11 (4.8)§§	76.1%§§§
76–87	93	28 (30.1)	16 (17.2)	12 (12.9)	57.1%	94	26 (27.7)	13 (13.8)	13 (13.8)	50.0%

Abbreviation: OCVI, optically correctable visual impairment.
z-Test (1988 *vs* 2000 values): $^{*}P = 0.051$; $^{**}P = 0.005$; $^{***}P = 0.045$; $^{\S}P = 0.029$; $^{\S\S}P = 0.003$; $^{\S\S\S}P = 0.033$.
[a]Subjects with $VA_{UC} > 0.5$ logMAR and $VA_{BC} \leqslant 0.5$ logMAR.
[b]OCVIs with $VA_{PR} \leqslant 0.5$ logMAR.
[c]OCVIs with $VA_{PR} > 0.5$ logMAR.
[d](corrected OCVIs/total OCVIs) $\times 100$.

improved status in 2000 (nine had corrected OCVIs, and the other two no longer had OCVIs because they had undergone cataract extraction).

Table 3 shows the odds ratios (OR) for the single variables associated with uncorrected OCVIs in the 1988 and 2000 studies. The significant risk factors that emerged in 1988 were male sex and refractive errors associated with other eye diseases. In 2000, uncorrected OCVIs were significantly more likely to be found in subjects aged 76–87 years, those with 5 years of schooling or less, retirees, and subjects whose refractive errors were associated with other eye diseases. Multivariate stepwise logistic regression analysis confirmed that male sex (OR 2.0, 95% CI 1.1–3.8) and refractive errors with other eye diseases (OR 2.3, 95% CI 1.3–4.3) represented significant risks for uncorrected OCVIs in the 1988 population, whereas in 2000, the only significant risk factor was limited education (5 years or less: OR 4.3, 95% CI 1.3–13.8).

Discussion

To our knowledge, this is the first attempt to assess age-specific correction rates for OCVI and their temporal trends in a Western population. The reliability of our data is supported by the high participation rates and the identical methods, standardized examination procedure, and classification criteria used in the studies. In addition, we were able to investigate age-specific changes based on the analysis of samples that were completely independent of one another. The total 1988 and 2000 populations were characterized by a 48% overlap, and their comparison would have been statistically inappropriate. Nevertheless, the decrease observed in the whole-population prevalence of uncorrected OCVIs (1988, 7.5%; 2000, 4.1%) and the increase in the percentage of OCVIs that were currently being corrected with the subject's habitual lenses (1988, 61.9%; 2000, 77.8%) seem to be very important from clinical and social points of view.

Our approach to the identification of risk factors for uncorrected OCVI differs from that used by other investigators.[13,15,16,22] In those studies, the reference group was composed of subjects who did not need refractive correction, whereas in our study, subjects with uncorrected OCVIs were compared with those who had corrected OCVIs. A similar approach was used in Bangladesh,[11] and it seems more appropriate.

On the whole, the attitude of Ponzans towards the use of refractive correction seems to have changed over time. In 1988, uncorrected OCVIs were distributed uniformly throughout the population, with no relation to age, educational level, or occupation, although they were significantly more common in men than in women. In

Table 2 Changes in the frequency of OCVI and nOCVI, uncorrected and corrected OCVIs in the sample examined twice

Ponza 1988	*Ponza 2000*				*Total*
	NoVI[a]	*Corrected OCVI*	*Uncorrected OCVI*	*nOCVI*[b]	
No VI[a]	284	43	17	11	355
Corrected OCVI	4	20	7	2	33
Uncorrected OCVI	2	9	0	1	12
nOCVI[b]	0	0	0	5	5
Total	290	72	24	19	405

Abbreviations: OCVI, optically correctable visual impairment; nOCVI, non-optically correctable visual impairment; VI, visual impairment.
$n = 405$.
[a]Subjects with $VA_{UC} \leqslant 0.5$ logMAR.
[b]Subjects with $VA_{UC} > 0.5$ logMAR and $VA_{BC} > 0.5$ logMAR.

Table 3 Characteristics of the subjects with uncorrected *vs* corrected OCVIs and OR for uncorrected OCVIs in Ponza 1988 and Ponza 2000 Eye Studies

Variable	*Ponza 1988*				*Ponza 2000*			
	Uncorrected OCVIs	*Corrected OCVIs*	*OR (95% CI)*	P	*Uncorrected OCVIs*	*Corrected OCVIs*	*OR (95% CI)*	P
Age (years)								
40–51	6	18	1.0		4	28	1.0	
52–63	16	36	1.3 (0.4–4.0)	0.808	6	43	1.0 (0.3–3.8)	0.756
64–75	41	52	2.4 (0.9–6.5)	0.143	11	35	2.2 (0.6–7.7)	0.312
76–87	12	16	2.3 (0.7–7.4)	0.291	13	13	7.0 (1.9–25.7)	0.006
Gender								
Female	42	88	1.0		20	70	1.0	
Male	33	34	2.0 (1.1–3.7)[a]	0.030	14	49	1.0 (0.5–2.2)	0.843
Marital status								
Married	54	83	1.0		27	95		
Single	21	39	0.8 (0.4–1.6)	0.668	7	24	1.0 (0.4–2.6)	0.851
Education								
8 years and over	4	17	1.0		4	52	1.0	
5 years and less	71	105	2.9 (0.9–8.9)	0.137	30	67	5.8 (1.9–17.6)[a]	0.002
Occupation								
Non-manual labour	14	28	1.0		2	27	1.0	
Manual labour	17	24	1.4 (0.6–3.5)	0.590	5	15	4.5 (0.8–26.1)	0.173
Housewife	22	42	1.0 (0.5–2.4)	0.921	11	40	3.7 (0.8–18.1)	0.163
Retired	22	28	1.6 (0.7–3.7)	0.407	16	37	5.8 (1.2–27.5)	0.031
Refractive error (type)								
Pure	28	71	1.0		13	80	1.0	
With other diseases	47	51	2.3 (1.3–4.2)[a]	0.007	21	39	3.3 (1.5–7.3)	0.004

Abbreviations: CI, confidence interval; OCVI, optically correctable visual impairment, OR, odds ratio.
[a]Still significant after multivariate step-wise logistic regression analysis. *P*-values assessed with the *z*-test.

Ponza, awareness of the importance of VA seemed to be increased in 2000, and uncorrected OCVIs were confined to certain marginal components of the population (subjects with limited/no education, aged 76–87 years, and retirees). Uncorrected OCVIs were very strongly associated with limited/no education, particularly among the very elderly (indeed, none of the subjects in the oldest group had more than 5 years of schooling). Due to this association, other variables (age, retirement, and refractive errors associated with other eye diseases) were not confirmed as significant risk factors in the multivariate logistic regression analysis. Almost two-thirds (15 of 24 = 64%) of incident uncorrected OCVIs in 2000 (Table 2) were associated with the

progression or onset of cataracts during the 12-year interval between the two studies. Similarly, the presence of an unoperated cataract in at least one eye was also associated with most of the incident cases of non-optically correctable VI (9 of 14 = 64%).

On the basis of these findings, it appears that the refractive error services available in Italy do a satisfactory job of eliminating refractive errors in the working-aged, better educated sectors of the population: among subjects 63 years of age or younger, the OCVI correction rates were close to 90% by year 2000. These rates drop progressively thereafter, and roughly half of the 76- to 87-year olds with OCVIs were living with uncorrected impairments. It seems unrealistic to expect that refractive correction will actually be used by all subjects who need it, even in an industrialized country. As the authors of the Blue Mountains Eye Study in Australia noted, some people simply do not feel the need for correction.[22] Even in the Ponza study some people continue to consider a suboptimal VA 'a normal part of aging' or 'sufficient for their daily activities'.

For one thing, optimal correction requires regular follow-up examinations and adjustment of lens prescriptions (especially with the onset of age-related eye diseases like cataract). Although public health clinics in Italy are distributed throughout the territory, even short trips of a few blocks can be a problem for the elderly. The public health clinic in Ponza is located at the centre of the island, whereas the majority of the inhabitants live near the coasts and need a car or bus (which is indeed available and runs every 10–15 min) to reach the clinic.

As for the cost, a complete ophthalmologic examination through Italy's public health system is quite economical (€20, approximately US$13), and for many groups the examination is completely free of charge. These groups include invalids, victims of occupational injuries, and subjects with glaucoma or diabetes, as well as approximately 10 million persons over 64 years of age with family incomes below €36 000 per year (approximately $24 000). (It should be noted that the total number of over 64-year olds is only around 11 million!)

The cost of corrective lenses, however, is borne entirely by the patient, and it is substantially higher that of the eye examination. A pair of glasses with plastic lenses and basic, non-designer frames cost at least €100 (approximately $70). Elderly retired persons living on a fixed income are more likely to eliminate this expense and 'bother' and live with their VI, especially when the problem is less severe.

The increase in the prevalence of total OCVIs among 52- to 63-year olds is mainly the result of the increasing frequency of subjects with pure refractive errors, which rose significantly ($P = 0.021$) from 11.5% (38 of 331) in 1988 to 19.0% (41 of 216). It was accompanied by even more substantial increases in the prevalence of corrected OCVIs and in the OCVI correction rate). This improvement may be related to changes in the educational level of this age group, which also improved markedly. Almost half (44.9%) the subjects reported at least 8 years of schooling in 2000, as opposed to only 5.8% in 1988 ($P < 0.001$).

In the samples aged 64–75 years, a higher educational level (8 years or more: 1988, 5.4%; 2000, 17.4%; $P = 0.048$) and an increased frequency of cataract surgery (1988, 4.6%; 2000, 10.0%; $P = 0.021$) may have contributed to the decreases in total and uncorrected OCVIs (and therefore, to the increase of OCVI correction rate). It is also possible that there was a decrease in the progression rate of cataract-related disability in this population. In fact, the mean age of subjects with vision-impairing cataracts (severe enough to lower the VA_{BC} by more than 0.5 logMAR or to require surgical removal in at least one eye) increased significantly from 72.5 ± 7.8 to 75.3 ± 6.1 years.[25]

If we analyse our data using the broader definition of correctable VI (<20/40 in the better eye) and the more restrictive age limit used in that study (49 years and over), the prevalence of uncorrected OCVIs in Ponza (15.0% (121 of 809) in 1988, 12.3% (74 of 600) in 2000) is markedly higher than that found in the Blue Mountains community (7.5% in 1994 and 5.6% in 2000).[22] This striking difference is mainly due to Ponzans' tendency to neglect less severe forms of VI. In fact, the percentage of uncorrected OCVIs is appreciably lower when the cutoff for impairment is VA < 20/70 (8.6% (70 of 809) *vs* 5.0% (30 of 600)). Older age and lower educational level were associated with correctable VI in both cross sections examined in the Australian study[22] but only in the second cross section examined in Ponza. It is important to note that the follow-up in our study was more than twice as long as that of the Blue Mountains Study. During the 12 years that elapsed between our two studies, substantial improvements occurred in the educational levels of the study participants. Such marked changes are unlikely to occur within the 5-year span that separated the two studies in Blue Mountains.

Table 4 shows the OCVI correction rates in Ponza in 2000 compared with those reported in other studies on refractive error correction. Not surprisingly, the OCVI correction rate of Ponza is considerably higher than those reported in Bangladesh and in Timor-Leste.[11,15] The rates for Ponza are also appreciably higher than those reported for the population of Tehran aged 46–55 years, but the difference is less evident for older age groups.[13] The latter observation probably reflects an older mean age for this subset in the Ponza sample (aged 70.1 ± 7.5 years). OCVI correction rates for Ponzans aged 65 years and over (50.0%) are lower than that reported in Taiwan (71.2%).[16] Participants in the latter study were more

Table 4 Comparison of OCVI correction rates in Ponza (2000) and those observed in other studies

Author	*Previous studies*				*Ponza 2000 Eye Study*			
	Country	*Age (years)*	*OCVI VA cut-off*	*OCVI correction rate[a] (%)*	*Sample size*	*Total OCVI*	*Corrected OCVI*	*OCVI correction rate[a] (%)*
Bourne *et al*[11]	Bangladesh	30 and over	<6/12	25.2	836[b]	235	163	69.4
Bourne *et al*[11]	Bangladesh	30 and over	<6/18	40.5	836[b]	153	119	77.8
Fotouhi *et al*[13]	Iran	46–55	<20/40	59.6	199	48	42	87.5
Fotouhi *et al*[13]	Iran	56 and over	<20/40	48.9	467	157	88	55.4
Ramke *et al*[15]	Timor-Leste	40 and over	<6/18	17.0	836	153	119	77.8
Kuang *et al*[16]	Taiwan	65 and over	<6/12	71.2	310	116	58	50.0

Abbreviation: OCVI, optically correctable visual impairment.
[a]Also referred to as spectacle coverage rate.[11,13,15,16]
[b]Age 40 years and over.

Table 5 Age-specific data on OCVIs in Ponza 2000 re-elaborated to reflect conventional 10-year age groups

Age (years)	*Examined*	*Total OCVIs[a] no. (%)*	*Corrected OCVI[b] no. (%)*	*Uncorrected OCVI[c] no. (%)*	*OCVI correction rate[d] (%)*
40–49	257	26 (10.1)	22 (8.6)	4 (1.6)	84.6
50–59	182	39 (21.4)	36 (19.8)	3 (1.6)	92.3
60–69	154	38 (24.7)	29 (18.8)	9 (5.8)	76.3
70–79	192	41 (21.4)	27 (14.1)	14 (7.3)	65.9
80+	58	10 (17.2)	5 (8.6)	5 (8.6)	50.0
Total	843	154 (18.3)	119 (14.1)	35 (4.2)	77.3

Abbreviation: OCVI, optically correctable visual impairment.
[a]Subjects with $VA_{UC} > 0.5$ logMAR and $VA_{BC} \leqslant 0.5$ logMAR.
[b]OCVIs with $VA_{PR} \leqslant 0.5$ logMAR.
[c]OCVIs with $VA_{PR} > 0.5$ logMAR.
[d](corrected OCVIs/total OCVIs) × 100.

likely to be men (61 *vs* 43% in Ponza), younger (65- to 74-year olds accounted for 74 *vs* 64% in Ponza), and better educated (38% completed high school *vs* 5% in Ponza), and these differences may in part justify the higher rates of correction. The cutoff used in this study was 6/12, and as noted above, Ponzans tended to neglect mild to moderate VIs. In fact, in subjects aged 65 and over, the OCVI correction rate in Ponza was considerably higher (41 of 63 = 65%) when a 6/18 cutoff was used. In general, the same trend is evident in the entire sample.

To facilitate comparison with data from other studies, Table 5 shows age-specific prevalence rates for Ponza in 2000 re-distributed according to conventional 10-year age groups.

It is conceivable that the examinations carried out in our 1988 study contributed to some degree to the decreased prevalence of uncorrected OCVIs that we observed in 2000, but we feel that its actual effect on our data was probably quite limited. In fact, among the subjects examined twice (Table 2), the incidence of uncorrected VIs was fairly high (6% for OCVIs and 4.7% for those that could not be corrected with lenses alone).

In conclusion, since 1988, the prevalence of uncorrected OCVIs in Ponza has been clearly dropped, and the OCVI correction rates have been increased. This finding is consistent with the decreasing prevalence of overall VI observed in Blue Mountains Eye Study, where the trend has been putatively attributed to the increased availability of local eye care services, earlier cataract surgery, and improved public health education.[22] During the 12-year interval between our two studies, access to local outpatient ophthalmologic health care services did not change at all in Ponza. However, cataract surgery undoubtedly became a more accessible and less invasive procedure. In addition, there was a documented improvement in the level of education in Ponza, which is likely to be associated with different visual needs and a greater awareness of eye diseases and the importance of eye examinations. These factors probably contributed to the decreasing rates of OCVI we observed in the small Italian community.

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References

1 Tielsch JM, Sommer A, Witt K, Katz J, Royall RM. Blindness and visual impairment in an American urban population. The Baltimore Eye Survey. *Arch Ophthalmol* 1990; **108**: 286–290.
2 Klein R, Klein BE, Linton KL, De Mets DL. The Beaver Dam Eye Study: visual acuity. *Ophthalmology* 1991; **98**: 1310–1315.
3 Attebo K, Mitchell P, Smith W. Visual acuity and the causes of visual loss in Australia. The Blue Mountains Eye Study. *Ophthalmology* 1996; **103**: 357–364.
4 Liou HL, McCarty CA, Jin CL, Taylor HR. Prevalence and predictors of undercorrected refractive errors in the Victorian population. *Am J Ophthalmol* 1999; **127**: 590–596.
5 Weih LM, VanNewkirk MR, McCarty CA, Taylor HR. Age-specific causes of bilateral visual impairment. *Arch Ophthalmol* 2000; **118**: 264–269.
6 Thiagalingam S, Cumming RG, Mitchell P. Factors associated with undercorrected refractive errors in an older population: the Blue Mountains Eye Study. *Br J Ophthalmol* 2002; **86**: 1041–1045.
7 Munoz B, West SK, Rodriguez J, Sanchez R, Broman AT, Snyder R *et al*. Blindness, visual impairment and the problem of uncorrected refractive error in a Mexican American population: Proyecto VER. *Invest Ophthalmol Vis Sci* 2002; **43**: 608–614.
8 Dandona R, Dandona L, Naduvilath TJ, Srinivas M, McCarty CA, Rao GN. Refractive errors in an urban population in southern India: the Andhra Pradesh Eye Disease Study. *Invest Ophthalmol Vis Sci* 1999; **40**: 2810–2818.
9 Dandona R, Dandona L, Kovai V, Giridhar P, Prasad MN, Srinivas M. Population-based study of spectacles use in southern India. *Indian J Ophthalmol* 2002; **50**: 145–155.
10 Zainal M, Ismail SM, Ropilah AR, Elias H, Arumugam G, Alias D *et al*. Prevalence of blindness and low vision in Malaysian population: results from the National Eye Survey 1996. *Br J Ophthalmol* 2002; **86**: 951–956.
11 Bourne RRA, Dineen BP, Huq DMN, Ali SM, Johnson GJ. Correction of refractive error in the adult population of Bangladesh: meeting the unmet need. *Invest Ophthalmol Vis Sci* 2004; **45**: 410–417.
12 Schémann JF, Inocencio F, de Lourdes Monteiro M, Andrade J, Auzemery A, Guelfi Y. Blindness and low vision in Cape Verde Islands: results of a national eye survey. *Ophthalmic Epidemiol* 2006; **13**: 219–226.
13 Fotouhi A, Hashemi H, Raissi B, Mohammad K. Uncorrected refractive errors and spectacle utilization rate in Tehran: the unmet need. *Br J Ophthalmol* 2006; **90**: 534–537.
14 Dineen B, Bourne RRA, Jadoon Z, Shah SP, Khan MA, Foster A *et al*. On behalf of the Pakistan National Eye Survey Study Group. Causes of blindness and visual impairment in Pakistan. The Pakistan National Blindness and Visual Impairment Survey. *Br J Ophthalmol* 2007; **91**: 1005–1010.
15 Ramke J, du Toit R, Palagyi A, Brian G, Naduvilath T. Correction of refractive error and presbyopia in Timor-Leste. *Br J Ophthalmol* 2007; **91**: 860–862.
16 Kuang TM, Tsai SY, Hsu WM, Cheng CY, Liu JH, Chou P. Correctable visual impairment in an elderly Chinese population in Taiwan: the Shihpai Eye Study. *Invest Ophthalmol Vis Sci* 2007; **48**: 1032–1037.
17 Casson RJ, Newland HS, Muecke J, McGovern S, Durkin S, Sullivan T *et al*. Prevalence and causes of visual impairment in rural Myanmar: the Meiktila Eye Study. *Ophthalmology* 2007; **114**: 2302–2308.
18 Rutzen AR, Ellish NJ, Schwab L, Graham PJ, Pizzarello LD, Hemady RK *et al*. Blindness and eye disease in Cambodia. *Ophthalmic Epidemiol* 2007; **14**: 360–366.
19 Resnikoff S, Pascolini D, Mariotti SP, Pokharel GP. Global magnitude of visual impairment caused by uncorrected refractive errors in 2004. *Bull World Health Organ* 2008; **86**: 63–70.
20 Thylefors B. A global initiative for the elimination of avoidable blindness. *Am J Ophthalmol* 1998; **125**: 90–93.
21 Pararajasegaram R. Vision 2020—The Right to Sight: from strategies to action. *Am J Ophthalmol* 1999; **128**: 359–360.
22 Foran S, Rose K, Wang JJ, Mitchell P. Correctable visual impairment in an older population: the Blue Mountains Eye Study. *Am J Ophthalmol* 2002; **134**: 712–719.
23 Nucci C, Cedrone C, Culasso F, Cesareo M, Ricci F, Corsi A *et al*. Incidence of visual impairment in the Ponza Eye Study, Italy. *Eye* 2005; **19**: 175–182.
24 Cedrone C, Nucci C, Scuderi G, Ricci F, Cerulli A, Culasso F. Prevalence of blindness and low vision in an Italian population. A comparison with other European studies. *Eye* 2006; **20**: 661–667.
25 Cedrone C, Ricci F, Nucci C, Cesareo M, Macrí G, Culasso F. Age-specific changes in the prevalence of best-corrected visual impairment in an Italian population. *Ophthalmic Epidemiol* 2007; **14**: 320–326.
26 Ricci F, Cedrone C, Cerulli L. Standardized measurement of visual acuity. *Ophthalmic Epidemiol* 1998; **5**: 41–53.
27 World Health Organization. *International Classification of Diseases and Related Health Problems*,10th Revision. World Health Organization: Geneva, Switzerland, 1992; 456–457.