J Nutr Health Aging. 2019;23(8):687-693

DECLINE IN INSTRUMENTAL ACTIVITIES OF DAILY LIVING OVER 4-YEAR: THE ASSOCIATION WITH HEARING, VISUAL AND DUAL SENSORY IMPAIRMENTS AMONG NON-INSTITUTIONALIZED WOMEN

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Abstract: *Objective:* Most older adults express the wish to live at home as long as possible, thus autonomy promoting measures are essential. Hearing and visual impairments are common among older people, and they have been consistently associated with functional disability. However, longitudinal data are scarce, notably regarding dual sensory impairments (both in hearing and vision). We aimed at assessing the relationship between hearing, visual, and dual sensory impairments, and subsequent decline in instrumental activities of daily living (IADL). *Design:* Longitudinal. *Setting:* the French E3N-elderly sub-cohort. *Participants:* 4,010 community-dwelling older women born between 1925 and 1930, and free of IADL limitations in 2006. *Measurements:* Hearing and visual impairments were self-reported in 2006. IADLs were evaluated in 2006 and 2010. *Results:* After 4 years of follow-up, 588 women became limited in their IADLs. In logistic regression models adjusted for potential confounders, odds ratios [95% confidence interval] for developing IADL limitations were 1.18 [0.98; 1.41], 1.98 [1.26; 3.11], and 2.61 [1.50; 4.54] for hearing, visual, or both sensory impairments respectively, compared with no sensory impairment at baseline. *Conclusion:* Results suggest that among autonomous older women, visual, and to a lesser extent, hearing impairment, have a short-term negative impact on their ability to perform daily activities, with some evidence of a multiplicative effect between sensory impairments. Appropriate evaluation and management of sensory impaired elderly, and more particularly those with dual impairments, may contribute to prevent disability in aging.

Key words: Women, cohort, vision, hearing, IADL, dual sensory impairment.

Introduction

Older adults with limitations in everyday activities become more often institutionalized than autonomous ones (1, 2), highlighting the importance to prevent disability in aging. Besides advanced age (3) and multiple morbidities (4, 5), factors that have been associated with daily activity limitations include inappropriate dietary habits (6, 7), and physical inactivity (8, 9). Hearing and visual impairments, which are frequently observed in older populations (10), are also important factors of disability. In particular, they have been consistently related to higher prevalences of disability in studies focused on visual impairment (11-15), hearing impairment (16), or dual impairments (17-22). Causes of visual impairment include refractive errors (myopia, hyperopia, presbyopia, and astigmatism), as well as eye diseases such as cataract, glaucoma, age-related macular degeneration, or diabetic retinopathy. Hearing impairment is mainly due to age-related hearing loss or presbycusis which is a multifactorial sensorineural loss. It is frequently associated with impairment in speech discrimination. In many cases, sensory impairment can be corrected by hearing aids or visual devices, which make sensory impairments an interesting target to preserve autonomy in elderly and in turn, promote their quality of life.

If a direct link between sensory impairment and activity limitations is easy to assess for some domains (for example, ability to use transportation means is severely affected by vision impairment), how sensory impairment can prospectively affect limitation occurrence among autonomous older subjects has been little studied (11, 16). Data are particularly scarce on the specific impact of dual sensory impairment, i.e. concurrent vision and hearing impairments in the disablement process (23-25). Preliminary studies on dual impairments suggested a cumulative effect of sensory impairments on the probability to become functionally impaired (17-21, 23, 24) but were limited by their cross-sectional design or their small size.

We hypothesized that, among autonomous older people, those with a dual sensory impairment would be more likely to become limited in their daily activities than those with a single sensory impairment, the latter being themselves more likely to become limited than women with no sensory impairment at all. To explore this hypothesis, we used data on the eldest women of the E3N cohort, those born 1925-1930, who were sent twice a specific questionnaire on aging twice, in 2006 and in 2010. We investigated the association between self-reported sensory impairments in 2006 in autonomous women, and the subsequent decline in instrumental activities of daily living (IADL).

Methods

Cohort and study population

The study included the oldest women involved in the ongoing E3N (Etude épidémiologique auprès des femmes de la Mutuelle Générale de l'Education Nationale) prospective

Received November 19, 2018
Accepted for publication December 11, 2018
Published online August 3, 2019, http://dx.doi.org/10.1007/s12603-019-1231-9

cohort study (26) i.e. those born between 1925 and 1930, subsequently referred to as the E3N-elderly. The E3N cohort has been launched in 1990 to investigate factors associated with major chronic diseases among women born between 1925 and 1950 and affiliated with the health insurance plan for Public Education employees and their families. All women gave a written informed consent and were biennially sent questionnaires on their medical outcomes and lifestyle habits. In 2006 and in 2010, the E3N-elderly were included in a specific aging survey including questionnaires on sensory impairments, and on social and everyday activities.

Assessment of IADL decline

In 2006 and 2010, the E3N-elderly evaluated their functional abilities by filling up the IADL questionnaire (27). The tool evaluates eight domains of daily living: using the telephone, using transportation means, shopping, handling medications, handling finances, doing the laundry, preparing meals, and tidying the house. Every item is scored 0 or 1 according to the inability or the ability to perform the corresponding activity. The final score is the sum of the 8 items and ranges from 0 to 8 with 0 the lowest degree of autonomy and 8 the highest one. In the present study, we included only women with no IADL limitations in 2006, and investigated the occurrence of IADL limitations in 2010, hereafter named "IADL decline".

We additionally explored the association between sensory impairments and the cognitive components of IADL decline: we isolated the four items that are especially sensitive to cognitive impairment (i.e. using the telephone, using transportation means, handling medications, and handling finances) (28), and created a three-category outcome: women free of any IADL limitation in 2010 (no IADL decline), women with at least one cognitive IADL limitation in 2010 (cognitive-type IADL decline), and other limited women (other type-IADL decline).

Assessment of sensory impairments

Visual impairment was defined as self-reported difficulties in reading a newspaper and/or recognizing a 4-metre far person, with correcting devices if needed (29, 30). Hearing impairment was assessed through self-reported difficulties in listening to and understanding a conversation in a noisy environment, with correcting devices if needed (31, 32). Each impairment was considered as present vs. absent (33). To operationalize dual sensory impairment and explore the effect associated with accumulated sensory impairments, we further crossed these two variables and defined a 4-category impairment variable (no, hearing only, visual only, and dual).

Assessment of potential confounders

Models were adjusted for potential confounders, i.e. factors potentially associated with both IADL limitations and sensory impairments, namely age, level of education, marital status, recreational physical activity, social activities, and a comorbidity index. Specifically, the level of education (no high school diploma/1-2 university years/above 2 university years) was reported at baseline in 1990. "Recreational" physical activity was ascertained in 1993, combining activities of cycling, walking, and sports, averaged over the winter and summer seasons, and was expressed in metabolic equivalent task (MET) per hour over a week (34) (tertiles, <13, 13-28, or >28). The compendium assigned MET values were 6.0 for cycling and other sports, and 3.0 for walking (34). In 2006, women reported their marital status (living with someone, living alone) as well as their social activities. The social activity index was based on the score of the 3-Cités study (35) with questions on the participation frequency at 11 social activities (e.g. invited by friend or family to their home, going to the theater/cinema, attending a club or leisure association, etc.). Responses were coded 0 (rarely or never), 1 (1 to 3 times a month), 2 (once a week), 3 (at least twice a week), and the final score ranged from 0 to 33. As recommended by Isaac et al., the final score was categorized into 3 groups: limited (0-7.5), moderate (8-11.5), and dense (12-33). Regarding comorbidities, we defined a 3-category (none, one, two or more) from the number of prevalent or past major conditions among myocardial infarction, stroke, hypertension, diabetes, bronchitis, emphysema, hepatitis B/C, gastric ulcer, arteritis in the lower limbs, cancer, Alzheimer's disease, hypothyroidism, fracture, and depressive symptoms. Most conditions had been validated through medical reports or previously described procedures (36-38).

Study sample

Among the 10,041 participants of the E3N-elderly subcohort, 907 died before 2006 and 189 dropped out before that time, leaving 8,945 women who were sent the specific questionnaire on aging in 2006 and in 2010. In total, 5,689 returned both questionnaires (n=7,224 in 2006 and n=6,268 in 2010). We excluded 949 women with missing values or equivocal answers to one or more IADL items, and 209 with missing data regarding either visual or hearing impairment in 2006. There were no statistical differences between included women and women excluded because of missing data in sensory impairment regarding age (77.6.±.1.6 and 77.5 ± 1.5 years respectively, p=0.19) or the IADL score (7.8 ± 0.8 and 7.7 ± 0.8 respectively, p=0.29).

Finally, we excluded the 521 women who were limited in at least one IADL in 2006, thus restricting our population to the 4,010 women free of any IADL limitation in 2006.

Missing values

Missing values for confounders were less than 5% and, to limit sample attrition, were imputed to the modal category of the overall population (level of education, marital status). Concerning the social activity index, missing data in specific items were imputed to the "rarely or never" response and multiple answers to the median value of the person's answers.

Table 1
Women's characteristics according to visual and hearing impairment status in 2006, E3N-elderly subcohort (n=4,010)

	No visual impairment	Visual impairment	p[a]	No hearing impairment	Hearing Impairment	p[a]
	n= 3,903	n=107		n=1,919	n=2,091	
Age mean ± SD	77.59 ± 1.59	77.87 ± 1.49	0.062	77.54 ± 1.57	77.66 ± 1.61	0.088
IADL in 2010 (score/8) mean ± SD	7.76 ± 0.74	7.54 ± 1.04	0.004	7.77 ± 0.76	7.74 ± 0.75	0.169
Social activity level (%)			0.163			0.106
Dense	41.7	32.7		42.9	40.2	
Moderate	34.3	38.3		32.8	35.9	
Limited	23.9	29.0		24.3	23.9	
Level of education (%)			0.676			0.868
>2 years of university	28.5	28.0		28.1	28.8	
1-2 years of university	55.9	53.3		56.0	55.8	
No high school diploma	15.6	18.7		15.9	15.5	
Marital status (%)			0.372			<0.001
In a relationship	56.7	52.3		60.0	53.4	
Alone	43.3	47.7		40.0	46.6	
"Recreational" physical activity in METs-h/week (%)			0.362			0.381
<13	33.6	38.3		32.7	34.6	
13-28	34.4	28.0		34.3	34.2	
>28	32.0	33.6		32.9	31.2	
Comorbidity indexb (%)			0.229			0.018
None	16.8	14.0		18.1	15.4	
1	47.4	42.1		47.7	46.8	
≥2	35.9	43.9		34.2	37.8	

a. Chi^2 test for categorical variables, Student t test for continuous variables; b. Number of prevalent or past major conditions among myocardial infarction, stroke, hypertension, diabetes, bronchitis, emphysema, hepatitis B/C, gastric ulcer, arteritis in the lower limbs, cancer, Alzheimer's disease, hypothyroidism, fracture, and depressive symptoms

Statistical analysis

Descriptive statistics used means and standard deviations for quantitative variables and percentages for categorical ones. We used Chi square tests to study associations between women's characteristics, and visual and hearing impairments.

To investigate the association between sensory impairments and IADL decline, we carried out multivariate logistic regression. Polytomous logistic regression was additionnally performed when distinguishing the type of IADL decline (no decline, cognitive-type decline, other-type decline). Associations were expressed as odds ratios (OR) with 95% confidence intervals (95%CI), and p-values.

To test the hypothesis that age, marital status, level of education, or level of social activity could modify the association between visual or hearing impairments and IADL decline, we performed separate models to test interaction terms between each sensory impairment and the potential effect modifiers and implemented stratified analyses if the p-value related to the interaction term was less than 0.05.

Statistical analyses were carried out using SAS, version 9.3 (SAS Institute, Inc., Cary, NC). P-values for statistical significance were set as <0.05.

Results

The 4,010 community-dwelling older French women included in the study were aged 78 ± 1.6 years in 2006. Most of them had up to 2 university years (55.9%), and were living at home with someone (56.6%). Among them, 588 (14.7%) experienced an IADL decline after 4 years of follow-up, which was quite evenly distributed between cognitive-type decline (n=279) and other-type decline (n=309). In 2006, 52.1% of women reported a hearing impairment, and 2.7% a visual impairment. In total, a dual impairment was reported by 1.7% of the study women. Among the 2,091 women who reported a hearing impairment, 1,535 (73.4%) had no hearing aids, and 556 (24.6%) had hearing aids that insufficiently corrected the impairment. All women reporting visual impairments (n=107) had visual devices that insufficiently corrected their visual impairment (Data not tabulated).

Table 2
Association between visual, hearing, and dual sensory impairments in 2006 and subsequent IADL decline in 2010, E3N-elderly subcohort (n=4,010)

	No decline	IADL decline	Univariate[a]		Multivariate[b]	
	%	%	OR [95%CI]	p-values	OR [95%CI]	p-values
	n=3,422	n=588				
MODEL 1[c]						
Visual impairment						
No	97.72	95.07	Reference		Reference	
Yes	2.28	4.93	2.14 [1.38; 3.31]	0.001	1.98 [1.26; 3.11]	0.003
Hearing impairment						
No	48.60	43.54	Reference		Reference	
Yes	51.40	56.46	1.21 [1.01; 1.44]	0.035	1.18 [0.98; 1.41]	0.077
MODEL 2						
Sensory impairment pattern				0.0009		0.004
No impairment	47.63	42.18	Reference		Reference	
Visual impairment only	0.96	1.36	1.60 [0.73; 3.52]	0.243	1.55 [0.69; 3.47]	0.284
Hearing impairment only	50.09	52.89	1.18 [0.98; 1.41]	0.073	1.16 [0.97; 1.40]	0.110
Dual impairment	1.32	3.57	2.85 [1.66; 4.88]	<0.001	2.61 [1.50; 4.54]	0.001

a. adjusted for age; b. adjusted for age, level of education, marital status, social activity level, "recreational" physical activity, and comorbidity index; c. model mutually adjusted

Women with hearing impairments were less likely to be living at home with someone (p<0.0001) and to report few comorbidities (p=0.0177) than unimpaired women (Table 1). Visually impaired women had a lower mean IADL score in 2010 (p=0.004) than non-impaired ones. Hearing impairment was not associated with the mean 2010 IADL score.

Sensory impairments and IADL decline

Among visually impaired women, 27.1% underwent IADL decline as compared to 14.3% among unimpaired (p<0.001). After adjustment for level of education, marital status, social activity level, "recreational" physical activity, and the comorbidity index, women with visual impairment had a higher risk of IADL decline than women with no visual impairment in 2006 (OR: 1.98, 95%CI: [1.26; 3.11]) (Table 2).

Among hearing impaired women, 15.9% underwent IADL decline as compared to 13.3% among unimpaired (p=0.023). After multivariate adjustment, the association between hearing impairment and IADL decline was borderline statistically significant (OR: 1.18, 95%CI: [0.98; 1.41]) (Table 2).

Dual visual and hearing impairment was associated with higher odds of IADL decline compared to women with no sensory impairment (OR: 2.61, 95%CI: [1.50; 4.54]) (Table 2).

When separately investigating cognitive-type and other-type IADL decline, visual impairment was slightly more strongly associated with cognitive-type decline (OR: 2.20, 95%CI [1.23; 3.93]) than with the other-type decline (OR: 1.88, 95%CI [1.04; 3.39]). Dual sensory impairments almost tripled the risk of reporting cognitive-type decline (OR=2.95, 95%CI [1.49; 5.83]) and was also strongly associated with other-type decline (OR: 2.48, 95%CI [1.17; 5.26]) (Table 3).

There was no evidence of any effect modification by age, marital status, or level of education.

Discussion

Among 4000+ French women aged 76 and older, all autonomous at baseline, those with a dual sensory impairment were at more than a 2.5-fold higher risk of IADL decline after a 4-year follow-up. Visual sensory impairment appeared to be the main contributor to the association but there was some evidence that hearing impairment had an aggravating effect. Our results add to the literature on the longitudinal association between visual and hearing impairments and the increased risk of functional decline, and highlight the importance of adequately managing sensory impairments in older adults.

In this specific population, we confirmed the hypothesis of an increased probability of IADL decline among women with even a single sensory impairment compared to those with no such impairment. The 4-year risk of IADL decline doubled in case of a visual impairment whereas self-reported hearing impairment was associated with a 20% increased risk

Table 3
Association between visual, hearing, and dual sensory impairments in 2006 and subsequent IADL decline in 2010 by type of decline, E3N-elderly subcohort (n=4,010)

	No IADL decline	Cognitive-type IADL decline		Polytomic analysis[a]	Other-type IADL decline		Polytomic analysis[a]
			OR [95%CI]	p-values		OR [95%CI]	p-values
	n=3,422	n=279			n=309		
Cognitive IADL in 2010 (score/4) mean (± SD)	4	2.79 ± 0. 63			4		
Other IADL in 2010 (score/4) mean (± SD)	4	2.96 ± 1. 07			2.86 ± 0.38		
MODEL 1[b]							
Visual impairment %							
No	97.72	94.62	Reference		95.47	Reference	
Yes	2.28	5.38	2.20 [1.23; 3.93]	0.008	4.53	1.88 [1.04; 3.39]	0.037
Hearing impairment %							
No	48.60	48.03	Reference		39.48	Reference	
Yes	51.40	51.97	1.01 [0.78; 1.29]	0.963	60.52	1.41 [1.11; 1.79]	0.006
MODEL 2							
Sensory impairment pattern %							
No impairment	47.63	46.95	Reference		37.86	Reference	
Visual impairment only	0.96	1.08	1.02 [0.30; 3.42]	0.981	1.62	2.00 [0.75; 5.28]	0.164
Hearing impairment only	50.09	47.67	0.95 [0.74; 1.23]	0.702	57.61	1.41 [1.10; 1.80]	0.007
Dual impairment	1.32	4.30	2.95 [1.49; 5.83]	0.002	2.91	2.48 [1.17; 5.26]	0.018

The "cognitive" IADL are the four IADL that are especially sensitive to cognitive impairment: telephone, transportation means, medications, and finances). The "other" IADL are shopping, laundry, preparing meal, and housecleaning; a. adjusted for age, level of education, marital status, social activity level, "recreational" physical activity, and comorbidity index; b. model mutually adjusted

of borderline statistical significance. Previous findings on the association between hearing impairment and functional decline are inconsistent. Some studies reported an increased risk of functional decline among hearing-impaired older people (16, 39), while others reported no association (18, 23, 40). Differences in assessment of hearing impairment and in functional decline (subjective or objective) have been previously put forward to explain this heterogeneity (16). Another source of discrepancy may be the differences in follow-up duration across studies.

We hypothesized that, among autonomous older people, those with dual sensory impairment would be more likely to become limited in their daily activities than those who had a single sensory impairment. In this population, 1.7% of older women reported dual sensory impairments, a lower figure than previously reported in the literature (25) due to differences in study design, study population, and definition criteria. More particularly in our study based mainly on mailed questionnaires, visually impaired women would be less likely to be able to fill in the questionnaire, therefore reducing the population to the visually impaired women who were helped by someone (such a situation being classically observed in the E3N cohort, given the high commitment of the participants) or who used magnifying glass. However, this selection bias, in excluding some severe cases of visual impairments, would bias the estimate towards the null, so that the real effect of visual impairment on IADL decline may be even more pronounced. Plus, the prevalence of sensory impairments is higher among people with functional limitations; since we excluded women with IADL limitations in 2006, we therefore excluded some women with sensory impairment, thus reducing the prevalence of visual impairment to 2.7%, to be compared to previously reported prevalences of 9 to 18% (19). However, the prevalence of hearing impairment was not affected by a potential selection bias, since it was high in our population, 52%, as compared to previously reported figures of 24 to 33% (19). The low prevalence of visual impairment may also be associated with the quite high education level in our cohort, thus restricting visual impairment to severe eye disease such as age-related macular degeneration, while cataract, glaucoma, or diabetic retinopathy might be less common or better treated in that population. The low prevalence of dual impairment can be mainly attributed to the very low prevalence of visual impairment. When considering visual or hearing impairments alone, versus dual impairment, the latter was associated with a stronger risk of IADL decline than just the addition of risks associated with each impairment. The results suggest that while a hearing impairment alone has little effect on IADL decline, it increases the risk of IADL decline related to vision impairment.

Very little attention has been previously paid to the specific association between dual sensory impairment and cognitive decline. We observed a close relationship between dual

sensory impairments and cognitive-type decline as defined using the four cognitively discriminant IADLs i.e. using the telephone, handling finances, handling medications, and using transportation means. Dual sensory impairment was associated with a slightly stronger risk, 3-fold higher, of cognitive-type decline than of other types of IADL decline as compared with women with no sensory impairment. The stronger association with cognitive-type decline may be related to the fact that some of the four cognitive IADLs rely on hearing (e.g. telephone use). Thus, older people with visual impairment should be especially targeted for screening and treating hearing impairment, in order to decrease the risk of IADL decline, especially of cognitive-type IADL decline.

This work has some limitations. Like all cohorts of volunteers, this study is prone to participation bias, with an over-representation of educated as well as healthy and highly equipped women due, among other reasons, to their affiliation to a specific health insurance plan. Associations reported here could therefore be even stronger in the general population with a larger proportion of insufficiently equipped subjects regarding visual and hearing impairments. Recently, it has been reported a prevalence of 38.8% (CI 95%, 35.2%-42.5%) of uncorrected refractive error among French elderlies from the 3-Cité ALIENOR cohort study (41). Our conclusions are also limited by a rather large percentage of missing data regarding the outcome based on the eight IADLs, and by non-responses to the questionnaire, which are likely to correspond to the most severely disabled women. Additionally, as discussed above, associations found in this study could be even higher in the general population, which makes hearing and visual impairment particularly relevant for preventive measures. Both exposure variables were derived from subjective measures and they should be considered as complaints of a perceived dysfunction (42). In a population of educated women such as ours, self-reports have however been proven very reliable on a large number of exposures and outcomes in the E3N cohort study (43). In addition, self-perceived sensory impairments can help understand how older people perceived their own sensory abilities independently from medically-assessed hearing or visual ability. The assessment of IADL decline is also a limitation of the present study since it is a dynamic concept (that can change both ways over time). However again, in a large prospective study, it is a rather good proxy of daily life activity ability assessment.

The study also has strengths including its prospective design of a 4-year follow-up, and information on many potential confounders. The 4-year follow-up period between the two IADL scores is rather short and therefore leads to limited power because of a limited number of women who lost autonomy between the two periods; however, it also enabled us to investigate changes in the autonomy status associated with sensory impairment in women who had little advanced in age between the two periods.

Conclusion

In a large sample of French older women, visual impairment, and to a lesser extent, hearing impairment were associated with higher risk of IADL decline after 4-year of follow-up. We found some evidence of a multiplicative effect between sensory impairments in the disablement process that should be confirmed in other studies, since they would have important implications on preventing loss of autonomy in older people. Indeed, both sensory impairment and functional decline are very common among older people, thus managing sensory impairments may be one of the early preventive measures which, while promoting quality of life, could limit functional decline, and prevent institutionalization (44).

Fundings: This work was supported by a grant from the Doctoral School of Public Health from the University Paris-Sud Paris-Saclay. The research was carried out using data from the E3N cohort study from the INSERM and support was provided by the "Mutuelle Générale de l'Education Nationale" (MGEN), Gustave Roussy, the League against Cancer, and the Investissement d'Avenir ANR-10-coho-00006 grant for the constitution and maintenance of the E3N cohort. The financial supports played no specific role in the study.

Conflict of interests: The authors declare there are no conflicts.

Ethical standards: The study was approved by the French National Commission for Data Protection and Privacy and informed consents were provided.

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