Clinical science

Self-reported dual sensory impairment and related factors: a European population-based cross-sectional survey

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ABSTRACT

Background Data on population-based self-reported dual vision and hearing impairment are sparse in Europe. We aimed to investigate self-reported dual sensory impairment (DSI) in European population.

Methods A standardised questionnaire was used to collect medical and socio-economic data among individuals aged 15 years or more in 29 European countries. Individuals living in collective households or in institutions were excluded from the survey.

Results Among 296 677 individuals, the survey included 153 866 respondents aged 50 years old or more. The crude prevalence of DSI was of 7.54% (7.36–7.72). Among individuals aged 60 or more, 9.23% of men and 10.94% of women had DSI. Eastern and southern countries had a higher prevalence of DSI. Multivariable analyses showed that social isolation and poor self-rated health status were associated with DSI with ORs of 2.01 (1.77–2.29) and 2.33 (2.15–2.52), while higher income was associated with lower risk of DSI (OR of 0.83 (0.78–0.89). Considering country-level socioeconomic factors, Human Development Index explained almost 38% of the variance of age-adjusted prevalence of DSI.

Conclusion There are important differences in terms of prevalence of DSI in Europe, depending on socioeconomic and medical factors. Prevention of DSI does represent an important challenge for maintaining quality of life in elderly population.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Very few population-based studies in Europe have focused on vision and hearing sensory impairment (dual sensory impairment).

WHAT THIS STUDY ADDS

⇒ This cross-sectional European population-based survey showed that the overall crude prevalence of self-reported dual sensory impairment was 7.54% (95% CI 7.36 to 7.72) in the adult population and 14.78% (95% CI 14.35 to 15.21) in the 70+ age group.

⇒ In this study, sizeable variations of prevalence of self-declared dual sensory impairment were observed, depending on age, gender, country and socioeconomic status.

HOW THIS STUDY MIGHT AFFECT RESEARCH

⇒ Better understanding of these factors could improve preventive strategies aimed at limiting the prevalence of dual sensory impairment in Europe.

INTRODUCTION

Thanks to an overall socioeconomic development, public health initiatives, improvements in healthcare and other parameters, life expectancy, including healthy life expectancy, has markedly increased globally.[1–3] In association with the ageing of the population, the crude prevalence of age-related diseases has increased. According to the Global Burden of Disease (GBD) Study, sensory impairments including vision loss and hearing loss belong to most common causes for disability-associated life years.[4] Dual sensory impairment (DSI) has been defined as the combination of impaired vision and hearing and is commonly observed in older populations.[5–7] In a context of DSI, individuals cannot compensate for the loss in one sense by using the other sense. This profoundly disturbs gathering of information about environment and prevents or alters communication with other people. Common causes of vision impairment in the European elderly population, according to the Vision Loss expert group, include undercorrection of refractive errors including functional presbyopia, glaucoma, cataract, diabetic retinopathy and age-related macular degeneration.[8] Common causes of hearing impairment in elderly populations include presbycusis, cerumen occlusion, noise exposure,[9 10] middle ear ossification, ear infections,[11] ototoxic medication and cardiovascular disease.[10 12 13]

DSI reduces life expectancy[14–16] and quality of life by limiting independence, favouring social isolation and depression.[17–24] There are not many population-based studies in Europe focusing on DSI and associated factors.[25–28] In this context, the current study investigated self-reported DSI in a general population-based survey providing

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cross-sectional national data from adult individuals on health status, health determinants and healthcare activities in the European Union. We sought to ascertain the association between self-reported DSI and other variables of interest having a potential interaction with DSI. We identified these through review of the literature, with a particular focus on elderly individuals,[29] potential gender inequities,[20] functional status[24 30] social isolation,[17 31] depression,[26] medical history of diabetes and smoking status,[32] with the additional perspective of socioeconomic factors extracted at a country-by-country level.

MATERIALS AND METHODS

Study design and population

One of the objectives of the EUROVISION project funded by the European Union Horizon 2020 in 2018 (H2020-EU.1.3.2) was to describe the prevalence of self-declared DSI in European countries and to identify related demographic and socioeconomic factors, health determinants and healthcare access issues based on the European Health Interview Survey 2 (EHIS) conducted between 2013 and 2015. This survey included individuals aged 15 years and older from representative population-based samples of 28 member states of the European Union, and of two neighbouring countries (Iceland and Norway), excluding people living in collective households or in institutions.

Procedures

Population censuses, population registers, dwelling registers, national health insurance registries, postcode address files or samples from the Labour Force Survey, depending on the countries participating in the survey, were used as sampling frames. The data were collected using a standardised questionnaire comprising 147 variables, by face-to-face or telephone interviews, postal mail, email or through the internet. The majority of the data originated from telephone and face-to-face interviews. As described in a previous publication, each standardised questionnaire comprised a demographic and socioeconomic component and a public health component divided into a European health status module, a European health determinant module and a European healthcare module (online supplemental table S1).[33]

The sample size recommended in the Eurostat guidelines varied between countries with an average of 7000. The effective sample size ranged from 4001 to 25 325 and did not reach the recommended value for member states with a relatively small population (Slovakia, Slovenia, Sweden, Malta, Luxembourg, Lithuania, Iceland, Hungary, Croatia, Finland, Estonia, Denmark, Czech Republic, Cyprus).

The sample size of individuals, country by country, is detailed in online supplemental figure S1.

Categorising variables

Sensory status

Vision status was investigated by two variables labelled PL1 (‘do you wear glasses or contact lenses’) and PL2 (‘difficulty in seeing, even when wearing glasses or contact lenses’). PL1 was binary (yes or no). PL2 responses used a four-level Likert scale: ‘no difficulty’ (1), ‘some difficulty’ (2), ‘a lot of difficulty’ (3), ‘cannot do at all/unable to do’ (4). Binary vision impairment status was defined from PL2: ‘no self-reported vision impairment’ (response 1) and ‘self-reported vision impairment’ (responses 2, 3 or 4).

Hearing status was investigated by two variables labelled PL3 (‘do you use hearing aids’) and PL4 (‘difficulty in hearing what is said in a conversation with one other person in a quiet room even when using a hearing aid’). For PL3, the participants could give three different responses: ‘yes’ (1), ‘no’ (2), ‘profoundly deaf’ (3). PL4 responses used the same four-level Likert scale as PL2. Binary hearing impairment status was defined from PL4: ‘no self-reported hearing impairment’ (response 1) and ‘self-reported hearing impairment’ (responses 2, 3 or 4). Based on these definitions, individuals categorised as having both self-reported vision impairment and hearing impairment were considered as having self-reported DSI. Because the current study focused on DSI, we chose to restrict our analyses to individuals aged 50 years old or more.

Associated factors

Composite variables were created from original questionnaire variables to investigate their potential association with DSI. These variables included self-rated health, limiting long-standing illness (illnesses or health problems that lasted for the past 6 month or longer), functional limitations, chronic conditions (myocardial infarction, coronary heart disease or angina pectoris, stroke or diabetes in the past 12 months), depression, physical activity, daily alcohol consumption, daily smoking, social isolation, wealth and education. Definitions of these variables are provided in online supplemental table S2.

Additional data

We investigated country-level socioeconomic factors potentially associated with DSI during the same period of the survey. These factors included the Human Development Index (HDI), the Multidimensional Poverty Index, the Gender Inequality Index and the Inequality-adjusted HDI (IHDI) extracted from the United Nations Development Programme database (http://hdr.undp.org/en/indicators/137506). We also obtained the Gross Domestic Product per capita (GDP), total health expenditure (THE) and out-of-pocket expenditure (% of current health expenditure) from the World Bank (https://data.worldbank.org/indicator).

For regional analyses, Europe was divided into four regions according to the United Nations, as follows: Northern Europe with Denmark, Estonia, Finland, Iceland, Ireland, Latvia, Lithuania, Norway, Sweden and UK; Southern Europe with Croatia, Greece, Italy, Malta, Portugal, Slovenia and Spain; Western Europe with Austria, France, Germany, Luxembourg and The Netherlands and Eastern Europe with Bulgaria, Czech Republic, Hungary, Poland, Romania and Slovakia. While not part of any UN region, Cyprus was included in the analysis as a member of Southern Europe, leading to a total of 29 countries providing data for the current study. Belgium was excluded from the analyses because PL4 data were missing.

Statistical analysis

All analyses were performed using the survey unit weights supplied in the data sets. These adjusted the crude data to enhance the representativeness of the survey data in relation to the sampled national populations. According to the survey protocol, they allowed for overall calculations and intercountry comparisons, and accounted for sampling design, non-response, gender and age structure of the populations and (for some countries) regional distribution and educational attainment as well. Weighting efficiency was 51.7%. More detailed information is found in online supplemental files 2–4.

Age and interview method-standardised prevalence and 95% CIs were computed using the direct method (SAS stdrate procedure). The reference age distribution was taken to be the 5-year wide European (28) population data from Eurostat (https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=demo_pjan&lang=en) and the reference interview method distribution was that of the entire data set.

ORs and their 95% CIs were computed using logistic regression (SAS surveylogistic procedure), adjusting for age and sex. For univariable analysis, only complete observations for the variable of interest (without missing data) were used. For the multivariable analyses, multiple data imputation was first carried out (SAS mi procedure) due to the large proportion of observations with one or more missing value in a variable of interest (48%) and also to mitigate possible bias due to a few countries not having asked some questions. Only the factors of interest were imputed (the variable coding for DSI was not). The number of imputations was set at 50 and extra variables were included as covariates for prediction. No collinearity between the predictors was observed.

For univariable analyses and other analyses with age-adjusted prevalences, the following age groups were used 50–59, 60–69, 60+, 70+, 75+. For the socioeconomic analysis, least-square linear regression (SAS reg procedure) was used for linear regression analyses between prevalence and socioeconomic factors. For multivariable models, model selection was performed using stepwise selection with all variables as candidates (except IHDI and log GDP per capita because of collinearity issues with HDI). All analyses were performed with SAS software, V.9.4. All figures were created using GraphPad Prism V.5.03 for Windows, GraphPad Software, La Jolla California USA, except for the maps which were generated using SAS and were based on SAS/GRAPH MAPS library map templates. As such they are covered by the SAS/GRAPH copyright.

RESULTS

EHIS 2 included 164 818 participants aged 50 years old or more of whom 10 952 were excluded because of missing vision and/or hearing status data. The analysed sample, thus, consisted of 153 866 respondents (55.30% women).

Among them, a total of 101 013 individuals declared themselves to have normal vision and hearing (of which 54.29% were women), of whom 16 939 had neither optical nor hearing aids (of which 45.11% were women). On the other hand, 12 202 individuals (7.93%) were categorised into the DSI group. These data are detailed in table 1 and figure 1.

Sample size and crude prevalences of DSI, vision impairment and hearing impairment with and without correction by country are detailed in online supplemental table S3.

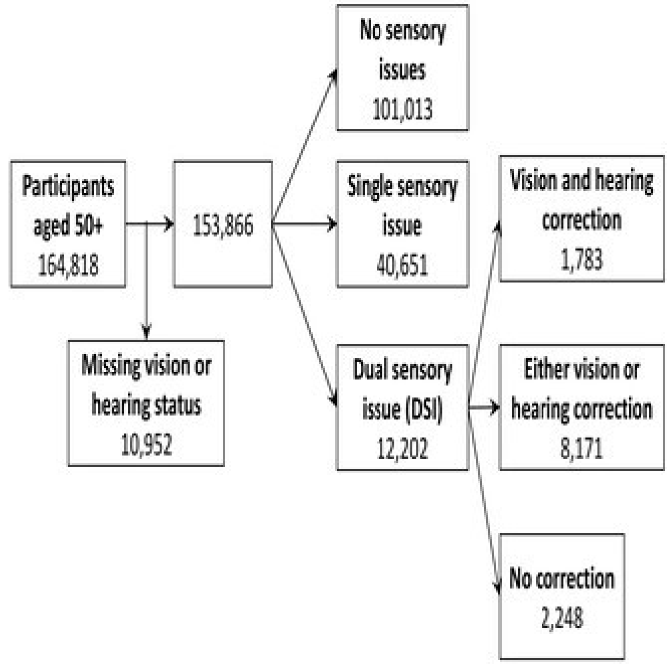

Figure 1 Flowchart of sensory issues and corrections in the participants.

In the European population, the crude prevalence of self-declared DSI varied with age from 2.98% (95% CI 2.77 to 3.18) in the 50–59 age group to 15.14% (95% CI 14.71 to 15.57) in the 70+ age group. Analysis by region showed that respondents in eastern and southern countries had the highest age and interview method-adjusted prevalence of self-reported DSI with values of 13.06% (95% CI 12.69 to 13.42) and 8.55% (95% CI 8.22 to 8.87), respectively. Western and Northern European countries had the lowest adjusted prevalence of self-reported DSI with values of 3.90% (95% CI 3.51 to 4.29) and 6.65% (95% CI 6.38 to 6.92), respectively. Furthermore, considerable intercountry differences were observed, with adjusted prevalence ranging from 1.26% (95% CI 0.86 to 1.66) in Norway to 16.22% (95% CI 15.01 to 17.43) in Bulgaria. This variability in DSI prevalence was even observed between countries within the same region. In Northern Europe, prevalence of self-reported DSI ranged from 1.26% (95% CI 0.86 to 1.66) in Norway to 11.21% (95% CI 10.26 to 12.17) in Latvia.

These data are detailed by country and by region for the different age groups (50–59, 60–69, 60+ and 70+) in table 2 and on European map in figure 2.

Table 1 Sample size and crude prevalence of vision and hearing status

		Normal hearing				Hearing issues			
		No hearing aid		Hearing aid		No hearing aid		Hearing aid	
		n (% women)	Prevalence	n (% women)	Prevalence	n (% women)	Prevalence	n (% women)	Prevalence
Normal vision	No glasses/lenses	16 939 (45.11%)	10.20 (10.00 to 10.40)	424 (48.58%)	0.28 (0.24 to 0.32)	1067 (41.61%)	0.66 (0.60 to 0.71)	220 (45.91%)	0.15 (0.12 to 0.18)
	Glasses/lenses	79 705 (56.61%)	53.42 (53.07 to 53.76)	3945 (47.30%)	2.80 (2.68 to 2.92)	7812 (48.43%)	4.95 (4.80 to 5.10)	1933 (47.75%)	1.39 (1.31 to 1.48)
Vision issues	No glasses/ lenses	7062 (50.69%)	3.86 (3.73 to 3.98)	152 (43.42%)	0.09 (0.07 to 0.11)	2248 (52.40%)	1.27 (1.20 to 1.35)	244 (51.23%)	0.15 (0.12 to 0.17)
	Glasses/ lenses	21 391 (63.91%)	13.90 to 13.66 to 14.14)	1014 (55.23%)	0.77 (0.70 to 0.83)	7927 (61.18%)	4.82 (4.67 to 4.96)	1783 (54.68%)	1.30 (1.22 to 1.39)

CIs at the 95% level are given between brackets.

Table 2 Overall age and interview methods-adjusted prevalence (%) of DSI by region and by country and for different age groups

		Age			
	All	50–59	60–69	60+	70+
Europe	7.52 (7.34 to 7.70)	2.81 (2.61 to 3.01)	4.74 (4.49 to 5.00)	10.15 (9.89 to 10.41)	14.78 (14.35 to 15.21)
East	13.06 (12.69 to 13.42)	2.10 (1.73 to 2.48)	5.95 (5.43 to 6.46)	19.17 (18.65 to 19.69)	30.50 (29.60 to 31.40)
Bulgaria	16.22 (15.01 to 17.43)	3.38 (2.31 to 4.46)	10.09 (8.32 to 11.87)	23.38 (21.70 to 25.06)	34.76 (31.99 to 37.53)
Czech Republic	11.40 (10.53 to 12.26)	0.71 (0.00 to 1.64)	4.29 (3.05 to 5.54)	17.36 (16.19 to 18.53)	28.55 (26.53 to 30.57)
Hungary	7.69 (6.65 to 8.73)	3.50 (2.25 to 4.75)	4.45 (3.05 to 5.84)	10.03 (8.61 to 11.45)	14.81 (12.33 to 17.30)
Poland	13.08 (12.42 to 13.74)	3.76 (3.09 to 4.44)	8.01 (7.08 to 8.94)	18.28 (17.32 to 19.24)	27.07 (25.36 to 28.79)
Romania	9.22 (8.59 to 9.85)	1.55 (1.01 to 2.08)	5.52 (4.65 to 6.38)	13.50 (12.59 to 14.41)	20.34 (18.81 to 21.87)
Slovakia	12.72 (11.49 to 13.95)	3.24 (2.05 to 4.42)	9.11 (7.12 to 11.10)	18.01 (16.17 to 19.85)	25.63 (22.47 to 28.79)
North	6.65 (6.38 to 6.92)	2.36 (1.93 to 2.78)	4.10 (3.74 to 4.46)	9.04 (8.70 to 9.39)	13.28 (12.70 to 13.85)
Denmark	4.84 (4.01 to 5.67)	3.35 (2.16 to 4.53)	4.01 (2.76 to 5.26)	5.68 (4.56 to 6.79)	7.11 (5.29 to 8.92)
Estonia	6.76 (5.79 to 7.73)	2.14 (1.26 to 3.01)	4.73 (3.25 to 6.21)	9.34 (7.92 to 10.76)	13.29 (11.02 to 15.55)
Finland	10.52 (9.48 to 11.55)	6.40 (4.90 to 7.90)	8.44 (6.92 to 9.96)	12.81 (11.45 to 14.18)	16.56 (14.19 to 18.93)
Iceland	2.11 (1.47 to 2.75)	0.90 (0.18 to 1.62)	1.52 (0.46 to 2.58)	2.79 (1.83 to 3.75)	3.87 (2.25 to 5.49)
Ireland	7.78 (7.05 to 8.50)	4.74 (3.75 to 5.73)	7.02 (5.79 to 8.25)	9.47 (8.46 to 10.49)	11.58 (9.93 to 13.23)
Latvia	11.21 (10.26 to 12.17)	4.22 (3.21 to 5.23)	7.17 (5.68 to 8.65)	15.12 (13.76 to 16.48)	21.93 (19.85 to 24.01)
Lithuania	9.28 (8.24 to 10.33)	0.68 (0.15 to 1.21)	4.44 (3.07 to 5.80)	14.09 (12.48 to 15.69)	22.35 (19.83 to 24.88)
Norway	1.26 (0.86 to 1.66)	0.45 (0.06 to 0.84)	0.61 (0.21 to 1.00)	1.71 (1.12 to 2.30)	2.65 (1.56 to 3.75)
Sweden	5.19 (3.93 to 6.46)	2.15 (0.93 to 3.37)	4.53 (2.61 to 6.45)	6.89 (5.08 to 8.70)	8.92 (5.99 to 11.85)
United Kingdom	3.77 (3.41 to 4.12)	2.54 (1.93 to 3.16)	3.18 (2.72 to 3.63)	4.45 (4.02 to 4.89)	5.55 (4.82 to 6.27)
South	8.55 (8.22 to 8.87)	3.20 (2.87 to 3.54)	4.84 (4.38 to 5.30)	11.53 (11.07 to 11.99)	17.26 (16.54 to 17.99)
Croatia	10.03 (8.91 to 11.15)	4.09 (2.91 to 5.27)	7.22 (5.53 to 8.91)	13.35 (11.73 to 14.96)	18.59 (15.96 to 21.23)
Cyprus	4.52 (3.70 to 5.35)	0.27 (0.00 to 0.59)	1.60 (0.69 to 2.50)	6.90 (5.56 to 8.24)	11.44 (8.87 to 14.01)
Greece	13.80 (12.63 to 14.98)	2.49 (1.44 to 3.54)	8.69 (6.92 to 10.47)	20.12 (18.50 to 21.74)	29.90 (27.51 to 32.30)
Italy	9.20 (8.65 to 9.75)	3.12 (2.56 to 3.68)	4.77 (4.03 to 5.51)	12.59 (11.82 to 13.36)	19.29 (18.09 to 20.49)
Malta	4.51 (3.68 to 5.33)	0.85 (0.17 to 1.52)	1.58 (0.70 to 2.47)	6.55 (5.32 to 7.79)	10.80 (8.31 to 13.29)
Portugal	7.20 (6.43 to 7.98)	4.29 (3.14 to 5.43)	4.81 (3.69 to 5.93)	8.83 (7.82 to 9.84)	12.27 (10.70 to 13.84)
Slovenia	10.74 (9.53 to 11.94)	5.66 (3.96 to 7.36)	7.09 (5.33 to 8.85)	13.57 (11.95 to 15.19)	19.12 (16.52 to 21.72)
Spain	6.44 (5.94 to 6.95)	2.03 (1.50 to 2.56)	3.66 (2.88 to 4.44)	8.90 (8.18 to 9.63)	13.39 (12.25 to 14.54)
West	3.90 (3.51 to 4.29)	1.86 (1.44 to 2.29)	2.40 (1.84 to 2.97)	5.04 (4.47 to 5.61)	7.30 (6.34 to 8.25)
Austria	3.72 (3.03 to 4.40)	1.96 (1.48 to 2.44)	2.26 (1.49 to 3.04)	4.70 (3.63 to 5.77)	6.78 (4.97 to 8.60)
France	9.09 (8.32 to 9.85)	4.40 (3.52 to 5.28)	6.24 (5.16 to 7.31)	11.70 (10.61 to 12.79)	16.38 (14.54 to 18.22)
Germany	5.81 (5.26 to 6.36)	2.97 (2.39 to 3.55)	4.03 (3.20 to 4.85)	7.40 (6.57 to 8.23)	10.29 (8.94 to 11.63)
Luxembourg	12.12 (10.53 to 13.71)	9.95 (7.93 to 11.97)	10.39 (7.65 to 13.13)	13.34 (10.99 to 15.68)	15.86 (11.98 to 19.75)
Netherlands	1.97 (1.49 to 2.45)	0.61 (0.06 to 1.17)	0.76 (0.14 to 1.39)	2.72 (2.02 to 3.42)	4.40 (3.11 to 5.68)

DSI, dual sensory impairment.

Age-adjusted prevalence of self-declared DSI was 7.45% (95% CI 7.20 to 7.70) for men and 7.88% (95% CI 7.62 to 8.14) for women, with female sex being significantly associated with DSI (OR 1.06, 95% CI (1.00 to 1.12)). Age-adjusted prevalence of self-declared DSI was lower in women than in men in the age groups 50–59 and 60–69, at 2.75% (95% CI 2.47 to 3.02) and 4.64% (95% CI 4.30 to 4.99) versus 3.21% (95% CI 2.91 to 3.52) and 5.00% (95% CI 4.62 to 5.37), respectively. It was higher in women in the 60+ age group, at 10.94% (95% CI 10.58 to 11.31) versus 9.23% (95% CI 8.87 to 9.59) in men. These results are detailed in table 3.

In univariable analysis, the odds of DSI were significantly associated with limiting long-standing illness, depression and social isolation, with ORs of 3.64 (95% CI 3.42 to 3.87), 3.41 (95% CI 3.20 to 3.64) and 3.37 (95% CI 3.00 to 3.79) respectively, while higher income and education level were significantly associated with lower DSI, with ORs of 0.65 (95% CI 0.60 to 0.69) and of 0.73 (95% CI 0.65 to 0.81), respectively. These data are detailed in online supplemental table S4. A gender effect was evident in relation to numerous variables, with more women than men reporting DSI in association with functional limitations, physical inactivity and lower educational status, while men with DSI reported higher daily smoking than women with DSI and men with greater wealth reported a lower prevalence of DSI than women. These results are presented in online supplemental table S5.

In multivariable analysis, poor self-rated health status, social isolation and limiting long-standing illness were significantly associated with self-reported DSI, with ORs of 2.33 (95% CI 2.15 to 2.52), 2.01 (95% CI 1.77 to 2.29) and 1.87 (95% CI 1.74 to 2.01), respectively. Higher income was associated with lower self-reported DSI, with an OR of 0.83 (95% CI 0.78 to 0.89). These results are detailed in table 4.

At the country level, the HDI, the inequality-adjusted HDI (IHDI), the log of the gross GDP (log GDP per capita) and current health expenditures (as % of GDP) were all negatively associated with age and interview method-adjusted prevalence of self-declared DSI. With an R^2 of 0.3834, HDI explained almost 38% of the variance of age-adjusted prevalence of DSI across countries. The scatterplot of the age-standardised prevalence of DSI versus HDI with the linear regression line is presented in figure 3. During multivariable model selection, only the HDI

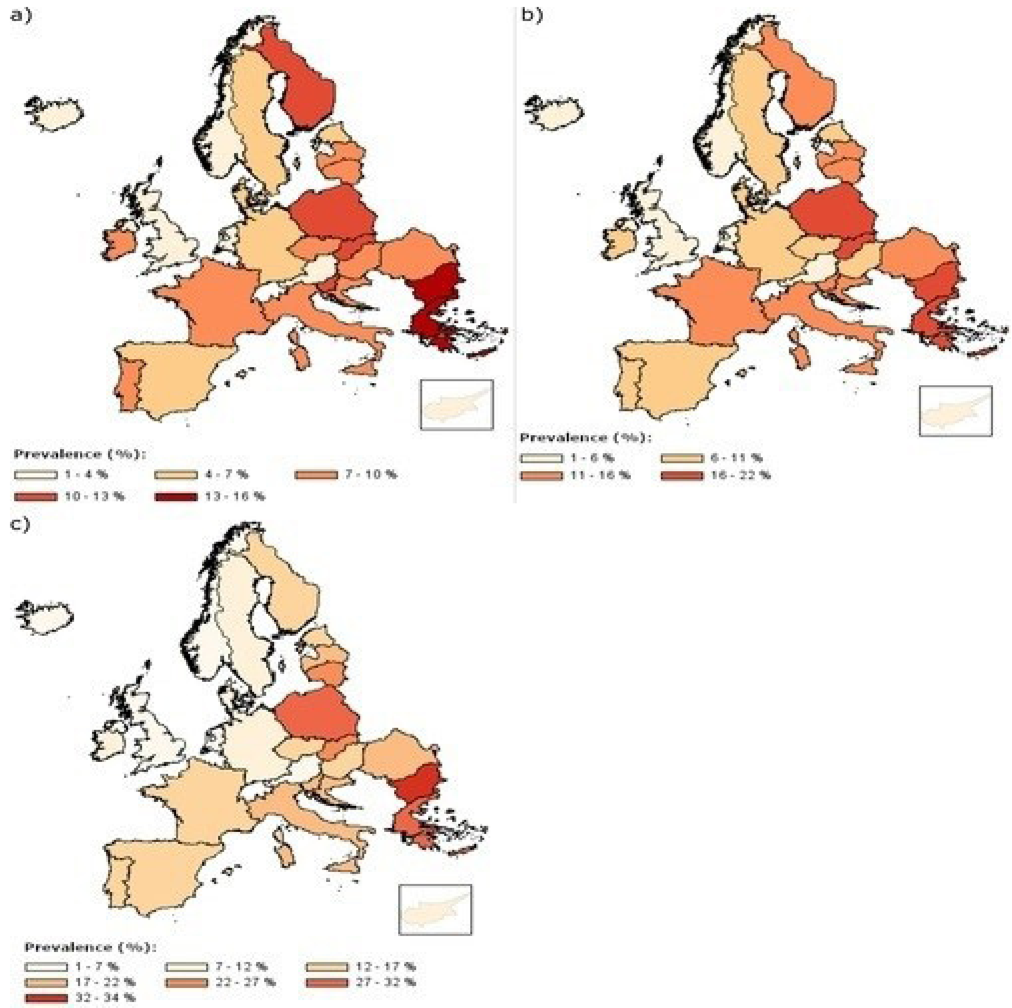

Figure 2 Age and interview methods-adjusted prevalence of self-declared DSI in (A) individuals aged 50+, (B) individuals aged 60+, (C) individuals aged 70+. DSI, dual sensory impairment.

Table 3 Age-adjusted prevalence of all DSI by age group, comparison by gender

Age	Gender	N	Age adjusted prevalence (%) (95% CI)
50–59	**All**	52 065	2.98 (2.78 to 3.18)
	M	24 135	3.21 (2.91 to 3.52)
	F	27 930	2.75 (2.47 to 3.02)
60–69	**All**	49 378	4.81 (4.55 to 5.06)
	M	22 717	5.00 (4.62 to 5.37)
	F	26 661	4.64 (4.30 to 4.99)
60+	**All**	101 801	10.39 (10.13 to 10.64)
	M	44 637	9.23 (8.87 to 9.59)
	F	57 164	10.94 (10.58 to 11.31)
70+	**All**	52 423	15.16 (14.73 to 15.59)
	M	21 920	13.64 (13.03 to 14.25)
	F	30 503	16.24 (15.65 to 16.84)
All	**All**	153 866	7.73 (7.55 to 7.91)
	M	68 772	7.45 (7.20 to 7.70)
	F	85 094	7.88 (7.62 to 8.14)

DSI, dual sensory impairment.

was included in the resulting model. These results are detailed in table 5.

DISCUSSION

On a population-based level, data on self-declared DSI and associated factors are rather sparse in Europe because most studies have focused on a single sensory impairment. This cross-sectional European population-based survey provides novel insights into self-declared DSI, country by country. This study reveals that the overall crude prevalence of self-reported DSI was 7.54% (95% CI 7.36 to 7.72) while major variations were observed between countries and regions (age and interview methods-adjusted prevalence ranging from 13.06% (95% CI 12.69 to 13.42) in Eastern to 3.90% (95% CI 3.51 to 4.29) in Northern Europe). When comparing the 70+ to the 50–59 age group, DSI-adjusted prevalence was higher by almost a factor of 5 (table 2), from 2.81% (95% CI 2.61 to 3.01) to 14.78% (95% CI 14.35 to 15.21), showing that DSI is a public health concern for the elderly population, more prone to frailty,[34 35] multimorbidity and social isolation than the younger population.[17 20 24 27 28 31 36 37]

Among individuals aged 60 or more, the crude prevalence of self-declared DSI was 10.17% (9.91 to 10.43). This result was

Table 4 Multivariable logistic regression analysis between self-reported DSI and health, socio-economic and life-style related variables in Europe

	OR (95% CI)	Estimate	SE	t-value	P value
Self-rated health (good vs poor)	2.33 (2.15 to 2.52)	0.84	0.04	20.47	<0.0001
Limiting long-standing illness (yes vs no)	1.87 (1.74 to 2.01)	0.63	0.04	17.33	<0.0001
Chronic illness (yes vs no)	1.37 (1.29 to 1.45)	0.31	0.03	10.34	<0.0001
Depression (yes vs no)	1.39 (1.31 to 1.47)	0.33	0.03	10.73	<0.0001
Physical activity (no vs yes)	1.43 (1.34 to 1.53)	0.36	0.03	11.15	<0.0001
Near-daily alcohol consumption (yes vs no)	0.80 (0.72 to 0.90)	−0.22	0.06	−3.94	<0.0001
Daily smoking (yes vs no)	0.94 (0.86 to 1.03)	−0.06	0.05	−1.29	0.1987
Social isolation (yes vs no)	2.01 (1.77 to 2.29)	0.70	0.07	10.72	<0.0001
Wealth (higher vs low)	0.83 (0.78 to 0.89)	−0.18	0.04	−5.08	<0.0001
Education (high vs intermediate)	0.90 (0.81 to 1.01)	−0.10	0.06	−1.75	0.0807
Education (low vs intermediate)	1.38 (1.30 to 1.47)	0.32	0.03	9.78	<0.0001

DSI, dual sensory impairment.

similar to that observed in another population study based on residents aged 65 years or more in Japan (9.7%). In that study, DSI was defined by objective measurements including visual acuity and pure-tone audiometric tests (VA <0.5 in the better eye combined with inability to hear a 30 dB signal at 1 kHz bilaterally).[20] In another population-based study conducted in a community sample of Chinese people aged 60+ years in Hong Kong, the prevalence of DSI was lower (6.5%).[38] In a cross-sectional analysis of a US population-based survey (n=13 092 individuals) including non-institutionalised adults 51 years and older, vision and hearing were rated on a Likert scale as poor, fair, good, very good and excellent. Similarly to the current study, self-declared DSI was defined as poor or fair vision and hearing and rates of DSI were very similar to those observed in the current study in the population aged 50+ (7.9% vs 7.54, respectively).[39]

Comparison to Western studies.

The Canadian longitudinal study is a population-based cohort study of Canadians aged 45–85 years (mean age 63 years) at baseline, focusing on the prevalence of self-reported hearing,

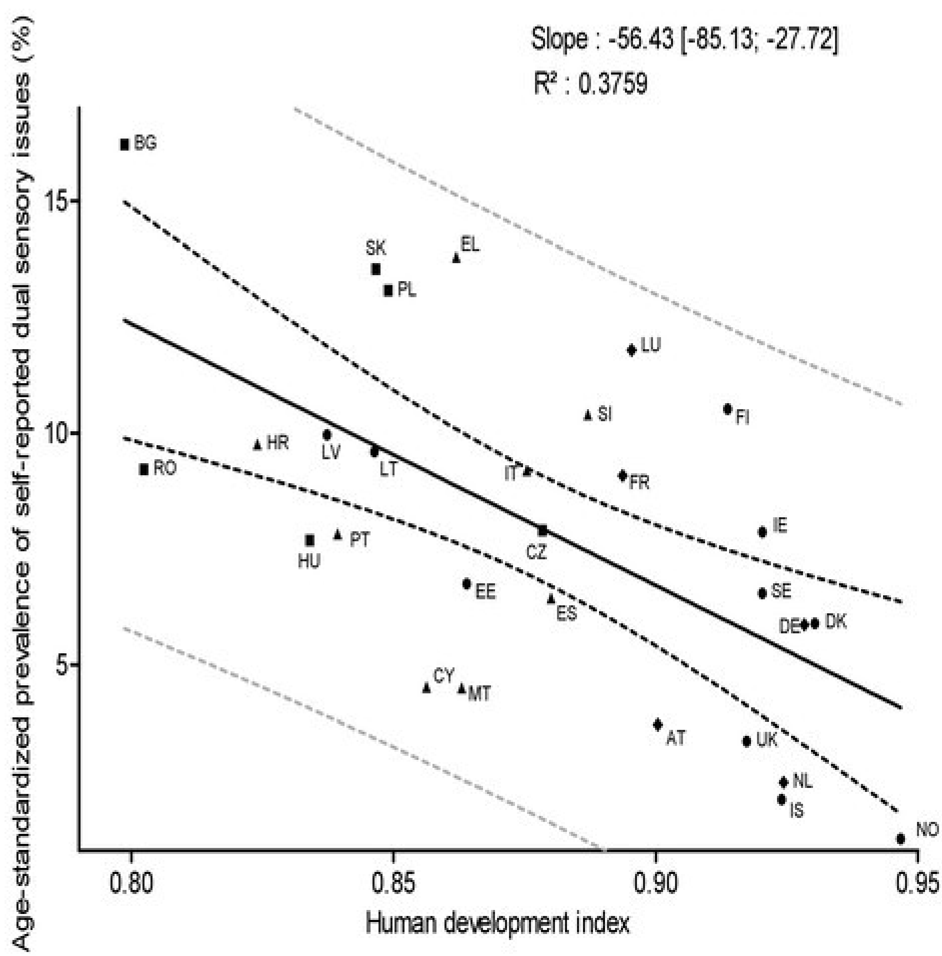

Figure 3 Scatterplot of age and interview methods-standardised prevalence of DSI vs HDI in European countries with linear regression line. black dashed lines: 95% CI; grey dashed lines: 95% prediction interval.

Table 5 Association between socio-economic indicators and age and interview methods-adjusted prevalence of DSI, vision problems and hearing problems

	β (95% CI)	P value	R^2
DSI			
HDI	−59.04 (−88.61 to −29.47)	**0.0003**	0.3834
IHDI	−44.14 (−68.84 to −19.44)	**0.0011**	0.3325
GII	20.46 (0.37 to 40.54)	**0.0462**	0.1392
log(GDP per capita)	−3.26 (−5.10 to −1.41)	**0.0012**	0.3271
CHE	−1.05 (−1.80 to −0.30)	**0.0077**	0.2352
OOP	0.11 (−0.03 to 0.25)	0.1264	0.0844
Vision problems			
HDI	−137.76 (−213.49 to −62.03)	**0.0009**	0.3315
IHDI	−100.32 (−164.11 to −36.52)	**0.0032**	0.2704
GII	45.27 (−4.74 to 95.29)	0.0743	0.1094
log(GDP per capita)	−6.88 (−11.74 to −2.01)	**0.0073**	0.2301
CHE	−2.73 (−4.53 to −0.92)	**0.0045**	0.2546
OOP	0.15 (−0.21 to 0.51)	0.3917	0.0263
Hearing problems			
HDI	−45.16 (−83.63 to −6.69)	**0.0231**	0.1769
IHDI	−35.57 (−66.58 to −4.57)	**0.0261**	0.1703
GII	11.4 (−12.56 to 35.36)	0.3376	0.0341
log(GDP per capita)	−2.52 (−4.85 to −0.19)	**0.0350**	0.1544
CHE	−0.69 (−1.61 to 0.24)	0.1401	0.0789
OOP	0.09 (−0.07 to 0.25)	0.2676	0.0453

Boldface: p-value<0.05.
ß, linear regression coefficient; GDP, gross domestic product; GII, Gender Inequality Index; HDI, human development index; IHDI, inequality-adjusted human development index; OOP, out of pocket expenditure; THE, total health expenditure.

vision and dual sensory difficulties. In this study, self-reported prevalence of dual sensory difficulties defined by fair or poor vision and hearing was 1.76%, lower than the prevalence of DSI in the 50–59 years age group in the current study (2.81%).[40] However, at least mild dual sensory loss was prevalent among 6.1% of women and 6.4% of men, similar to age-adjusted prevalence of self-declared DSI for men (7.45%) and for women (7.88%) in the current study.[41]

UK Biobank is a large population-based prospective cohort study of adults aged 40 to 69 years (mean age 56.8 years). At baseline 733 (0.65%) participants had DSI.[42] In our study, prevalence of DSI in the 50–59 age group was 2.81% (table 2), much higher than that of the UK Biobank. However, the results of this study cannot be directly compared with the current study, because vision and hearing were objectively determined by visual acuity and speech-reception-threshold.

Data based on respondents aged 50+at baseline from the US Health and Retirement Study, the English Longitudinal Study of Ageing and the Survey of Health, Ageing and Retirement in Europe, three population-based studies showed that the proportion of self-reported DSI was 7%, 5.8% and 7.7%, respectively.[43] These results are very similar to the prevalence of DSI among individuals aged 50+ (7.52%, table 2) in our study.

The Baltimore Longitudinal Study of Aging (BLSA) is a prospective US longitudinal study investigating psychological and physical ageing initiated in 1958. Healthy community-dwelling volunteers from were recruited to study ageing over the adult lifespan. In this study, visual acuity was measured on the ETDRS chart and visual impairment was defined by any corrected LogMAR score greater than or equal to 0.3 in the better seeing-eye. For hearing function, audiometric testing was performed and hearing impairment was defined by an averaged hearing threshold greater than 25 dB in the better-hearing ear. In BLSA, the proportion of expected DSI was 1.6%, the proportion of three sensory impairment including vision and hearing (plus proprioceptive or vestibular impairment) were 0.83%, and 0.09% for four sensory impairments in the 60–69 years age group. In our study, the proportion of age-adjusted DSI was 4.74% (table 2), higher than in the BLSA. However, in this study, objective methods were used to evaluate sensory variables and the selected sample was healthier than the general US population.[44]

NHANES was a study aimed at assessing the health of a representative sample of non-institutionalised US residents. The prevalence of DSI using objective assessments of hearing and vision was calculated from data collected between 1999 and 2006. In this study, 11.3% of adults aged 80+ had a DSI, which is slightly lower than the prevalence reported in the current study for European populations aged 70+ (14.78%, table 2).[45]

The National Health Interview Survey (NHIS) is a cross-sectional survey of the US noninstitutionalised population conducted by the National Center for Health Statistics. In this study, self-reported DSI criteria were very similar to our criteria, and DSI prevalence was 16.6% for the age group 80+, slightly higher than the DSI prevalence of our 70+population (14.78).[46]

Lack of assistive device despite sensory impairment can reflect difficulties in the access to the healthcare system (including nurses, physicians, opticians and hearing care) for social, economic or medical reasons. An association was observed between social isolation and self-reported DSI in multivariable analysis, with an OR of 2.01 (table 4). In this context, social isolation can be not only a cause of DSI by limiting accessibility to the healthcare system but also a consequence of DSI by preventing normal social interactions. Our study's cross-sectional design did not allow us to more precisely investigate the relationship between social isolation and self-reported DSI. The term medical reasons can include chronic or limiting long-standing illness implying difficulties in obtaining appropriate healthcare or pointlessness of assistive devices due to an advanced stage of sensory impairment (ie, completely blind people cannot be helped by optical correction).

Considering socio-economic data, we observed a strong association between DSI and social isolation (OR=2.01 (1.77 to 2.29)) and wealth (OR=0.83 (0.78 to 0.89)) (table 4). On a worldwide level, lower HDI and total health expenditure or gross domestic product per capita (THE/GDP) have been associated with a higher prevalence of moderate to severe visual impairment and blindness.[47] Our study confirms a similar association for self-reported DSI at a European level. At a country-by-country level, HDI, a composite indicator combining life expectancy, education and ability to have a decent standard of living, was strongly negatively associated to the self-declared DSI (R^2=0.3834), vision problems (R^2=0.3315) and hearing problems (R^2=0.1769) (table 5). Furthermore, IHDI, LogGDP and THE/GDP were also negatively associated to age-adjusted prevalence of self-reported DSI and vision problems while IHDI and LogGDP were negatively associated to age-adjusted prevalence of self-reported hearing problems. In other words, the prevalence of DSI was lower in wealthier European countries. The heterogeneity of socioeconomic factors among European countries is much lower than among different countries in the world. Indeed, HDI and GDP per capita range from 0.70 to 0.90 and roughly from 14 510$ to 127 671$ in Europe, whereas they range from 0.3 to 0.9 and from 596$ to 127 671$ globally, for the 2016–2017 period.[47] These data support the hypothesis that unfavourable socioeconomic factors maybe a strong association of hearing or vision problems through difficulties accessing healthcare.

Disparities in access to healthcare between countries may also be explained by differences in health policies, the effectiveness of national social security and health systems, access to universal basic health coverage for all, and access to affordable rehabilitation services, with differential access to private insurance providing better coverage for those who can afford it.[48]

Gender differences were also observed in this study. In the 60+age group, self-declared DSI prevalence was higher among women than men (10.94% (95% CI 10.58 to 11.31) vs 9.23% (95% CI 8.87 to 9.59)) while self-reported DSI prevalence was higher among men than women in the younger age groups (table 3). Other studies have demonstrated that prevalence of vision problems and hearing problems is higher among women than men.[6 49–51] Higher prevalence of DSI has also been observed among women than men in another study,[20] where DSI was associated with depression among women but not among men. On the other hand, we observed a similar association between DSI and depression for women and men with ORs of 3.26 (95% CI 3.00 to 3.55) and 3.64 (95% CI 3.29 to 4.04), respectively (online supplemental table S5).

In NHANES, there was no significant difference of prevalence rates for DSI at any age decade according to gender,[45] and in NHIS, there was a slightly but significantly higher prevalence of DSI in men vs women (3.6% vs 3.2%; $p<0.001$).[46] In EHIS, higher prevalence of self-reported DSI among women could be explained by better self-awareness of DSI or by difficulties of access to healthcare services and treatments for aged women, more frequently isolated than aged men for life expectancy reasons.

Strengths and limitations

The major strength of this study is the large, European population-representative sample of data, from adults aged 50 years or more, including a detailed questionnaire. Considering the few questions related to hearing and vision status in EHIS 2, they were validated by the Washington Group on Disability Statistics short set of questions.

Limitations include the cross-sectional nature of the study design, which prevented drawing any conclusions in terms of causality between potential explanatory variables and DSI. Furthermore, the survey excluded people living in collective households and institutions, even though it is very likely that the prevalence of DSI is higher in this group of the population.[52–56] Finally, the loss of granularity incurred by the merging of the oldest age groups in the 75+ group prevents drawing conclusions for the oldest individuals. Because they likely display the highest prevalence of DSI and may face significant challenges in accessing care, a detailed study of this part of the population is called for. Finally, the self-report nature of responses to the questionnaire may also lead to underestimation or overestimation, depending on potential psychological factors.

CONCLUSIONS

In Europe, between countries and regions, there are important variations of prevalence of self-declared DSI, depending on age, gender and socio-economic status. This study showed that elderly people were much more prone to have a DSI and that socioeconomic factors were identified as one of the main parameters associated with higher prevalence of DSI.

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