The European Journal of Public Health Advance Access published November 8, 2013
European Journal of Public Health, 1–6

doi:10.1093/eurpub/ckt171

Burden of disability attributable to vertigo and dizziness in the aged: results from the KORA-Age study

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Background: Complaints of vertigo and dizziness are common in primary care in the aged. They can be caused by distinct vestibular disorders, but can also be a symptom in other conditions like non-vestibular sensory loss, vascular encephalopathy or anxiety. The aim of this study was to investigate the specific contribution of vertigo and dizziness to the total burden of disability in aged persons when controlling for the presence of other health conditions. **Methods:** Data originate from the MONICA/KORA study, a population-based cohort. Survivors of the original cohorts who were 65 years and older were examined by telephone interview in 2009. Disability was assessed with the Health Assessment Questionnaire. Logistic regression was used to adjust for potential confounders and additive regression to estimate the contribution of vertigo and dizziness to disability prevalence. **Results:** Adjusted for age, sex and other chronic conditions, vertigo and dizziness were associated with disability (odds ratio 1.66, 95% confidence intervals 1.40–1.98). Both men and women aged between 65 and 79 years were among the strongest contributors to the burden of disability, with a prevalence of 10.5% (6.6–15.1) in men and 9.0% (5.7–13.0) in women. In men, this effect is stable across all age-groups, whereas it decreases with age in women. **Conclusions**: Vertigo and dizziness independently and relevantly contribute to population-attributable disability in the aged. They are not inevitable consequences of ageing but arise from distinct disease entities. Careful management of vertigo and dizziness might increase population health and reduce disability.

Introduction

Vertigo and dizziness, subjective sensations of disorientation or of motion without any actual motion present, are common problems in the aged.[1–3] They present with a prevalence of up to 50%, depending on the age-group and population under study.[4,5] Vertigo and dizziness can be symptoms of distinct vestibular diseases such as benign paroxysmal positioning vertigo or Menière's disease; they can also be consequences of multifactorial deficits due to ageing of proprioceptive, somatosensory or vestibular systems.[6] Further, vertigo and dizziness can be a consequence of non-vestibular conditions, such as cardiovascular disease,[7] hypotension[8] or psychiatric conditions.[9] It is also often caused by medication causing low blood pressure or fatigue.[10]

Although the presence of vertigo and dizziness in the aged is often chronic, their consequences are underestimated. They are important risk factors for postural instability,[11] limitations in mobility and activities of daily life[4] and restrictions of social participation.[12] By increasing postural instability and the propensity for falls, vertigo is also a major risk factor for injuries and fractures,[1] thus contributing to the main avoidable reasons for disability, need for nursing care[13] and, ultimately, death.

Although vertigo and dizziness in the aged are theoretically consequential, their impact on the prevalence and burden of disability is still unknown. One major reason for this lack of attention might be that vertigo and dizziness in the aged are primarily seen as symptoms of other chronic conditions.

Recently, the disabling impact of major chronic diseases such as heart disease, cancer and arthritis was investigated.[14] Back pain and peripheral vascular disease were shown to be the single most relevant contributors. However, to fully understand the burden of disability in the aged, it is important to add vertigo and dizziness to the list of relevant contributors when investigating the disabling impact.

The aim of this study was to investigate the specific contribution of vertigo and dizziness to the total burden of disability in aged persons. Specifically, we wanted to quantify the prevalence and the disabling impact of vertigo and dizziness.

Methods

The KORA-Age study is carried out within the framework of KORA (Cooperative Health Research in the Region of Augsburg).[15] KORA consists of four surveys, S1–S4, which were based on representative samples of the population of Augsburg and two surrounding counties.[16] The KORA-Age cohort includes all participants of the MONICA/KORA Survey S1–S4 aged 65 years or older at the end of 2008, i.e. born in or before 1943. The study was carried out between November 2008 and January 2010.

After a mailed health survey, all participants were asked to participate in a 30-minute telephone interview. Interviews were performed by trained and experienced interviewers from the study centre in Augsburg. If the participant was unable to complete a telephone interview, either due to his or her mental or physical condition, a proxy interview with a family member, friend or caregiver was carried out. All participants had given informed consent before their inclusion in the study; in cases where the participant was unable to make an informed decision, consent was received from the patient's caregiver. Approval from the ethics committee of the Bavarian Medical Association was obtained (Reference number 08064).

Measures

Outcome

Disability was assessed with the Health Assessment Questionnaire Disability Index (HAQ-DI).[17] The HAQ-DI has been shown to be

reliable, sensitive to change and able to detect even small differences in functioning. It consists of 20 questions in eight domains (dressing and grooming, hygiene, arising, reach, eating, grip, walking and common daily activities) that can be answered on a scale from 0 (no difficulty) to 3 (unable to perform). The score of a domain is determined by the highest score in that domain. The HAQ-DI score is the mean of the eight domain scores. A HAQ-DI score of 0 corresponds to no disability, whereas a HAQ-DI of 3 corresponds to severe disability.[18]

Covariates

Presence of vertigo and dizziness as well as falls was assessed using standardized questions from the balance section of the National Health and Nutrition Examination Survey (NHANES) questionnaire (see http://www.cdc.gov/nchs/nhanes/nhanes2003-2004/BAQ_C.htm): 'During the last 12 months, have you had vertigo or dizziness, difficulty with balance, or difficulty with falling?'. If the answer was 'Yes', the following question was posed: 'Which of these problems have you had?'.

The other data were collected by self-report in a health questionnaire (cancer diagnosed in the past 3 years; diabetes; heart disease such as angina, congestive heart failure or coronary heart disease; stroke and hypertension) and in a telephone interview (lung disease such as asthma, emphysema or chronic bronchitis; joint disease such as arthritis or rheumatism; kidney disease; liver disease such as cirrhosis; gastrointestinal disease such as ulcer, colitis or gallbladder disease; eye disease such as glaucoma, cataract, macular degeneration, diabetic retinopathy or retinitis pigmentosa; depression using the Geriatric Depression Scale GDS-15;[19] anxiety using the Generalized Anxiety Disorder Scale-7[20] and neurological disease such as multiple sclerosis, Parkinson's disease or epilepsy) that was conducted within 4 weeks of the completion of the health questionnaire, described in detail by Kirchberger et al (2012).[19] In addition, the presence of fractures was assessed in the health questionnaire by the question: 'Did you ever sustain a fracture?', and if yes, 'What was the date (year) of the fracture?'. As fractures older than 5 years are unlikely to influence an individual's current functioning,[21] we used the variable 'Fracture in the last 5 years' in analysis.

Age-groups were defined according to birth cohorts, e.g. the group of 65–69-year-olds includes all participants born in 1939–1943. The reference date is 31 December 2008, and all data were collected via the aforementioned questionnaires and telephone interviews within a few months of this date. In analyses adjusting for age, age in years is used and relates to the time of the questionnaire.

Statistical Analyses

We calculated mean and standard deviation for continuous variables and absolute and relative frequency for categorical variables along with their 95% confidence intervals. In accordance with the literature,[22] disability was defined as HAQ-DI >0.

To analyse the disabling impact of vertigo and dizziness adjusted for other health conditions, we used logistic regression. The c-value indicates accuracy and predictive power of the model, with a range between 0.5 and 1; the higher the c-value, the better the model. Model fit was tested by the Hosmer–Lemeshow statistic, which should be non-significant ($P > 0.05$) to maintain the null hypothesis of adequate fit. We tested for collinearity using the Variance Inflation Factor and for logit-linearity using Box–Tidwell tests. As the loss of cases due to missing data is small (5%), we used complete case analysis to handle missing data.

To estimate the contribution of vertigo and dizziness to the burden of disability, we used an additive regression model, the so-called attribution model.[14,23] This method uses information on disability and disease prevalence to estimate a disease's actual contribution to disability. It models the risk for becoming disabled as a two-part model. The first part attributes a background risk to each person, i.e. the risk of becoming disabled for a person when one had no disease. If one or more diseases are present, each disease adds a disease-specific risk to the background risk. In other words, the prevalence of disability is decomposed into a part attributable to measured disease (i.e. vertigo, dizziness and other prevalent diseases) and a part not attributable to any of the included prevalent diseases, the background prevalence. Background and disease-specific risks are likely to be associated with age and sex.[18] Thus, we carried out the analyses stratified for sex and age-groups (65–69, 70–79 and older than 79 years). The assumption was made that all disease-specific risks and the background risk act as independent causes of disability. We did not consider other interactions besides the interaction with age and sex.

To calculate the disease-specific prevalence of disability, we estimated the specific probabilities of disability associated with diseases for each participant. Summing up these cause-specific probabilities for each individual yields the total estimated probability for disability for a particular person. Summing up all probabilities for vertigo and dizziness across all individuals yields the number of persons disabled by vertigo adjusted for all other diseases. Dividing this sum by the number of participants yields the prevalence of disability attributable to vertigo.

To clarify whether vertigo and dizziness primarily act as symptoms, e.g. of cardiovascular or metabolic disease, or as independent causes of disability, an additional model was calculated as a sensitivity analysis. This additional attribution model included all

Table 1 Sociodemographic characteristics stratified by disability status (prevalence of disability: HAQ-DI >0)

Variable		%	Prevalence of disability (%)	95% Confidence interval
Total			45	
Age in years, classes ($n = 4117$)	65–69	32	28	(0.25–0.30)
	70–79	49	45	(0.43–0.48)
	≥80	19	72	(0.69–0.75)
Sex ($n = 4117$)	Male	49	35	(0.33–0.37)
	Female	51	54	(0.52–0.56)
Vertigo and dizziness ($n = 4080$)	No	73	38	(0.36–0.40)
	Yes	27	63	(0.60–0.66)
Hypertension ($n = 4108$)	No	41	39	(0.37–0.42)
	Yes	59	48	(0.46–0.51)
Eye disease ($n = 4116$)	No	61	38	(0.36–0.40)
	Yes	39	56	(0.53–0.58)
Heart disease ($n = 4117$)	No	74	40	(0.39–0.42)
	Yes	26	57	(0.54–0.60)
Diabetes ($n = 4110$)	No	83	42	(0.40–0.44)
	Yes	17	57	(0.54–0.61)
Joint disease ($n = 4117$)	No	84	41	(0.39–0.42)
	Yes	16	65	(0.61–0.68)
Falls ($n = 4080$)	No	86	41	(0.39–0.42)
	Yes	14	68	(0.64–0.72)
Lung disease ($n = 4117$)	No	89	43	(0.41–0.44)
	Yes	11	63	(0.58–0.67)
Fracture in last 5 years ($n = 4088$)	No	90	43	(0.41–0.44)
	Yes	10	61	(0.56–0.66)
Gastrointestinal disease ($n = 4117$)	No	91	43	(0.42–0.45)
	Yes	9	57	(0.52–0.62)
Anxiety ($n = 3929$)	No	92	40	(0.39–0.42)
	Yes	8	69	(0.63–0.74)
Stroke ($n = 4112$)	No	93	43	(0.41–0.44)
	Yes	7	70	(0.65–0.76)
Kidney disease ($n = 4117$)	No	96	44	(0.42–0.46)
	Yes	4	61	(0.53–0.69)
Cancer ($n = 4105$)	No	96	44	(0.43–0.46)
	Yes	4	50	(0.43–0.57)
Neurological disease ($n = 4117$)	No	97	44	(0.42–0.45)
	Yes	3	73	(0.64–0.80)
Liver disease ($n = 4117$)	No	98	44	(0.43–0.46)
	Yes	2	55	(0.44–0.65)
Depression ($n = 3935$)	No	98	42	(0.40–0.43)
	Yes	2	89	(0.79–0.95)

health conditions but not vertigo and dizziness. We assessed independent impact of vertigo and dizziness by analysing the resulting differences in the estimates. Lower disease estimates in the new model (without vertigo and dizziness) indicate that vertigo and dizziness can be seen as symptoms of the respective conditions, whereas a lower background risk indicates an independent effect of vertigo and dizziness on disability.

Analyses were carried out with R 2.15.1.[24]

Results

A total of 5991 participants in the KORA S1–S4 surveys were contacted by a mailed health survey, with a response rate of 76% resulting in 4565 completed questionnaires. Of these people, 4127 (90%) participated in the telephone interview. The HAQ-DI sum score could be calculated for 4117 participants. The 4117 participants had a mean age of 73.6 years (SD 6.1) and were 51.2% female.

The 12-month prevalence of vertigo or dizziness was 26% (male 23%, female 30%), ranging from 21% in those younger than 70 years to 37% in those 80 years and older.

Mean HAQ-DI score was 0.32 with 45% of all participants presenting with any disability (HAQ-DI >0, women 54%, men 35%). Table 1 shows sociodemographic characteristics of the participants, prevalences of the investigated conditions and prevalence of disability within each disease group.

The average disability score (HAQ-DI) in individuals with vertigo and dizziness was higher than in those without vertigo and dizziness, a difference that disappeared in men in the first half of the ninth decade. The average score also increased with age. Overall, women with vertigo and dizziness had a higher average score than men; especially those in higher age-groups (figure 1).

Impact of vertigo and dizziness on disability

Adjusted for age, sex and chronic health conditions, vertigo and dizziness were significantly associated with disability (odds ratio = 1.6, table 2). Fit of the logistic model was adequate (Hosmer–Lemeshow P-value = 0.299, c-value = 0.775).

Contribution of vertigo and dizziness to the burden of disability

In both men and women, vertigo and dizziness accounted for the highest attributable prevalence of disability. There was a sex-specific difference in disease effects (figure 2, Supplementary table S3 and S4). Disease-specific attributable prevalences decreased with age. The proportion of disability prevalence not attributable to specific diseases was about two times higher in women than in men. More precisely, this so-called background risk increased from 26.5–27.1 to 40.7% in men and from 45.7–49.7 to 69.2% in women (Supplementary tables S3 and S4).

Sensitivity analysis

In both, men and women and across all age-groups, including or excluding vertigo and dizziness did minimally change the disease-specific attributable prevalences of disability. However, when vertigo and dizziness entered the model, background disability, i.e. the proportion of disability prevalence not attributable to specific diseases, decreased considerably (Supplementary tables S5 and S6).

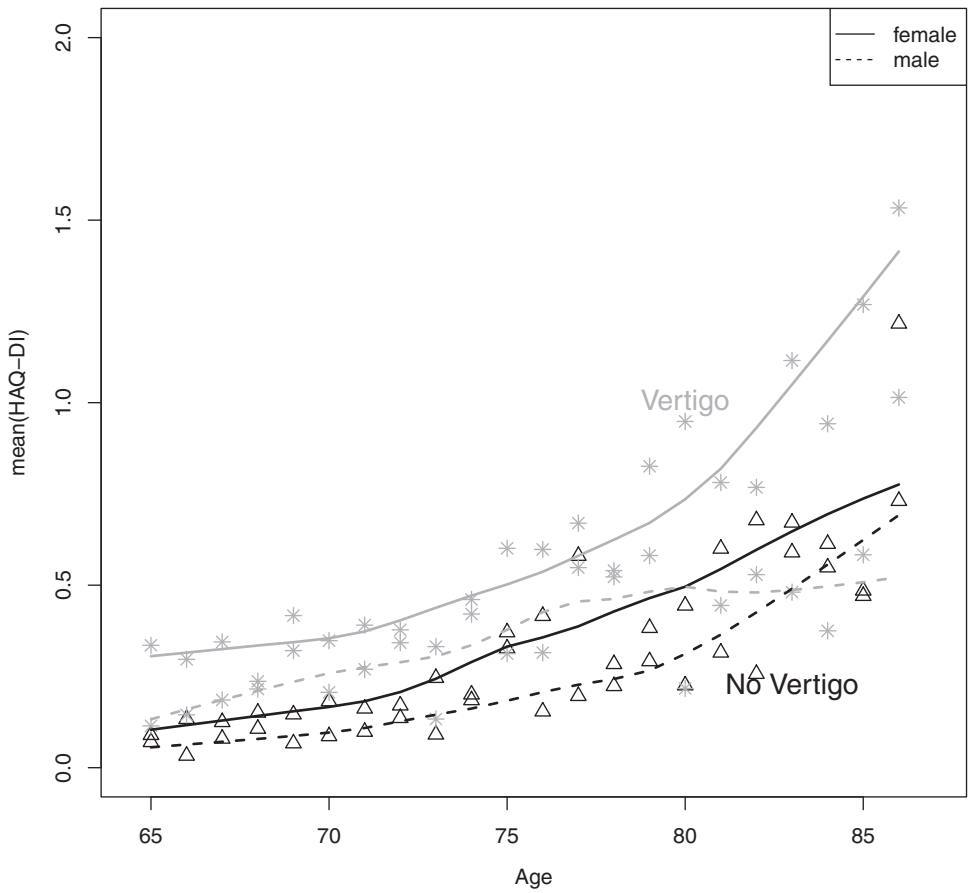

Figure 1 Disability in persons with and without vertigo and dizziness in different age-groups, stratified by sex. Asterisk (vertigo and dizziness) and triangles (no vertigo or dizziness) represent the point estimates of the respective age-group. The curves were plotted by fitting lowess smoother on the relative frequency values.[25]

Table 2 Results of multivariate logistic regression modelling the impact of vertigo and dizziness on disability

Variable	Odds ratio	95% Confidence interval
Age in years, classes (ref: <70)		
70–79	1.95	(1.65–2.31)
≥80	5.11	(4.05–6.46)
Sex (ref: male)	2.52	(2.16–2.93)
Vertigo and dizziness	1.66	(1.40–1.98)
Depression	5.45	(2.45–14.0)
Joint disease	2.43	(1.99–2.96)
Neurological disease	2.14	(1.34–3.44)
Anxiety	1.96	(1.46–2.63)
Pulmonary disease	1.93	(1.52–2.46)
Stroke	1.91	(1.39–2.62)
Falls	1.69	(1.35–2.11)
Diabetes	1.64	(1.35–2.00)
Kidney disease	1.52	(1.03–2.26)
Fracture in last 5 years	1.34	(1.15–1.56)
Heart disease	1.32	(1.11–1.57)
Cancer	1.28	(0.89–1.82)
Gastrointestinal disease	1.27	(0.98–1.65)
Eye disease	1.20	(1.03–1.40)
Hypertension	1.16	(1.00–1.35)
Liver disease	1.05	(0.64–1.72)

Discussion

To our knowledge, this is the first study to show how prominently vertigo and dizziness contribute to the burden of disability in the population of individuals aged ≥65. We showed that this contribution is independent of the effect of other health conditions. This finding has relevant implications for the recognition of vertigo and dizziness in the aged. Prevention and treatment of vertigo and dizziness in the aged may be pathways to improving functioning and decreasing the need for nursing care.

Prevalence of vertigo and dizziness

The 1-year prevalence of vertigo and dizziness in our study is higher than previously reported in the German general population.[3,26] This is in line with findings reporting that prevalence of vertigo rises with age.[1] Studies investigating populations of comparable age found similar prevalences.[1,5]

Impact of vertigo and dizziness on disability

In agreement with other literature, we found that when adjusted for the presence of other chronic health conditions, vertigo and dizziness were independently associated with disability. Also, we confirmed the higher risk for women of all ages. The association of vertigo and dizziness with disability was shown in a sample of older adults in the USA. Depending on the disability measures used, Aggarwal et al.[27] found an equal or even stronger association.

The association of dizziness and limitations in activities of daily living was shown when controlling for conditions such as heart disease, chronic lung disease, diabetes and cancer, as well as for sociodemographic factors.[28] Two studies from The Netherlands that were conducted in primary care settings found that for patients with dizziness aged ≥65, 60% reported moderate to severe disability; here, dizziness was also associated with long-term disability.[29]

Contribution of vertigo and dizziness to the burden of disability

In our study, vertigo and dizziness, along with joint diseases (i.e. arthritis and rheumatism), were the strongest contributors to the burden of disability, irrespective of age and sex. This has two interesting implications. First, by controlling for other potentially

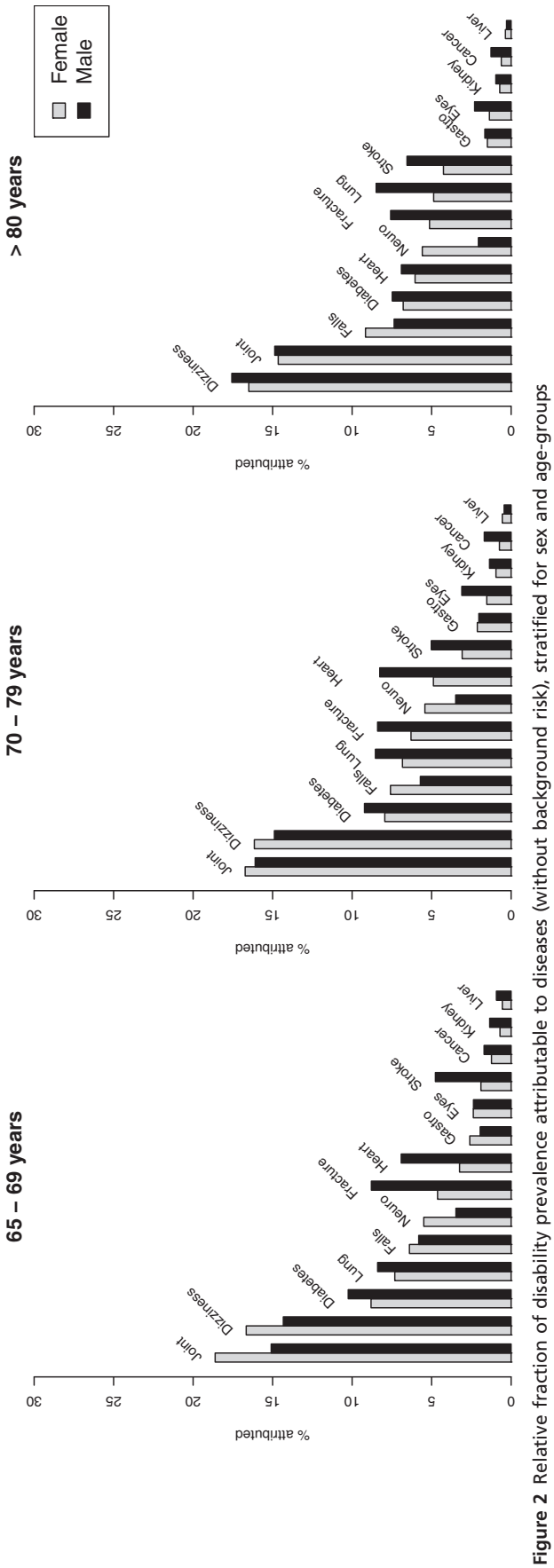

Figure 2 Relative fraction of disability prevalence attributable to diseases (without background risk), stratified for sex and age-groups

disabling health conditions, a separate effect of vertigo and dizziness can be shown. Sensitivity analysis showed that including or excluding vertigo and dizziness from the model left disease-specific attributable prevalences of disability unchanged, but considerably increased the estimate of the background risk. We conclude from this result that vertigo and dizziness are unique causes of disability, not primarily acting as symptoms of one of the included diseases that could plausibly have caused them, e.g. hypertension, heart disease, neurological disease or diabetes.

Second, the detrimental impact of vertigo in the aged can be explained by its distinct destabilizing effect. Vertigo and dizziness are specific and important risk factor for falls and injuries.[1,30] Thus, even fear of falling or the anticipation of a vertiginous episode impairs mobility.[31,32] As a consequence, decreased mobility leads to even faster deconditioning, frailty and disablement.[33] This vicious circle is known for joint diseases[34] and for immobility due to hospitalization.[35] Not surprisingly, the independent effect of joint disease on the prevalence of disability was large in our study. This is in agreement with the literature.[36] The effects of vestibular rehabilitation and balance training on independence and mobility in the aged have been repeatedly shown.[37,38]

Limitations

Our study has some potential limitations. Due to the observational cross-sectional study design, no causal relationships could be examined and reverse causation could not be ruled out. The cross-sectional nature of the data also implies that only present chronic diseases can be included as independent competing causes of disability. Potential effects of past morbidity will be part of the background risk.

Another potential source of bias is that information on morbidity was collected by personal or proxy interview. However, previous studies have shown self-report of health conditions in this specific study setting to be reliable.[39]

We also acknowledge that the sample is certainly biased by selection due to the non-response of more disabled persons. The issue of non-participation in KORA surveys has been studied in detail before.[40] It was shown that non-participants include a higher percentage of persons with worse health and that severely impaired persons were less likely to participate in our study. Thus, our study is likely to yield conservative results. It may have underestimated the true prevalence of disability and consequently also the true impact of diseases on disability.

Conclusion

In conclusion, the results of our study indicate that vertigo and dizziness independently and relevantly contribute to population-attributable disability in the aged. It is up to the practitioner to explore the causes for vertigo and dizziness rather than treat them as unavoidable consequences of ageing. Vertigo and dizziness are treatable and manageable symptoms. Recognizing them may prevent consequences such as falls, injuries, deconditioning and immobility, and ultimately, disability and need for nursing care.

Supplementary data

Supplementary data are available at *EURPUB* online.

Acknowledgements

The authors thank the staff of the KORA study centre in Augsburg who was involved in conducting the studies and the team at the Helmholtz Zentrum München for maintaining these complex data. Parts of the work have been presented during the IEA meeting, 6 September 2012, in Porto, and at the 2012 meeting of the Barany Society in Uppsala, 11 June 2012.

Funding

The KORA research platform (KORA, Cooperative Research in the Region of Augsburg) was initiated and financed by the Helmholtz Zentrum München - German Research Center for Environmental Health, which is funded by the German Federal Ministry of Education and Research and by the State of Bavaria. The KORA-Age project was financed by the German Federal Ministry of Education and Research (BMBF FKZ 01ET0713 and 01ET1003A) as part of the 'Health in old age' program. 'Functioning and disability among aged persons' was funded by the German Research Foundation (GR 3608/1-1). This project was supported by funds from the German Federal Ministry of Education and Research under the Grant code 01 EO 0901. The authors bear full responsibility for the content of this publication.

Conflicts of interest: None declared.

Key points

- Vertigo and dizziness are known problems in the aged, with a reported prevalence of up to 50%, and either symptoms of distinct vestibular disorders or consequences of non-vestibular, often multifactorial, deficits.
- Vertigo and dizziness increase postural instability and the propensity for falls, injuries and fractures.
- Our study shows that vertigo and dizziness in the aged are among the strongest contributors to disability in the older population independent from other conditions.
- Health care of older individuals should consider vertigo and dizziness as treatable and manageable distinct disease entities rather than side effects of other conditions. This may prevent consequences and increase health.

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