Vertigo and dizziness: challenges for epidemiological research

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Abstract

Introduction
Vertigo and dizziness are among the most common chief complaints when patients seek medical advice and affect a considerable part of adults of working age. With a high lifetime prevalence and high burden of disease, vertigo and dizziness can be severely disabling symptoms because of their high impact on daily life. Although most vestibular disorders are manageable they are often under- and misdiagnosed in primary care. Epidemiological data on vertigo and dizziness is scarce and inconsistent. Challenges that make epidemiological research difficult include case definition and diagnostic algorithms, data collection procedures and standardization of routine data. Vertigo and dizziness as symptoms are difficult to describe and to standardize. With very few exceptions, vertigo has been regarded in epidemiological studies as a symptom or consequence of some other underlying disease of cardiovascular or neurological origin and has hardly been the focus of epidemiological research. Epidemiological data also vary depending on data collection procedures, study design and sample. In epidemiological studies, detailed diagnostic work-ups of vestibular and non-vestibular causes of vertigo may be impossible. Nevertheless, representative studies could include simple and non-invasive bedside tests to verify diagnoses and give deeper insight into determinants and distribution of vestibular disorders. With the growing number of dedicated dizziness units at hospitals, a systematic approach to data collection in clinical cohorts is needed. This also requires a common classification of disorders. The aim of this review was to discuss the challenges for epidemiological research in vertigo and dizziness.

Conclusion
Successfully transferring terminology, procedures, diagnostic algorithms and therapy options from a specialized clinical setting to the primary care setting is necessary if such knowledge is to be of any practical utility for the health system. Costs, benefits, effectiveness and potential harm of this implementation must be shown.

Introduction
Vertigo and dizziness belong to the most common chief complaints when patients seek medical advice. However, vertigo as well as dizziness are symptoms present in a wide variety of disorders. Despite the frequency of these symptoms, there is a lack of epidemiological data for the following reasons: (1) in contrast to headache, lumbago or dyspnoea, patients have problems to describe their complaints; (2) disorders presenting with vertigo and dizziness fall in different medical subspecialties (e.g. general practice, otorhinolaryngology, neurology, psychiatry, ophthalmology, cardiology); (3) diagnostic categories are not established across medicine; and (4) most syndromes are not represented in international classification systems (e.g. ICD-10).

Vertigo can be either a reaction to stimulus, e.g. following unaccustomed head movements as in a carrousel or on a ship, or the result of a discrepancy between visual and vestibular information, e.g. in a moving car or on an exposed mountain ridge. The most frequent cause of pathologic vertigo is an impairment of the vestibular system. Three semicircular canals and the otolithic apparatus in the bony labyrinth of the inner ear provide information about the position of head in space. The eighth cranial nerve carries this information to the vestibular nuclei in the brainstem. Pathways to the spinal cord support postural stability. Closed connections to the eye muscles via the vestibulo-ocular reflex (VOR) ensure stable images on the retina during head movements. Vertigo can be of peripheral origin, i.e. a problem of the labyrinth or the vestibular nerve, or of central origin, as a consequence of a lesion of the cerebellum or brain stem. Further, psychogenic vertigo can develop following organic vestibular disorders, or might develop as a comorbid condition of phobia or panic attacks. The visual and the somatosensory systems contribute to postural stability. Impaired sensory functions or impaired interaction between sensory systems can cause vertigo and dizziness.

Patients may describe their complaints as light-headedness,
unsteadiness of gait, imbalance, perception of rotation, or anxiety. They may encompass problems in vision and gaze stabilization, impaired postural control, or vegetative symptoms such as hyperhidrosis and nausea. Although dizziness and vertigo are overlapping entities and are sometimes used interchangeably they are not the same. Vertigo can be associated with a sensation of rocking or spinning and can in many cases be attributed to disorders of the peripheral or central vestibular system. Dizziness describes a more general discomfort without the erroneous perception of large scale movements and can reflect vestibular as well as non-vestibular disorders. An individual may report dizziness when experiencing imbalance, e.g. in peripheral neuropathy due to diabetes, in Parkinson’s disease, cerebellar ataxia, arterial hypotension, depression, or anxiety.

The long held belief that symptom quality is useful to direct to underlying causes has been seriously challenged. A widely used definition of vertigo and dizziness was based on four mutually exclusive entities: (a) vertigo, i.e. the spinning sensation caused by vestibular disease, (b) fainting or pre-syncope of orthostatic or cardiovascular origin, (c) imbalance of neurological origin and (d) dizziness of psychiatric, toxic or metabolic origin. Such a classification has been shown to be misleading and dangerous. It ignores the high variability in the perception of vertigo and dizziness in patients and the impact of additional signs and symptoms for the diagnosis.

Why is this interesting and important for epidemiologists? Vertigo and dizziness count among the most common complaints in outpatient practices and affect a considerable part of adults of working age. With a high lifetime prevalence and high burden of disease, vertigo and dizziness can be severely disabling symptoms because of their high impact on daily life. Although most vestibular disorders are manageable, they are often under- and misdiagnosed in primary care. Psychiatric comorbidity such as anxiety, depression, panic disorders and agoraphobia may account for avoidance behaviour, increased disability and increased health care utilization. Finally, vertigo and dizziness are specific and important risk factor for falls and injuries, especially in the aged. Still, epidemiological data on vertigo and dizziness is scarce and inconsistent.

The objective of this article is to give a short overview of the epidemiological findings on dizziness and vertigo and to discuss some of the major challenges that vertigo and dizziness and namely vestibular disorders pose for epidemiological research.

**Prevalence**
The lifetime prevalence of moderate or severe dizziness or vertigo was 30% in the adult German population. Of all cases with vertigo and dizziness, 24% (i.e. 7% of the general population, 1-year prevalence 5%) were assumed to be of vestibular origin as ascertained by an intensified semi-standardized telephone interview. A recent French population-based study found the 12-month prevalence of vertigo (“a feeling that things are spinning or moving around”) to be 48%. Agrawal et al. reported the 5-year prevalence of vestibular dysfunction to be 35% in the US population aged 40 and older. This was established via structured interviews and balance testing. Based on medical claims data, a 1-year prevalence of vertigo of 3% was reported for the adult population of Taiwan. Table 1 gives an overview on the most relevant prevalence studies. Peripheral vestibular disorders are frequent causes for dizziness and vertigo; benign paroxysmal positioning vertigo (BPPV) is the most frequent form of peripheral vestibular disorders with a lifetime prevalence of 2% in the general population. About 20% of the patients referred to specialized dizziness clinics are diagnosed with BPPV. Other, less-frequent peripheral forms of vestibular disorders include Menière’s disease with a reported prevalence ranging from 3.5 per 100,000 to 51.3 per 100,000 and vestibular neuritis with an annual incidence of 3.5 per 100,000. Central vestibular forms of vertigo include cerebrovascular diseases, brain stem and cerebellar lesions, infections and vestibular migraine. With a lifetime prevalence of 1% vestibular migraine was reported to be the second most common cause of recurrent vertigo. With the exception of BPPV and vestibular migraine there are no reliable estimates for prevalence of specific disorders in the general population. The full spectrum of benign recurrent vertigo is still not completely understood.

Postural imbalance is one consequence of visual stimulation of height that occurs when looking, for example, from a tower or a cliff. It is a common physiological phenomenon experienced by everyone at a height of several meters, when the distance between the eye and the nearest objects within the environment becomes large. However, as with psychosomatic symptoms and behaviour, the individual response to this visual stimulation varies. Visual height intolerance occurs when a trigger causes the apprehension of losing one’s balance and falling. A recent population-based study showed that almost 30% of the general population is affected by this. However, a recent qualitative study showed that reaction to visual height intolerance might be highly subjective. Presumably, susceptibility to intolerance of visual height stimuli reflects a continuum ranging from less distressing body reactions to panic-like symptoms characteristic of specific, severe phobias.

Motion sickness arises when the signals of motion from the different sensory channels are inconsistent. Vertigo as a result of movement can...
Critical Review

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Table 1  Studies reporting epidemiological measures of vertigo and dizziness

<table>
<thead>
<tr>
<th>Author (year)</th>
<th>Study type, mode of data collection</th>
<th>Sample size</th>
<th>Population</th>
<th>Frequency measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yardley et al. (1998)</td>
<td>Cross-sectional survey, postal</td>
<td>2064</td>
<td>Random sample from north London practices, UK, aged 18–64</td>
<td>23.3% (1 month) dizziness</td>
</tr>
<tr>
<td>Neuhauser et al. (2005)</td>
<td>Cross-sectional survey with two stage sampling, semi-standardized telephone interview</td>
<td>8318 1003 (with moderate/severe dizziness completed neurologic interview)</td>
<td>Representative sample from German general population, aged 18 and above</td>
<td>29.5% (lifetime) dizziness/vertigo 4.9% (1 year) vestibular vertigo 7.4% (lifetime) vestibular vertigo (age- and sex-adjusted) 1.4% (1 year) vestibular vertigo (age- and sex-adjusted)</td>
</tr>
<tr>
<td>Agrawal et al. (2009)</td>
<td>Cross-sectional survey, face-to-face interviews and balance testing</td>
<td>5086</td>
<td>Representative sample of US adults, aged 40+</td>
<td>35.4% (5 years) vestibular dysfunction (Romberg testing and difficulty with falling or balance in the last 12 months)</td>
</tr>
<tr>
<td>Stevens (2008)</td>
<td>Cross-sectional survey, face-to-face interviews and balance testing</td>
<td>2925</td>
<td>Sample from general UK adult population, aged 65+, frail and disabled persons excluded</td>
<td>21.5% poor balance 11.1% dizziness</td>
</tr>
<tr>
<td>Gopinath et al. (2009)</td>
<td>Cross-sectional survey, face-to-face interviews</td>
<td>2751</td>
<td>General adult population, Blue Mountains region west of Sydney, Australia, aged 50+</td>
<td>36.2% (1 year) dizziness/vertigo 10.0% (1 year) vestibular vertigo (rotational/spinning)</td>
</tr>
<tr>
<td>Wiltink et al. (2009)</td>
<td>Cross-sectional survey, face-to-face interviews</td>
<td>1269</td>
<td>Representative sample from German general population, aged 14–90</td>
<td>15.8% (4 weeks) dizziness</td>
</tr>
<tr>
<td>Mendel et al. (2010)</td>
<td>Cross-sectional survey, postal</td>
<td>2547</td>
<td>Representative sample from population of north-eastern Stockholm, Sweden, aged 18+</td>
<td>21% (1 year) dizziness/unsteadiness</td>
</tr>
<tr>
<td>Lai et al. (2011)</td>
<td>Cross-sectional claims, data from national Taiwan health insurance claims database</td>
<td>527,807</td>
<td>General Taiwanese adult population with at least one consultation in 2006, aged 18+</td>
<td>3.13% (1 year) diagnosis of vertigo based on ICD-9</td>
</tr>
<tr>
<td>Bisdorff et al. (2013)</td>
<td>Cross-sectional survey, self-administered questionnaire</td>
<td>2987</td>
<td>Sample from a preventive medicine center in north-eastern France, aged 18+</td>
<td>59.2% (12 months) vertigo/dizziness/unsteadiness</td>
</tr>
</tbody>
</table>
be either a physiological reaction or intolerance to movement due to vestibular disease. Thus there are no reliable estimates on prevalence or risk factors, posing another challenge to epidemiological research of vertigo and dizziness. Specifically in the old, medication is a potential risk factor for vertigo and dizziness. Several classes of drugs are known to induce dizziness, among those many psychotropic and antihypertensive drugs. Also, polypharmacy and potentially inadequate use of medication are risk factors for vertigo and dizziness in the old.

**Distribution and comorbidity**
Consistently across studies, prevalence is reported to be higher in women. An association of hormone status with vertigo has therefore been suggested but not examined systematically. With a clear female preponderance, vertigo is more frequent in persons with migraine and vice versa. Consequently, Lee et al. showed that migraine-associated vertigo was also associated with progesterone receptor genes, hypothesizing that this accounts for a differential response to hormonal fluctuations.

A number of studies report increasing prevalence of vertigo and dizziness with age, but absolute numbers vary depending on diagnostic definitions and age groups. Dizziness and balance disorders affect more than half of the older population. Vestibular disorders frequently interact with other common disorders such as migraine and psychiatric disorders, namely anxiety, social phobia and depression. An association with other chronic conditions, e.g. diabetes and hypertension, has been described.

**Consequences**
The distinct negative impact of vertigo and dizziness on quality of life has been consistently reported. Insufficient neuro-otological work-ups and the resulting incomplete treatment may account for chronicity and a sense of impetus. The economic burden can be considerable. Vertigo of organic origin, e.g. vestibular disease, may cause secondary anxiety disorders. Likewise, an underlying psychiatric disorder can encompass dizziness. Patients with both dizziness and anxiety reported increased use of health care resources. From the patients’ perspective, vertigo has an impact on multifaceted aspects of functioning and disability, mainly body functions and activities and participation. Modifying contextual factors must be taken into account to cover the complex interaction between the health conditions, environmental triggering factors, and the individuals’ personalities and coping strategies.

**Challenges for epidemiological studies**
There are several challenges in vertigo and dizziness that make epidemiological research difficult, namely case definition and diagnostic algorithms, data collection procedures and standardization of routine data. To start with the case definition, as detailed above, the systematic approach to the diagnosis of vestibular disorders is clear-cut. Nevertheless, dizziness as a symptom is difficult to describe and to standardize. Clinical diagnosis can be difficult due to the possible differential options. Consequently, population-based studies suffer from inconsistent definitions. So far, and with very few exceptions, vertigo has been regarded in epidemiological studies as a symptom or consequence of some other underlying disease of cardiovascular or neurological origin. Therefore, it has hardly been the focus of epidemiological research. As a consequence, there are no representative cohort studies with sufficient neuro-otological expertise that could yield reliable data on prevalence and incidence of specific vestibular disorders. Published data mostly rely on the case-mix of selected patients seen in emergency departments and specialized dizziness clinics where diagnostic expertise is high but chronic and severe cases are overrepresented. Easy to apply paper-and-pencil diagnostic algorithms lack sufficient sensitivity. Almost 45% of outpatients are primarily seen and treated by a general practitioner who is mostly without specific neuro-otological expertise. Thus, vestibular disorders are under-diagnosed in the community setting.

Epidemiological data reported in studies also vary depending on data collection procedures (e.g. validated telephone survey, questionnaire, face-to-face interview, or clinical examination), study design (retrospective case series, prospectively collected observational data, controlled clinical trials) and sample. Likewise, reported prevalences vary depending on time frame (12 months, 4 weeks, lifetime) and quality of the symptoms elicited by specific questions.

Coding and classification of vestibular disorders is another obstacle to epidemiological analysis. While there are distinct classification efforts, vertigo is not well represented in ICD-10. Subsequently, medical claims data is likely to be biased. This complicates the analysis of routine data. To meet this challenge, the committee for the international classification of vestibular disorders of the Bárány Society is currently preparing a series of consensus documents in collaboration with the main otoneurological experts and societies to set standards for terminology and diagnosis. Documents are already available for benign paroxysmal vertigo and vestibular migraine.
Discussion

The authors have referenced some of their own studies in this review. These referenced studies have been conducted in accordance with the Declaration of Helsinki (1964) and the protocols of these studies have been approved by the relevant ethics committees related to the institution in which they were performed. All human subjects, in these referenced studies, gave informed consent to participate in these studies.

Vertigo and dizziness are among the most frequent disorders in medical care. Although their impact is often underestimated, they may cause considerable impairment and restriction of activities and participation. Still, frequency, determinants and the course of the underlying disease entities are largely unknown. Diagnosis and treatment in the community setting tend to be difficult.

Epidemiological cohorts usually collect data over long time spans in large samples. In such settings, detailed diagnostic work-ups of vestibular and non-vestibular causes of vertigo may be impossible. Nevertheless, representative studies could include simple and non-invasive bedside tests such as the video head impulse test to assess vestibular function and to validate diagnoses. Longitudinal studies could then be used to shed light on specific risk factors, intensity and impact over the life span and clarify age- and sex-specific differences. Issues of health services utilization and costs could be examined systematically.

With the growing number of dedicated hospital-based dizziness units, a systematic approach to data collection in clinical cohorts is needed. This also requires a common classification of disorders. Multicentric clinical cohorts are needed to investigate the consequences of different treatment options and to offer insights into chronification and comorbidity including genetic characterization.

Conclusion

A broader approach to health services is needed to translate the knowledge of clinical experts for the general practitioner. Successfully transferring terminology, procedures, diagnostic algorithms and therapy options from a specialized clinical setting to the primary care setting is necessary if such knowledge is to be of any practical utility for the health system. New ways of implementing diagnostic tools and algorithms into community practice have to be found, and costs, benefits, effectiveness and potential harm of this implementation must be shown to improve diagnosis and treatment of vertigo.

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References


