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Prevalence of Pediatric Dizziness and Imbalance in the United States

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Abstract

Objectives. Understand the prevalence of vestibular symptoms in US children.

Study Design. Cross-sectional analysis

Setting. 2016 National Health Interview Survey.

Subjects and Methods. Responses from the 2016 National Health Interview Survey for children ages 3 to 17 years were examined to determine the prevalence of vestibular symptoms and provider-assigned diagnoses.

Results. Dizziness or imbalance was reported in 3.5 (95% confidence interval, 3.1-3.9) million patients (5.6%) with a mean age of 11.5 years. Dizziness was reported in 1.2 million patients (2.0%) with a mean age of 12.7 years and balance impairment in 2.3 million patients (3.7%) with a mean age of 10.6 years. Prevalence of dizziness and imbalance did not vary by sex ($P = .6$, $P = .2$). Evaluation by a health professional was reported for 42% of patients with dizziness and 43% of patients with imbalance, with diagnoses reported in 45% and 48% of patients with dizziness and imbalance, respectively. The most common diagnoses reported for dizziness were depression or child psychiatric disorder (12%), side effects from medications (11%), head/neck injury or concussion (8.4%), and developmental motor coordination disorder (8.3%). The most common diagnoses reported for imbalance were blurred vision with head motion, "bouncing" or rapid eye movements (9.1%), depression or child psychiatric disorder (6.2%), head/neck injury or concussion (6.1%), and side effects from medications (5.9%).

Conclusion. The national prevalence of childhood vestibular symptoms is more common than previously thought. Reported diagnoses varied greatly from the literature, suggesting a need for increased awareness of causes of vestibular symptoms in children.

Keywords

pediatric vestibular, dizziness, vertigo, imbalance, balance impairment

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Vestibular disorders are common in adults, and the medical literature includes a large volume of research studies of vestibular dysfunction in the adult population.[1-7] Similarly, specialized medical programs directed toward the evaluation and management of vestibular disorders in adults are commonplace. However, vestibular disorders in children have received comparatively little attention until recently. This may be attributable to a number of factors, including variable abilities of children to report vestibular symptoms, limited awareness of vestibular disorders among pediatric health care providers, and a lack of specialized programs directed at studying and treating vestibular disorders in children. Fortunately, a number of such programs have begun to form in recent years, and the amount of research on pediatric vestibular disorders has started to grow accordingly.[8-15]

The symptoms caused by vestibular disorders in children vary greatly, but most fall into the general categories of dizziness or imbalance. Most vestibular disorders in children primarily cause either one or the other of these symptoms, with only some causing both symptoms in combination. Unfortunately, most prior epidemiological studies of pediatric vestibular disorders bundle dizziness and imbalance together, making a determination of the true incidence and causes of these complaints difficult to decipher.[11,12,14,16-21] In addition, most prior epidemiological studies of pediatric dizziness have included all types of dizziness symptoms, which may provide a less reliable estimate of the true prevalence of pediatric vestibular symptoms, due to the inclusion of nonvestibular types of dizziness symptoms.

The reported prevalence of vestibular symptoms in children has varied widely,[9-12,14,17-21] and most studies have been limited by small data sets or sample distributions that are not weighted in a fashion that is scalable to a population

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level. A reliable assessment of the current prevalence of pediatric vestibular symptoms and their management is an essential component to establishing the need for further clinical and research endeavors in the growing field of pediatric vestibular medicine. In addition, an accurate assessment of current care practices in the evaluation and management of children with vestibular complaints will help to determine whether greater efforts are needed to educate pediatric providers on a broader scale in the clinical care of children with vestibular complaints.

The recent addition of the Child Balance Supplement (CBS) to the National Health Interview Survey (NHIS) provides an excellent opportunity to determine the prevalence and practice patterns of vestibular symptoms in children and adolescents on a large, population-based scale. A prior study analyzed CBS data from the 2012 NHIS.[16] In the current study, we analyzed CBS data from the more recent 2016 NHIS to determine whether the prevalence and associated practice patterns of pediatric dizziness and imbalance have changed and also to analyze these patterns for dizziness and imbalance as independent entities, as opposed to bundling these symptoms together, as was done in the prior study. We also sought to determine whether increasing awareness of pediatric vestibular disorders has resulted in an increase in referrals to health care providers for these symptoms and to determine whether the relative proportions of causative diagnoses assigned to these patients coincide with those described in studies from specialized pediatric vestibular programs.

Methods

We conducted a cross-sectional analysis of data from the 2016 NHIS, which was distributed to households by the National Center for Health Statistics, a subsidiary of the US Centers for Disease Control and Prevention.[22] The NHIS is an interview survey designed to sample a population representative of the United States, with the goal of monitoring health and health trends in the United States.[23] Data are collected via in-person interview and phone interview by field representatives trained by the US Census Bureau Regional Offices.[24] We specifically analyzed data from the CBS portion of the 2016 NHIS, which included questions regarding symptoms, health care utilization, and diagnoses related to dizziness and balance impairment in children and adolescents. Data analysis was limited to sampled households with children ages 3 to 17 years who completed the CBS portion of the 2016 NHIS. Demographic data and responses to dizziness and imbalance questions were analyzed.

The CBS section asked parents to report whether their children had the following symptoms over the past year: (1) ''a spinning or vertigo feeling with a sense of movement, such as rocking of oneself or as if riding a Merry-Go-Round''; (2) ''feeling light-headed, fainting, or feeling [he/she] is about to pass out''; (3) ''blurred vision when head is moving, or rapid eye movements known as 'bouncing' eyes causing disorientation''; (4) ''poor balance, an unsteady or woozy feeling that makes it difficult to stand up or walk''; (5) ''frequent, unexpected falls''; (6) ''problems with body or motor coordination or clumsiness''; and (7) ''any other type of balance or dizziness problems.'' Two categories were constructed for further analysis: ''dizziness'' (those reporting symptom 1) and ''imbalance'' (those reporting at least 1 of symptoms 4, 5, or 6). The prevalence for each of these 2 categories was computed, respectively, with no patient counted more than once in either category. We excluded patients with only symptom 2 from these categories because a sensation of feeling like one is going to faint (aka ''presyncope'') is generally due to disorders of nonvestibular bodily systems (eg, cardiac, endocrine, hematologic, psychiatric). We also excluded patients with only symptom 3 from these categories since this symptom is frequently attributable to ophthalmologic disorders and is not a specific complaint of dizziness. We excluded patients with only symptom 7 from the analysis since this category is nonspecific, making it difficult to determine whether patients in this category had genuine vestibular symptoms. Patients were able to give multiple positive responses to the survey questions on symptoms and on provider-assigned diagnoses.

A Pearson's χ^2 test was employed to determine correlations between sex and dizziness or imbalance. Cross-tabulations were used to determine how many children were evaluated by health care providers for these symptoms and how many of those who sought care received specific diagnoses. Specific diagnoses assigned by health care providers were also analyzed. All statistical tests were run using Statistical Package for the Social Sciences (SPSS) (Version 24.0; SPSS, Inc, an IBM Company, Chicago, Illinois). Data were adjusted for the clustered, stratified, and weighted sampling approach used in the NHIS, with sample weights used to project population estimates on a nationally representative level. The exact method of sampling and calculation of sample weights is detailed in the 2016 NHIS Survey Description.[24] Sample estimates were considered reliable if their relative standard errors were <30%, consistent with recommendations from the National Center for Healthcare Statistics. Statistical significance was set at $P < .001$. This study was approved by the Institutional Review Board of Boston Children's Hospital.

Results

Complete data from the CBS section of the 2016 NHIS were available for a nationally representative raw sample of 9247 children ages 3 to 17 years (mean [SD] age = 10.3 [4.4] years), with weighted projections used to estimate prevalence rates on a national scale. There were 25% (SE, 1.0%) children of Hispanic ethnicity and 74% (0.8%), 15% (0.6%), 1.1% (0.2%), 5.3% (0.3%), and 4.9% (0.3%) reported race as white, black/African American, American Indian/Alaska Native, Asian, and multiple race, respectively.

Dizziness or imbalance symptoms were reported in an estimated 3.5 (95% confidence interval [CI], 3.1-3.9) million children (5.6%), based on the weighted response projections, with a mean (SE) age of 11.5 (0.2) years.

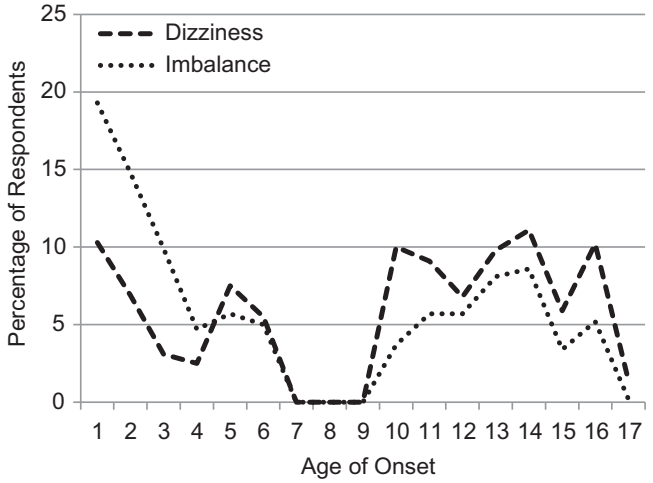

Figure 1. Reported age of onset of dizziness and imbalance.

Dizziness was reported in 1.2 million children (2.0%) with a mean (SE) age of 12.7 (0.3) years, and imbalance was reported in 2.3 million children (3.7%) with a mean (SE) age of 10.6 (0.3) years. Prevalence of dizziness and imbalance did not vary by sex ($P = .6$ and $P = .2$, respectively). Ages of onset of dizziness and of imbalance are shown in **Figure 1**. Imbalance was reported relatively more commonly in younger children, while dizziness was reported relatively more commonly for adolescents, although some overlap was seen, which was likely due to the concurrence of both dizziness and balance symptoms in some patients. A dramatic drop in the reporting of both dizziness and imbalance was seen for children between the ages of 7 and 9 years, resulting in a double peak of reported symptoms centered at infancy and at midadolescence. Reported frequency, duration, and how much of a problem symptoms were are shown in **Table 1**. Symptoms were reported as being perceived to be a ''moderate,''''big,'' or ''very big'' problem in 23% of respondents, while the remaining 77% indicated that the symptoms were perceived as a ''small problem'' or ''no problem.''

Evaluation by a health care provider for dizziness/imbalance was reported for 40% of children who reported any symptoms of dizziness or imbalance (symptoms 1-7), 42% in the dizziness group, and 43% of children in the imbalance group. Children were given diagnoses in 45% of cases in the dizziness group and in 48% of cases in the imbalance group. The most common diagnoses reported for dizziness were depression or child psychiatric disorder (12%), side effects from medications (11%), head/neck injury or concussion (8.4%), and developmental motor coordination disorder (8.3%) (**Table 2**). The most common diagnoses reported for imbalance were blurred vision with head motion, ''bouncing,'' or rapid eye movements (9.1%); depression or child psychiatric disorder (6.2%); head/neck injury or concussion (6.1%); and side effects from medications (5.9%) (**Table 3**).

Table 1. Reported Frequency and Duration of Dizziness or Imbalance Symptoms and How Problematic They Were.

Frequency of Symptoms	%	SE (%)
Daily (including constantly)	25	3.3
At least once per month, but less than daily	21	2.8
More than twice in the past year, but less than once per month	19	2.6
Once or twice in the past year	23	3.0
Not even once in the past year	12	2.3
Duration of symptoms		
Momentary, or less than 2 minutes	64	3.4
2 minutes to less than 20 minutes	14	2.5
20 minutes to less than 8 hours	13	2.3
8 hours to less than 24 hours	2.3	0.8
1 day to less than 14 days	3.2	1.2
2 weeks to less than 3 months	1.1	0.7
3 months or longer	2.9	1.3
How much of a problem were symptoms?		
No problem	36	3.3
A small problem	41	3.4
A moderate problem	15	2.5
A big problem	3.1	1.2
A very big problem	4.9	1.5

Discussion

The prevalence rate of dizziness and imbalance (symptoms 1-7) in the US pediatric population found in the current study of 2016 NHIS data was 5.6%, which is similar to the rate of 5.3% identified in the prior study of data from the 2012 NHIS.[16] The mean (SD) age of children included in the current study was 10.3 (4.4) years, which is also similar to that identified in the study of the 2012 NHIS data.[16] These findings suggest that the rate of these symptoms and the affected population has held relatively steady over the intervening 4-year period between the 2012 and 2016 NHIS. This prevalence is also noted to be much higher than that reported in a prior study that specifically used billing codes to determine the estimated prevalence of vestibular symptoms in children.[18] This discrepancy was likely partly due to the fact that many children in the NHIS were reported to have not reached the level of evaluation in a health care setting for their vestibular symptoms. As the current study employs a household-based survey, selection bias is largely eliminated as claims or billing-based data likely underestimate the true prevalence. A slightly higher overall percentage of children with dizziness or imbalance had reportedly seen a health care provider for their symptoms in the 2016 survey (40%) as compared to the 2012 survey (36%).[16] However, the groups of patients in the current study that only included those with symptoms that were

Table 2. Reported Diagnoses for Children with a Primary Symptom Complex of Dizziness.[a]

Diagnosis	Weighted No. (Thousands)	SE (Thousands)	%	SE (%)
Other health condition or cause	271.7	49.8	49	6.2
Depression or child psychiatric disorder	65.3	26.4	12	4.3
Side effects from medications (antibiotics, etc)	63.1	25.3	11	4.4
Head/neck injury or concussion	46.6	18.2	8.4	3.2
Developmental motor coordination disorder ("clumsy child")	45.7	16.4	8.3	2.9
Diabetes ("juvenile diabetes")	30.4	21.5	5.5	3.7
Crystals—loose or dislodged in the ear	29.3	13.1	5.3	2.4
Nutritional, such as low blood sugar (metabolic problem)	16.0	10.8	2.9	1.9
Low blood pressure	9.2	5.7	1.7	1.0
Genetic syndrome, such as Usher's or Waardenburg syndrome	8.7	6.1	1.6	1.1
Benign positional or paroxysmal vertigo (BPV)	7.2	7.2	1.3	1.3
Blurred vision with head motion, "bouncing," or rapid eye movements	1.1	1.1	0.2	0.2
Ear infection(s)—otitis media, fluid, viral labyrinthitis	0.0	0.0	0.0	0.0
Headache, including migraine	0.0	0.0	0.0	0.0
Malformation of the ear	0.0	0.0	0.0	0.0
Ménière's disease	0.0	0.0	0.0	0.0

[a]For the subgroup of dizziness patients, there were no recorded unknown responses, including "refused, unascertained, or I do not know." Data were unavailable for the following responses: "anxiety, including panic syndrome" and "neurological, such as cerebral palsy, seizure(s), etc."

Table 3. Reported Diagnoses for Children with a Primary Symptom Complex of Imbalance.[a]

Diagnosis	Weighted No. (Thousands)	SE (Thousands)	%	SE (%)
Other health condition or cause	515.8	68.0	49	4.9
Blurred vision with head motion, "bouncing," or rapid eye movements	95.8	31.1	9.1	2.8
Depression or child psychiatric disorder	65.6	24.3	6.2	2.2
Head/neck injury or concussion	64.3	21.5	6.1	2.0
Side effects from medications (antibiotics, etc)	62.8	25.3	5.9	2.3
Developmental motor coordination disorder ("clumsy" child)	39.8	15.0	3.8	1.4
Crystals—loose or dislodged in the ear	25.8	11.6	2.4	1.1
Malformation of the ear	23.7	23.7	2.2	2.2
Genetic syndrome, such as Usher's or Waardenburg syndrome	19.4	10.0	1.8	0.9
Nutritional, such as low blood sugar (metabolic problem)	19.1	11.2	1.8	1.1
Ear infection(s)—otitis media, fluid, viral labyrinthitis	15.7	10.5	1.5	1.0
Low blood pressure (hypotension)	15.6	8.1	1.5	0.8
Benign positional or paroxysmal vertigo (BPV)	7.2	7.2	0.7	0.7
Diabetes ("juvenile diabetes")	0.0	0.0	0.0	0.0
Headache, including migraine	0.0	0.0	0.0	0.0
Ménière's disease	0.0	0.0	0.0	0.0

[a]For the subgroup of imbalance patients, 2.6% (SE, 2.6%) recorded unknown responses, including "refused, unascertained, or I do not know." Data were unavailable for the following responses: "anxiety, including panic syndrome" and "neurological, such as cerebral palsy, seizure(s), etc."

more vestibular specific demonstrated higher rates of seeking care (42% for dizziness and 43% for imbalance), perhaps because such vestibular-specific symptoms may have been perceived by parents as being more concerning than non-vestibular-type symptoms, such as lightheadedness. It remains the case that seeking care from a health care provider was reported for less than half of children with dizziness or imbalance. This may be partially attributable to the fact that some children can compensate well for vestibular dysfunction, sometimes resulting in symptoms being short-lived, and thus parents may have opted not to seek care.[15] This may also be a result of parents perceiving a lack of a need for medical care or a lack of treatment options for children with vestibular symptoms, even when seeking care may have been appropriate. These data also suggest that vestibular problems may be more common in children than pediatric health care providers perceive, since a significant portion of children with vestibular symptoms do not end up

being seen in a health care setting. These factors indicate a need for increased awareness of vestibular disorders in the pediatric population.

In this study, we analyzed children with dizziness and imbalance separately rather than as 1 group. We believe that this distinction is important to make because the common causes and typical ages of onset of these individual symptoms vary in children. These symptoms are typically bundled together in epidemiological studies of vestibular disorders in children,[11,12,14,16-21] partly as an extension of the natural bundling of these symptoms in adults. However, this neglects the important distinction that most adults with reported imbalance likely developed these symptoms from a baseline of being able to walk steadily without balance impairment, often in conjunction with the onset of dizziness symptoms, while most children with reported symptoms of imbalance in the current study were <4 years old. Imbalance symptoms in this age group commonly present within a setting of motor delay, where most children have not yet developed a baseline of stable balance in the first place, and therefore such imbalance often may not result from pathology that would typically cause coincident dizziness. We observed a double peak in age of onset of dizziness. The initial peak in dizziness symptoms in infancy may have resulted from a perceived overlap of dizziness and imbalance symptoms by many parents of young children with balance impairment, since it is unlikely that most patients in that young age group would have been able to explicitly report dizziness. The second dizziness peak was observed in adolescents, which is more consistent with the age group where we have anecdotally seen the bulk of dizziness complaints in our pediatric vestibular program. This may partly result from adolescence being a common age group for the onset of migraine, which has been consistently reported in prior studies to be the most common cause of pediatric vertigo.[8-14,17,19,20,25] This may also relate to an increasing ability of adolescents to verbalize dizziness symptoms relative to younger children.

The relative proportions of specific causative diagnoses assigned to children with vestibular symptoms in the 2016 NHIS data evaluated in the current study were drastically different from what has been described consistently in prior studies of the relative incidences of specific vestibular disorders in the pediatric population.[11-14,19] This discrepancy likely primarily results from the fact that most of these prior studies were based on children seen for vestibular symptoms at specialized pediatric vestibular programs, where diagnostic accuracy may have been enhanced by increased accessibility to specialized diagnostic equipment and expertise. The diagnoses seen in the current study reflect those assigned by a variety of health care providers, including many in general practice settings where such subspecialty expertise and testing equipment may not have been available. These findings raise the serious concern that most children with vestibular symptoms may not receive accurate diagnoses, which could result in inappropriate diagnostic tests and treatments. This could result in a significant waste of health care dollars and could cause many children to have prolonged ongoing symptoms due to ineffective interventions.

Migraine variant disorders have consistently been reported to be the most common cause of vertigo in children and adolescents, [8-14,17,19,20,22] yet none of the children with dizziness in the 2016 NHIS were reported as being assigned a diagnosis of migraine as the cause of their dizziness symptoms. It is also worth noting that ''head/neck injury or concussion'' was the reported diagnosis for 8.4% of dizziness cases and 6.1% of imbalance cases, while ''crystals—loose or dislodged in the ear'' or ''benign positional or paroxysmal vertigo'' was the reported diagnosis for 6.6% of dizziness cases and 3.1% of imbalance cases. A recent study observed that approximately 17% of pediatric patients with prolonged dizziness symptoms after concussion had benign paroxysmal positional vertigo (BPPV), but many were not diagnosed with BPPV until months after the initial injury.[26] In addition, a subsequent study noted that BPPV may be more common than previously thought in the pediatric population and that it has many potential secondary causes in children beyond concussion.[27] Collectively, this information suggests that the NHIS rate of BPPV diagnosis may have been much lower than the true prevalence of this disorder in the pediatric age group, while many patients may have had dizziness that was attributed to concussion but may have instead been primarily a result of undiagnosed BPPV or other posttraumatic vestibular disorders. Nearly half of children with dizziness or imbalance were reported as being assigned a diagnosis of ''other health condition or cause.'' This may reflect a lack of specificity or accuracy in the diagnoses that were assigned by primary care providers without specialized expertise in the evaluation and management of vestibular disorders in children. This indicates a need for more education of pediatric health care providers on the workup and common causes of pediatric vestibular symptoms. In addition, this finding could also reflect a recall bias on the part of the survey participants, where parents might not have been able to remember what diagnoses were specifically given. If this were the case, then it suggests a need for more effective counseling of families on vestibular disorders affecting their children.

This study benefited from the large volume of data available through the NHIS database and its associated population-based scaling and weighting. However, a number of limitations to this study also deserve mention. Responses were reported by parents and not by the children directly, which was essential for younger children but may have been a major limiting factor for the reporting of dizziness, in particular, since it is a subjective symptom. We felt that it was important to break down the reported symptoms into larger categories of dizziness and of imbalance, since children routinely present to our pediatric vestibular program with either a chief complaint of dizziness or of imbalance but rarely both together. The age distribution and resulting diagnoses between these 2 symptom categories differ greatly, with balance complaints typically presenting in

younger children with motor delays and dizziness typically presenting in older children and adolescents with explicit episodes of vertigo. However, some overlap between these categories is inevitable, and we are not implying that these symptoms in children are consistently mutually exclusive. In addition, many common symptoms of vestibular disorders in children were not included in the survey. Oscillopsia is a common symptom of vestibular impairment and is perceived as a sensation of constant movement of one's visual fields. An attempt at capturing the symptom of oscillopsia was included in the survey by using the description of ''blurred vision with head movement.'' We excluded positive responses to this descriptor from the dizziness group analyses because this description does not adequately convey the symptom of oscillopsia and may be more frequently caused by ophthalmologic disorders than by a vestibular disorder. In addition, episodes of intermittent torticollis are also considered a sign of vestibular dysfunction in young children, but this symptom was not included in the survey, so many children with a vestibular disorder who presented with episodic torticollis, but without evident dizziness or imbalance, may have been missed. Also, while the NHIS is sent to a nationally representative sample, the total household response rate was 68%, which might affect how accurately the sample represents the overall US population.

Conclusion

The 2016 NHIS demonstrated that dizziness and imbalance affected approximately 2.0% and 3.7% of US children, respectively. Less than half of children received care or a diagnosis. The most common diagnoses given for pediatric dizziness varied greatly from those reported in the medical literature, with migraine variants being particularly underrecognized. These results collectively indicate a need for increased awareness among pediatric providers of vestibular dysfunction and its most common causes in children.

Author Contributions

Jacob R. Brodsky, study conception/design, data analysis/interpretation, drafting/revising manuscript, final manuscript approval, agreement to accountability; **Sophie Lipson**, data analysis/interpretation, drafting/revising manuscript, final manuscript approval, agreement to accountability; **Neil Bhattacharyya**, study conception/design, data acquisition/analysis, revising manuscript, final manuscript approval, agreement to accountability.

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