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#### **Permalink**

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#### **Journal**

The Laryngoscope, 124(12)

#### **ISSN**

0023-852X

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#### **Publication Date**

2014-12-01

#### **DOI**

10.1002/lary.24806

Peer reviewed

# Impact of Dizziness and Obesity on the Prevalence of Falls and Fall-Related Injuries

Harrison W. Lin, MD; Neil Bhattacharyya, MD, FACS

**Objectives/Hypothesis:** Quantify the relationships between dizziness, falls, and obesity among adults.

**Study Design:** Cross-sectional analysis of a national health survey.

**Methods:** Adult respondents in the 2008 National Health Interview Survey balance module were analyzed. With demographic information, data for balance and dizziness problems, reported falls, injuries from falls, and body mass index were extracted. Associations between balance/dizziness problems and falls or injuries from falls were determined. The additional association between obesity and falls or fall-related injuries in the setting of a balance/dizziness problem was determined.

**Results:** Among  $216.8 \pm 3.5$  million adult Americans,  $24.2 \pm 0.7$  million reported dizziness in the past 12 months ( $11.1\% \pm 0.3\%$ ; mean age,  $45.9 \pm 0.2$  years;  $51.7\% \pm 0.5\%$  female),  $11.5\% \pm 0.3\%$  had fallen in the prior 12 months, and  $26.3\% \pm 0.4\%$  were obese. Among individuals reporting dizziness,  $34.3\% \pm 1.3\%$  reported falls, whereas only  $9.1\% \pm 0.3\%$  of nondizzy individuals reported a fall (odds ratio [OR]: 5.1;  $P < .001$ ). Among dizzy individuals who reported a fall,  $45.8\% \pm 2.1\%$  were injured by the fall versus  $35.6\% \pm 1.4\%$  nondizzy individuals who fell (OR: 1.5;  $P < .001$ ). The addition of obesity to dizziness increased the odds of falling by 1.3 (95% confidence interval: 1.2-1.5;  $P < .001$ ) but did not significantly increase the odds of fall-related injury ( $P = .110$ ).

**Conclusions:** Dizziness/balance problems are strongly associated with both an increased tendency to fall and increased injury rate from falls among adults. The addition of obesity to dizziness was associated with a higher rate of falling but was not associated with a significantly higher rate of fall-related injury. Balance problems in conjunction with obesity need to be targeted in fall-prevention efforts.

**Key Words:** Dizziness, obesity, fall, injury, vestibular.

**Level of Evidence:** 2b.

*Laryngoscope*, 124:2797-2801, 2014

## INTRODUCTION

Balance, stability, and postural control are physical elements essential for the performance of activities of daily living. Maintenance of an upright stance while standing or in motion requires the rapid processing of a blend of inputs from the visual, vestibular, and proprioceptive sensory systems. These inputs typically allow for involuntary activation of lower-limb muscles that favorably position the rest of the body to counteract accelerating forces, namely gravity, acting on the body. Deficits in one or more of the sensory systems can result in impaired balance and instability, severely and negatively impact quality of life, and increase the risk of falls. Such

falls, particularly in the elderly population, can result in costly,<sup>1,2</sup> debilitating,<sup>3-6</sup> and catastrophic<sup>7</sup> outcomes.

Our group and others have recently reported on the high prevalence of dizziness and balance disorders in the elderly on a population basis,<sup>8-10</sup> and various studies have pointed to the age-related deficits in all three sensory systems as contributors to balance difficulties. Moreover, recent evidence has provided insight into the impact of obesity on maintaining balance.<sup>11-14</sup> The addition of superfluous weight to the body frame has been shown to negatively impact postural stability, which is thought to be the result of the increased mechanical demand on lower limb musculature and hyperactivation of proprioceptive receptors.<sup>12,15</sup> Because of these data and with substantially increased rates of obesity in the United States<sup>16,17</sup> and worldwide,<sup>18</sup> reaching an "epidemic"<sup>19</sup> and "global pandemic"<sup>18</sup> magnitude, we sought to determine the impact of dizziness and obesity on the rates of falls and fall-related injuries.

The National Health Interview Survey (NHIS) is a personal, household-based interview survey that has been administered by the US Census Bureau since 1957, and is a statistically representative sample of the American civilian population, serving to monitor health status and healthcare access. In the present study, we extracted data from the NHIS to 1) determine the prevalence of dizziness, obesity, and falls in the American general population; 2) assess the impact of symptomatic

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Editor's Note: This Manuscript was accepted for publication June 6, 2014.

Neil Bhattacharyya, MD, is a consultant for IntersectENT, Inc. and Entellus, Inc.

The authors have no other funding, financial relationships, or conflicts of interest to disclose.

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DOI: 10.1002/lary.24806

TABLE I.  
Epidemiology of Reported Symptom/Event or Patient Characteristics in the Prior 12 Months.

Symptom	No. (Millions)	SE Millions)	%	SE (%)	OR	95% CI	P
Dizziness or balance problem in past 12 months	24.2	0.7	11.1	0.3			
Obese	59.3	1.3	26.3	0.4			
Fall in past 12 months	25.8	0.8	11.5	0.3			
Dizziness → fall	8.3	0.4	34.3	1.3			
No dizziness → fall	17.5	0.7	9.1	0.3	5.09	4.51-5.74	<.001
Obesity → dizziness → fall	3.0	0.2	35.4	2.0			
Not obese → dizziness → fall	5.3	0.3	33.7	1.5	1.33*	1.21-1.48	<.001
Dizziness → fall-related injury	3.8	0.2	45.8	2.1			
No dizziness → fall-related injury	6.2	0.3	35.6	1.4	1.52	1.24-1.87	<.001
Obesity → dizziness → fall-related injury	1.5	0.1	50.2	3.5			
Not obese → dizziness → fall-related injury	2.3	0.2	43.3	2.6	1.17*	0.97-1.43	.110

\*These odds ratios represent the additional increased odds for the outcome (fall or fall-related injury) conferred by obesity on top of the dizziness symptomatology.

CI = confidence interval; OR = odds ratio; SE = standard error of the population estimate.

dizziness on the rates of falling and fall-related injuries; and 3) determine the impact of obesity on these rates. Such data regarding the prevalence and impact of dizziness and obesity on falls and fall-related injuries are of particular importance given the increasing rates of obesity and the rising number of older persons, who are at particular risk for balance disorders, falls, and devastating injuries.

## MATERIALS AND METHODS

Adult respondents in the 2008 NHIS balance module were analyzed as aggregated in the Integrated Health Interview Series.<sup>20</sup> As previously reported,<sup>9,21</sup> this survey module contained specific, targeted questions pertaining to dizziness and balance problems among adults in the United States. The study protocol was reviewed and received institutional review board exemption.

In addition to standard demographic information, patient body mass index (BMI) was extracted along with the balance module responses for adult patients (age  $\geq 18.0$  years). The presence of dizziness was identified as in previous studies as to whether or not the respondent had a problem with dizziness or balance in the past 12 months, not including when drinking alcohol. Fall data were captured in two forms: 1) whether the respondent had a fall in the past 12 months and 2) whether the respondent had an injury from the fall within the past 12 months. The fall was characterized as whether the respondent, "unexpectedly dropped to the floor or ground, standing, walking, or bending position." The survey question provided an example of an injury as, "a bruise, cut or wound, sprain, dislocation, fracture, broken bones, back pain, head or neck injury." The presence or absence of obesity was defined as BMI  $\geq 30.0$ .

Data were imported into SPSS version 22.0 (IBM, Armonk, NY) for analysis. The proportion of adults reporting dizziness or balance problems in the previous 12 months was determined along with standard demographic information. The percentages of adults who had fallen in the past 12 months, sustained an injury from the fall in the past 12 months, and who were obese by BMI categorization were also determined. The likelihood of falling and fall-related injury were determined for both dizzy and nondizzy individuals. Then, subset analysis

was performed for falling and fall-related injury for obese and nonobese individuals experiencing dizziness. Comparisons were conducted with  $\chi^2$  with statistical significance set at  $P < .05$ .

## RESULTS

Among  $216.8 \pm 3.5$  million adult Americans,  $24.2 \pm 0.7$  million (raw  $N = 2,490$ ) reported dizziness in the past 12 months ( $11.1\% \pm 0.3\%$ ; mean age,  $45.9 \pm 0.2$  years;  $51.7\% \pm 0.5\%$  female),  $11.5\% \pm 0.3\%$  had fallen in the prior 12 months, and  $26.3\% \pm 0.4\%$  were obese. Among individuals reporting dizziness,  $34.3\% \pm 1.3\%$  reported falls, whereas only  $9.1\% \pm 0.3\%$  of nondizzy individuals reported falling (odds ratio [OR]: 5.1;  $P < .001$ ). Among dizzy individuals who reported a fall,  $45.8\% \pm 2.1\%$  were injured by the fall versus  $35.6\% \pm 1.4\%$  for nondizzy individuals who fell (OR: 1.5;  $P < .001$ ).

The addition of obesity to dizziness increased the odds of falling by 1.3 (95% confidence interval [CI]: 1.2-1.5;  $P < .001$ ), but did not significantly increase the odds of a fall-related injury ( $P = .110$ ) (Table I).

## DISCUSSION

The ability to effectively and efficiently perform activities of daily living relies heavily on balance and postural stability. Difficulties with balance arising from abnormal signaling from one or more sensory systems, including the visual, proprioceptive, and vestibular systems, can manifest as dizziness and severely impair the ability to maintain an upright stance, ambulate safely, and participate in activities. Unfortunately, dizziness is a common complaint in the general American population and can present as sensations of unsteadiness, lightheadedness, vertigo, disequilibrium, or fainting and contribute to the likelihood of falls. Moreover, excess weight and obesity have been shown to add additional complexity to the maintenance of balance and postural stability. However, there are few reports on epidemiologic data on

the prevalence of these conditions and their impact on rates of falls and fall-related injuries. This study documents both the annual prevalence of dizziness symptoms and obesity in a general population and the impact of these symptoms on rates of falling and associated injuries.

Our results indicate that approximately one in 10 persons ( $11.1\% \pm 0.3\%$ ) in the general US population experiences annual problems with dizziness. This self-reported rate is comparable to those previously reported in the literature, although the definition of "dizziness" in questionnaire- and survey-based population studies will unfortunately vary considerably. Many studies employ the four-part dizziness categories of 1) vertigo, 2) presyncope, 3) disequilibrium, and 4) other dizziness, established in 1972 by Drachman and Hart,<sup>22</sup> or 1) true vertigo; 2) giddiness, lightheadedness, or wooziness; 3) feeling about to faint or lose consciousness; or 4) feeling unsteady, off balance, or about to fall or veer to one side, established by Clark et al. in 1994.<sup>23</sup> Conversely, other studies will simply allow for a general and nonspecific reporting of symptomatic dizziness. Moreover, the majority of studies on the prevalence of dizziness and balance disorders appear to focus on the elderly population, who are often the most affected and debilitated by such symptoms.

A review of the literature suggests that our data provided a lower estimate of the prevalence of dizziness in a general population. Various cross-sectional survey studies from Europe have placed the prevalence of self-reported dizziness in the adult population at 13% to 28.7%.<sup>24-26</sup> Agrawal and colleagues reported the 2001 to 2004 National Health and Nutrition Examination Survey (NHANES) data, and found that among the 6,785 American participants aged 40 years and above, 27.0% self-reported dizziness in the prior 12 months.<sup>27</sup> The differences in reported rates may be explained by the variations in age groups studied or the nature of the survey, which may introduce varying degrees of recall bias. Responses to questions on dizziness in smaller studies focused on dizziness symptoms may differ from those in a larger, general health survey such as the NHIS.

With regard to prevalence of falls in the general population, we found that over one in 10 individuals ( $11.5\% \pm 0.3\%$ ) had reported falling in the prior 12 months. This is similar to the self-reported rate of 7.9% found in the aforementioned NHANES data,<sup>27</sup> but much lower than the 26% rate reported among 1,497 individuals aged 20 years and above participating in a National Institute of Aging questionnaire study.<sup>28</sup> As expected, older populations have generally been found to have higher rates of falling, ranging from 16% to 60%,<sup>5,29-34</sup> and these rates will vary depending on the definition of a fall, and the age range and level of independence of the study population.

We moreover sought to better characterize the relationship of dizziness to rates of falling in adults. Notably, we found that of those individuals reporting dizziness in the prior year,  $34.3\% \pm 1.3\%$  had at least one fall in the time period. Comparatively, only  $9.1\% \pm 0.3\%$  of respondents who did not report any dizziness endured a fall

(OR: 5.1;  $P < .001$ ). To our knowledge this is the first description of the substantially increased risk of falling among individuals reporting dizziness in a general population. Collerton and cohorts reported a "marked overlap" of survey participants over 85 years of age reporting falls, dizziness, and blackouts, and found that 42.2% (134/317) of patients reporting dizziness and/or blackouts sustained at least one fall in the previous 12 months.<sup>34</sup> Conversely, in a survey study from the United Kingdom, only 7.8% of 356 individuals aged 65 years or older who endured a fall in the preceding year faulted dizziness as the reason for the fall.<sup>31</sup> Tinetti and colleagues found that surveyed individuals 72 years or older who reported chronic dizziness had a significantly higher relative risk (RR) of falling (RR: 1.35 [1.06-1.72]) compared to those who did not report dizziness.<sup>8</sup> With regard to studies examining the relationship between the risk of falling and objective findings, both Hansson and Magnusson and Agrawal et al. found statistically significant links between vestibular dysfunction and the risk of falling in the general<sup>27</sup> and elderly<sup>35</sup> population.

Furthermore, we found that respondents who reported dizziness and at least one fall in the preceding year had a 50% increased likelihood of incurring an injury from the fall compared to those who did not report dizziness and had at least one fall (45.8% vs. 35.6%; OR: 1.5;  $P < .001$ ). Again, we believe these data to be the first to describe the significantly increased risk of a fall-related injury among those who endured one or more falls and reported dizziness symptoms in the general population. These data suggest that the falls suffered by those with symptomatic dizziness are likely more severe and traumatic in nature. These rates of injuries related to falls are very comparable to those currently in the literature. Rates ranging from 17.5% to 70.5% have been reported, depending on the definition of an injury, including fractures, soft-tissue injuries, lacerations, and need for medical attention.<sup>3,5,28,29,32,36</sup>

Finally, we examined the impact of obesity on the rates of falls and fall-related injuries among those who self-reported dizziness. Interestingly, those who reported dizziness and were obese had a 30% increased odds of falling (OR: 1.3; CI: 1.2-1.5;  $P < .001$ ), but did not have significantly increased odds of suffering a fall-related injury (OR: 1.2; CI: 0.97-1.4;  $P = .110$ ). Of note, the impact of obesity on falls and fall-related injuries remains controversial. Although most studies show that obesity plays a substantial role in increasing disability and rates of falling,<sup>15,37</sup> the evidence on the effect of obesity on rates of fall-related injuries is conflicting. In a study of 10,785 respondents aged 65 years or older, Himes and Reynolds found that the odds ratio of falling was significantly higher with increasing BMI. However, the authors found that those who were overweight and moderately to severely obese were not more likely to be injured in a fall compared to individuals of normal weight, and moreover, those who were morbidly obese (BMI  $\geq 40$ ) were significantly less likely to be injured in a fall (OR: 0.62; CI: 0.44-0.87;  $P < .01$ ).<sup>37</sup> Other studies have similarly found that a lower BMI, which can be associated with a lower bone mass density, corresponds

with an increased risk for a fracture from a fall,<sup>38,39</sup> whereas a higher BMI can have a protective effect.<sup>39</sup> Conversely, in a study of 43,057 American men aged 40 to 75 years, a high waist circumference and waist-to-hip ratio were significantly associated with a higher relative risk for hip and wrist fractures.<sup>40</sup> However, a higher BMI was not associated with increased risk for fractures. Our data seem to contribute to the growing collection of evidence that although obesity may contribute to the risk of falling, obesity may also have neutral, and in some cases protective, effect on the risk of a fall-related injury.

In recent decades, obesity has become a leading national and global health problem given its rising prevalence and the detrimental role it plays in many chronic health conditions. The most recent comprehensive data on the prevalence of obesity in the United States were reported by Ogden and associates, who found in the 2011 to 2012 NHANES survey, that 34.9% of adult Americans aged 20 years and above were obese (BMI  $\geq 30$ ). Notably, they furthermore found that, compared to the 2003 to 2004 NHANES results, a significantly higher percentage of women aged 60 years or older were obese (from 31.5%–38.1%;  $P = .006$ ).<sup>17</sup> Given that the percentage of the American population 65 years of age and older is predicted to rise to 20% and increase in number from 35 million to 71 million by the year 2030,<sup>41</sup> the anticipated rise in the number of obese and elderly individuals experiencing symptomatic dizziness should contribute to the urgency of affirmatively addressing the obesity epidemic as a critical public health issue. Importantly, weight reduction in obese children<sup>42</sup> and adults<sup>11</sup> has been shown to significantly improve balance, stability, and postural control, and reduce fall probability. Accordingly, the medical and allied health community must make preparations to address and meet the needs of this growing cohort.

## CONCLUSION

Difficulties with balance and symptomatic dizziness can be severely disabling and substantially impact quality of life and the ability to independently perform activities of daily living. In this study, we have found that dizziness and balance problems are strongly associated with both an increased tendency to fall and increased rate of fall-related injury among adults. Furthermore, we found that the addition of obesity to dizziness led to an increased rate of falling but was not associated with a significantly higher rate of injuries from falls. Due to the increasing prevalence of obesity, particularly in the growing elderly population, efforts to reduce the rates of obesity and improve the care of individuals with balance disorders need to be undertaken with the goal of minimizing the rates of falls and injuries.

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