Learn More The DHI is a 25-item self-assessment inventory designed to evaluate the self-perceived handicapping effects imposed by dizziness. Brain Injury Recovery Multiple Sclerosis Vestibular Disorders The DHI is a 25-item self-report questionnaire that quantifies the impact of dizziness on daily life by measuring self-perceived handicap. Three domains: 1) Functional (9 questions, 36 points) 2) Emotional (9 questions, 36 points) 3) Physical (7 questions, 28 points) Item scores are summed. There is a maximum score of 100 (28 points for physical, 36 points for emotional and 36 points for functional) and a minimum score of 0. The higher the score, the greater the perceived handicap due to dizziness. Answers are graded: 0 (no) 2 (sometimes) 4 (yes) Jacobson, G.P., Newman, C.W. (1990). The development of the dizziness handicap inventory. Arch Otolaryngol Head Neck Surg, 116, 424-427. Multiple sclerosis (Cattaneo et al, 2007; n = 25 males = 8 & females = 17; mean age = 41.7 (12.5) years; onset of pathology = 8.7 (8.8) years of relapsing remitting/ secondary progressive type of multiple sclerosis) Multiple sclerosis (calculated from Cattaneo et al, 2007) Multiple Sclerosis (MS):(Cattaneo et al, 2006; n = 51 patients with MS; mean number of falls month prior to evaluation = 0.98 (1.8) falls; 16 males, 35 females; mean age = 45.3 (18.1) years; mean time of onset of pathology = 15.6 (7.6) years) Multiple Sclerosis: (Cattaneo et al, 2006) Mean = 38.5 (Non-fallers)Mean = 56.0 (Fallers)Statistically significant differences between mean scores of fallers and non-fallers Multiple Sclerosis (MS):(Cattaneo et al, 2007; n = 25 patients with MS; 8 males, 17 females; mean age = 41.7(12.5) years; mean onset = 8.7 (8.8) years)Excellent test-retest reliability (ICC = 0.90, 95% CI 0.77 - 0.96) Multiple Sclerosis: (Hebert et al, 2011; n = 38; 18 - 65 years; Intervention = vestibular rehabilitation (6 weeks); follow-up (4 weeks); able to walk 100 m; ≥ 45 on the Modified Fatigue Impact Scale Questionnaire and < 72 on the computerized Sensory Organization test) Excellent internal consistency (Cronbach's alpha = 0.91) Multiple Sclerosis (MS):(Cattaneo et al, 2006)Adequate correlation with Berg Balance Scale (r = -0.32)Adequate correlation with Dynamic Gait Index (r = -0.39)Adequate correlation with Timed Up and Go (r = 0.35)Adequate correlation with Hauser Ambulation Index (r = 0.32)Excellent correlation with Activities Specific Based Confidence Scale (ABC) (r = -0.70) Multiple Sclerosis:(Cattaneo et al, 2006 Adequate correlation of DHI to Berg Balance (r = 0.32), to Dynamic Gait Index (r = 0.39), to Timed Up and Go (r = 0.35) and to Hauser Ambulation Index (r = 0.32).Excellent correlation of DHI with Activities Specific Based Confidence Scale (r = -0.70)Adequate relationship exists between the numbers of dizzy spells/year (< 12, > 12, and permanent) and score on the DHI. Multiple Sclerosis (MS): (Cattaneo et al, 2006)Adequate ceiling effect (1.9%) Multiple Sclerosis (MS): (Cattaneo et al., 2006) Sensitivity = 50%Specificity = 77%(Hebert et al., 2011)Highly responsive (Effect size of 1.03 & 1.12 for experimental group vs. exercise control group and wait listed control group respectively at 10 weeks)Moderately responsive (Effect size of -0.35 and -0.84 for experimental group vs. exercise control group and wait listed control group respectively at 14 weeks.) Peripheral and central vestibular pathology:(Jacobson & Newman, 1990; n = 14, mean age 45 (13.48) years) Peripheral and central vestibular pathology. (Calculated from Jacobson & Newman, 1990) Vestibular Dysfunction:(Jacobson and Newman, 1990; n = 14; mean age = 45 (13.48) years)Pretreatment and post-treatment scores would have to differ by at least 18 points (95% confidence interval for a true change before the intervention could be said to have effected a significant change in a self-perceived handicap)Vestibular Rehabilitation:(Cohen & Kimball, 2003; n = 53 individuals with chronic vertigo due to a peripheral vestibular impairment; mean age = 51.1 years)DHI scores decreased from pretest to posttest and then continued to decline over the 6-month follow-up period (P = 0.001) Changes on the DHI Total score were highly associated with VADL Total score (P = 0.001) and with VADL Ambulation score (P = 0.001)(Cowand, et al, 1998; n = 37; mean age = 69.8 (SD = 16.2) years) The Sign test identified a significant difference between pre-rehabilitation and post-rehabilitation total DHI scores (p < 0.0001). Significant before and after differences were found for the physical (p 0.7) Vestibular Dysfunction:(Jacobson and Newman, 1990)Excellent internal consistency for total score (alpha = 0.89)Adequate to excellent internal consistency for the 3 sub-scales (alpha = 0.72 - 0.85)(Tamber et al., 2009)Excellent internal consistency fr the Norwegian Version of the DHI (Cronbach's alpha = 0.88-0.95) Vestibular Dysfunction:(Whitney et al., 1999; n = 71 subjects from a local balance and vestibular clinic; 15 males, 56 females; mean age = 65 (16.8) years)Excellent correlation with ABC (r = -0.64) (Fielder et al., 1996; n = 42)Good to Excellent correlation with SF-36 (r = 0.53-0.72; p < 0.001) (Jacobson et al., 1991)Total score DHI demonstrated a moderate statistically significant negative correlation with SOT conditions 2(r = -0.39, p = 0.001); 4(r = -0.36, p = 0.004); 5(r = -0.42, p = 0.0005); and 6(r = -0.35, p = 0.004)The functional subscale demonstrated a moderate statistically significant negative correlation with SOT conditions 2(r = -0.39, p = 0.001); 3(r = -0.29, p = 0.02); 4(r = -0.40, p = 0.001); 5(r = -0.48, p = 0.0001); and 6(r = -0.41, p = 0.0007)The emotional subscale demonstrated a moderate statistically significant negative correlation with SOT conditions 2(r = -0.35, p = 0.004); 4(r = -0.30, p = 0.01); 5(r = -0.39, p = 0.001); and 6(r = -0.37, p = 0.003)The physical subscale demonstrated a moderate statistically significant negative correlation with the equilibrium score on condition 2 of the SOT (r = -0.28, p = 0.02) (Jacobson & Calder, 1998).DHI-S highly correlated to the total score on the DHI (r = 0.86, p < 0.001) (Lim et al., 2012; n = 32; mean age = 55.6 years individuals with vestibular neuritis) Discovered varying level of correlation between the DHI and the composite score of the SOT and the equilibrium scores of the HS-SOT conditions 2 and 5 depending on the level of acuityExcellent correlation between DHI and SOT composite score at initial assessment (r = -0.787, p < 0.05)Excellent correlation between DHI and SOT composite score at one week follow-up (r = -0.679, p < 0.05)Adequate correlation between DHI and equilibrium score ratio of the HS-SOT condition 2 at initial assessment (r = -0.559, p < 0.05)Excellent correlation between DHI and equilibrium score ratio of the HS-SOT condition 2 at one week follow-up (r = -0.695, p < 0.05)Adequate correlation between DHI and equilibrium score ratio of the HS-SOT condition 2 at one month follow-up (r = -0.385, p < 0.05)Adequate correlation between DHI and equilibrium score ratio of the HS-SOT condition 2 at 2 month follow-up (r = -0.401, p < 0.05)Adequate correlation between DHI and equilibrium score ratio of the HS-SOT condition 5 at initial assessment (r = -0.402, p < 0.05)Adequate correlation between DHI and equilibrium score ratio of the HS-SOT condition 5 at one week follow-up (r = -0.539, p < 0.05)Excellent correlation between DHI and equilibrium score ratio of the HS-SOT condition 5 at one month follow-up (r = -0.625, p < 0.05)Adequate correlation between DHI and equilibrium score ratio of the HS-SOT condition 5 at 2 month follow-up (r = -0.461, p < 0.05)(Perez et al., 2003; n = 226, mean age = 45.3 ± 9.4 years, individuals with vestibular pathology) Adequate correlation between DHI and equilibrium score ratio of the HS-SOT condition 5 at 6 month follow-up (r = -0.394, p < 0.05)Adequate correlation between DHI total score and UCLA-DQ (r = 0.416; p < 0.01)Adequate correlation between DHI total score and SOT composite score (r = -0.345; p < 0.01) Vestibular Dysfunction: (Jacobson and Newman, 1990)Adequate relationship between the number of dizzy spells per year and score on the DHI (< 12, > 12, and permanent)(Perez et al., 2001)Excellent correlation between vestibular handicap factor and the DHI emotional (DHIe) subscale r = 0.927 p < 0.001, and DHI functional subscale (DHIf) r = 0.743 p < 0.001Adequate correlation between vestibular handicap factor and the DHI physical (DHIp) subscale r = 0.317 p < 0.001Excellent correlation between vestibular disability factor and the DHI emotional r = 0.847 p < 0.001Poor correlation between vestibular disability factor and the DHIf subscale 0.425 p 65 years old) patients pre-gamma knife surgery compared with post-gamma knife surgery (t = 1.34, p = 0.05) Benign Paroxysmal Positional Vertigo:(Lopez-Escamez et al, 2003; n = 40 individuals with pSCC BPPV)Dizziness Handicap Inventory Short Form total score significantly decreased from 18.05 ± 9.91 (mean ± standard deviation) at the first day to 9.54 ± 9.94 at 30 days (p < 0.001)All 36-Item Short Form Health Survey scale scores were correlated significantly with Dizziness Handicap Inventory Short Form total scores at 30 days after treatment Benign Paroxysmal Positional Vertigo (BPPV):(Whitney et al., 2005; n = 383 patients with a variety of vestibular diagnoses; mean age = 61 years)5 item BPPV subscale developed from current DHI is a significant predictor of likelihood of having BPPV Whiplash Associated Disorders:(Treleaven et al., 2005; n = 100; 50 with dizziness including males = 12 & females = 38 having a mean age = 35.5 (19- 46) years and their time since injury = 1.4 (0.35- 3) years; 50 without dizziness including males = 12 & females = 38 having a mean age = 35 (18-46) years and their time since injury = 1.6 (0.3- 3) years; individuals had to refrain from medications 24 hours prior to study.)Adequate correlation of DHI to Smooth Pursuit Neck Torsion Test (r = 0.31) Traumatic Brain Injury:(Kaufman et al., 2006; n = 10; 6 men and 4 women; community living individuals with normal gait and balance before pathology; average duration since TBI = 2.8 (0.4 - 14.4) years) Mild Traumatic Brain Injury:(Gottshall et al., 2003; n = 53 male active duty individuals who suffered mild TBI and 46 control subjects without TBI; Glascow Coma Scale score of 14-15; mean age = 22 years)Statistically significant correlation between all Dynamic Visual Acuity Test results measured and the DHI and the 1 week time point (p < 0.01)There was no significant or consistent correlation between the two tests after the 1 week periodTraumatic Brain Injury:(Kaufman et al., 2006; n = 10, individuals with TBI (6 men and 4 women) and 10 matched controls for age, gender, weight, and height; mean age = 41 (11) years; Average duration since the TBI was 2.8 years (range 0.4-14.4); 6 subjects with TBI had abnormal imaging studies)Excellent correlation between physical aspects of the subject's complaints of dizziness on the DHI were related to SOT 6 (platform and surround sway referenced) (r = 0.72, p = 0.02)Excellent correlation between the physical aspect of the DHI and the A/P motion of the subject (r = 0.83, p = 0.003)Excellent correlation between the functional aspect of the DHI and the COM M/L velocity (r = 0.65, p = 0.04)Excellent correlation between the total DHI and the M/L velocity (r = 0.71, p = 0.02) Traumatic Brain Injury:(Gotshall et al., 2003; n = 53 with mild traumatic brain injury) DHI significantly correlated with Dynamic Visual Acuity testing (After one week) Traumatic Brain Injury:(Basford et al., 2003; n = 20, 10 with TBI and 10 without TBI; 6 men and 4 women, ranging in age from 18 to 65 years; age, height and gender matched with controls)DHI scores were consistent with the subjects' complaints of unsteadiness and imbalance Elderly:(Whitney et al., 1999; n = 71, males = 15 & females = 56; age range = 26- 88 years) Excellent negative correlation between scores of DHI and ABC (Activity specific Balance Confidence Scale) (r = 0.64) Alghwiri, A. A., Marchetti, G. F., et al. (2011). "Content comparison of self-report measures used in vestibular rehabilitation based on the international classification of functioning, disability and health." Physical Therapy 91(3): 346-357.Alghwiri, A. A., Whitney, S. L., et al. (2012). "The development and validation of the vestibular activities and participation measure." Arch Phys Med Rehabil 93(10): 1822-1831. Find it on PubMedBasford, J. R., Chou, L. S., et al. (2003). "An assessment of gait and balance deficits after traumatic brain injury." Archives of Physical Medicine and Rehabilitation 84(3): 343-349. Find it on PubMedCattaneo, D., Jonsdottir, J., et al. (2007). "Reliability of four scales on balance disorders in persons with multiple sclerosis." Disability and Rehabilitation 29(24): 1920-1925. Find it on PubMedCattaneo, D., Regola, A., et al. (2006). "Validity of six balance disorders scales in persons with multiple sclerosis." Disability and Rehabilitation 28(12): 789-795. Find it on PubMedClendaniel, R. A. (2000). "Outcome measures for assessment of treatment of the dizzy and balance disorder patient." Otolaryngol Clin North Am 33(3): 519-533. Find it on PubMedCohen, H. S. and Kimball, K. T. (2003). "Increased independence and decreased vertigo after vestibular rehabilitation." Otolaryngol Head Neck Surg 128(1): 60-70. Find it on PubMedCowand, J. K., Wrisley, D. M., et al. (1998). "Efficacy of vestibular rehabilitation." Otolaryngol Head Neck Surg 118(1): 49-54. Find it on PubMedDuracinsky, M., Mosnier, I., et al. (2007). "Literature review of questionnaires assessing vertigo and dizziness, and their impact on patients' quality of life." Value in health 10(4): 273-284. Enloe, L. J. and Shields, R. K. (1997). "Evaluation of health-related quality of life in individuals with vestibular disease using disease-specific and general outcome measures." Physical Therapy 77(9): 890-903. Fielder, H., Denholm, S. W., et al. (1996). "Measurement of health status in patients with vertigo." Clin Otolaryngol Allied Sci 21(2): 124-126. Find it on PubMedGamiz, M. J. and Lopez-Escamez, J. A. (2004). "Health-related quality of life in patients over sixty years old with benign paroxysmal positional vertigo." Gerontology 50(2): 82-86. Find it on PubMedGottshall, K., Drake, A., et al. (2003). "Objective vestibular tests as outcome measures in head injury patients." Laryngoscope 113(10): 1746-1750. Find it on PubMedHansson, E. E., Månsson, N. O., et al. (2005). "Balance performance and self-perceived handicap among dizzy patients in primary health care." Scandinavian journal of primary health care 23(4): 215-220. Hebert, J. R., Corboy, J. R., et al. (2011). "Effects of vestibular rehabilitation on multiple sclerosis-related fatigue and upright postural control: a randomized controlled trial." Phys Ther 91(8): 1166-1183. Find it on PubMedJacobson, G. P. and Calder, J. H. (1998). "A screening version of the Dizziness Handicap Inventory (DHI-S)." Am J Otol 19(6): 804-808. Find it on PubMedJacobson, G. P. and Calder, J. H. (2000). "Self-perceived balance disability/handicap in the presence of bilateral peripheral vestibular system impairment." J Am Acad Audiol 11(2): 76-83. Find it on PubMedJacobson, G. P. and Newman, C. W. (1990). "The development of the Dizziness Handicap Inventory." Archives of Otolaryngology - Head and Neck Surgery 116(4): 424-427. Find it on PubMedJacobson, G. P., Newman, C. W., et al. (1991). "Balance function test correlates of the Dizziness Handicap Inventory." J Am Acad Audiol 2(4): 253-260. Find it on PubMedJarlsäter, S. and Mattsson, E. (2003). "Test of reliability of the Dizziness Handicap Inventory and the Activities-specific Balance Confidence Scale for use in Sweden." Advances in Physiotherapy 5(3): 137-144. Kammerlind, A. S., Bergquist Larsson, P., et al. (2005). "Reliability of clinical balance tests and subjective ratings in dizziness and disequilibrium." Advances in Physiotherapy 7(3): 96-107. Kaufman, K. R., Brey, R. H., et al. (2006). "Comparison of subjective and objective measurements of balance disorders following traumatic brain injury." Medical Engineering and Physics 28(3): 234-239. Find it on PubMed Krebs, D. E., Gill-Body, K. M., et al. (1993). "Double-blind, placebo-controlled trial of rehabilitation for bilateral vestibular hypofunction: preliminary report." Otolaryngol Head Neck Surg 109(4): 735-741. Find it on PubMedKurre, A., van Gool, C. J., et al. (2009). "Translation, cross-cultural adaptation and reliability of the german version of the dizziness handicap inventory." Otol Neurotol 30(3): 359-367. Find it on PubMedLim, H. W., Kim, K. M., et al. (2012). "Correlating the head shake-sensory organizing test with dizziness handicap inventory in compensation after vestibular neuritis." Otol Neurotol 33(2): 211-214. Find it on PubMedLopez-Escamez, J. A., Gamiz, M. J., et al. (2003). "Impact of treatment on health-related quality of life in patients with posterior canal benign paroxysmal positional vertigo." Otol Neurotol 24(4): 637-641. Find it on PubMedMruzek, M., Barin, K., et al. (1995). "Effects of vestibular rehabilitation and social reinforcement on recovery following ablative vestibular surgery." Laryngoscope 105(7 Pt 1): 686-692. Find it on PubMed Perez, I. G., Marta García-Granero, Eduardo Martin, Rafael García-Tapia, Nicolas (2001). "Factor analysis and correlation between Dizziness Handicap Inventory and Dizziness Characteristics and Impact on Quality of Life scales." Acta oto-laryngologica 121(545): 145-154.Perez, N., Martin, E., et al. (2003). "Dizziness: relating the severity of vertigo to the degree of handicap by measuring vestibular impairment." Otolaryngol Head Neck Surg 128(3): 372-381. Find it on PubMedPoon, D., Chow, L., et al. (2004). "Translation of the dizziness handicap inventory into Chinese, validation of it, and evaluation of the quality of life of patients with chronic dizziness." The Annals of otology, rhinology, and laryngology 113(12): 1006-1011. Robertson, D. D. and Ireland, D. J. (1995). "Dizziness Handicap Inventory correlates of computerized dynamic posturography." J Otolaryngol 24(2): 118-124. Find it on PubMedTamber, A. L., Wilhelmsen, K. T., et al. (2009). "Measurement properties of the Dizziness Handicap Inventory by cross-sectional and longitudinal designs." Health Qual Life Outcomes 7(2): 101. Find it on PubMedTreleaven, J., Jull, G., et al. (2005). "Smooth pursuit neck torsion test in whiplash-associated disorders: relationship to self-reports of neck pain and disability, dizziness and anxiety." J Rehabil Med 37(4): 219-223. Find it on PubMedVereeck, L., Truijen, S., et al. (2007). "Internal consistency and factor analysis of the Dutch version of the Dizziness Handicap Inventory." Acta Otolaryngol 127(8): 788-795. Find it on PubMedWackym, P. A., Hannley, M. T., et al. (2008). "Gamma Knife surgery of vestibular schwannomas: longitudinal changes in vestibular function and measurement of the Dizziness Handicap Inventory." J Neurosurg 109 Suppl: 137-143. Find it on PubMedWhitney, S. L., Hudak, M. T., et al. (1999). "The activities-specific balance confidence scale and the dizziness handicap inventory: a comparison." Journal of Vestibular Research 9(4): 253-259. Find it on PubMedWhitney, S. L., Marchetti, G. F., et al. (2005). "Usefulness of the dizziness handicap inventory in the screening for benign paroxysmal positional vertigo." Otol Neurotol 26(5): 1027-1033. Find it on PubMedWhitney, S. L., Wrisley, D. M., et al. (2000). "Physical therapy for migraine-related vestibulopathy and vestibular dysfunction with history of migraine." Laryngoscope 110(9): 1528-1534. Find it on PubMedWhitney, S. L., Wrisley, D. M., et al. (2004). "Is perception of handicap related to functional performance in persons with vestibular dysfunction?" Otol Neurotol 25(2): 139-143. Find it on PubMed As a library, NLM provides access to scientific literature. Inclusion in an NLM database does not imply endorsement of, or agreement with, the contents by NLM or the National Institutes of Health. Learn more: PMC Disclaimer | PMC Copyright Notice (1) Objectives: The evaluation of dizzy patients is difficult due to nonspecific symptoms that require a multi-specialist approach. The Dizziness Handicap Inventory (DHI) is widely used in the assessment of dizziness-related disability, but its internal structure needs further expansion. The aim of this study was to identify the subscales of DHI that may correlate with some vestibular or nonvestibular dysfunctions. (2) Material and methods: This observational study included 343 dizzy patients with one of the following clinical conditions: Vestibular impairment noncompensated or compensated, central or bilateral, benign paroxysmal positional vertigo (BPPV), migraine and psychogenic dizziness. Principal component analysis was used to examine the factorial structure of the questionnaire. (3) Results: The DHI questionnaire total scoring and its vestibular subscale distinguished between patients with compensated and uncompensated vestibular dysfunction with positive predictive values of 76% and 79%, respectively. The DHI items composing the F3 (positional) subscale revealed the highest scoring in the BPPV group with 75% sensitivity and 92% negative predictive value (NPV) in reference to Dix–Hallpike tests. The DHI total score and the subscales scores correlated with anxiety-depression, and the highest correlation coefficients were calculated for vestibular (F2 0.56) and anxiety (F5 0.51) subscales. (4) Conclusions: Our analysis revealed that the DHI vestibular subscale distinguishes between patients with compensated and uncompensated vestibular dysfunction. The positional subscale showed the highest scoring in the BPPV group with high sensitivity and low specificity of the test. The DHI is highly correlated with patients' psychological status. Keywords: DHI, vertigo, psychogenic dizziness, migraine, positional vertigo, vestibular dysfunction Dizziness and/or vertigo are the most common reported medical complaints affecting 15–35% of the adult population dependent on the study group [1,2]. Subjects reporting dizziness describe a range of sensations, such as feeling faint, woozy, weak, or unsteady. According to the Classification of Vestibular Disorders of the Barany Society, dizziness is defined as a nonvertiginous sensation of disturbed or impaired spatial orientation without a false or distorted sense of motion [3]. Diagnosis is usually difficult because these complaints are nonspecific and the differential diagnosis is broad. Consequently, dizziness is a cause of disability and inability to work. Primary care is the first point of contact for dizzy patients [4]. A self-reported questionnaire could be of great help in evaluating the clinical status of the patient. There are several questionnaires for vertigo and dizziness handicap assessment, e.g., Vestibular Disorders of Daily Living Scale (VADL); Activities-specific Balance Confidence (ABC); Vertigo Handicap Questionnaire (VHQ); Vertigo, Dizziness, Imbalance Questionnaire (VDI); UCLA-DQ: UCLA Dizziness Questionnaire. The Dizziness Handicap Inventory (DHI) is one of the most popular questionnaires for assessment of the dizziness handicap [5]. The DHI was developed by Jacobson and Newman to assess disabling grade [6]. The DHI consists of 25 items designed to determine dizziness-dependent changes grouped into three domains: Functional, emotional, and physical. Some studies that assessed patients with vestibular impairment used domains that differed from the original ones [7,8]. The DHI was originally developed in the English language for USA patients, but in the past decades, it has been translated and validated in many other languages, e.g., to German [9] or Spanish [10]. However, it has been observed that this questionnaire yields limited conclusions related to the clinically important information [8,10,11]. In the literature, a few studies have already concentrated on the relationship between the DHI score and (1) selected diseases or clinical status [12,13], and (2) vestibular testing objective methods [14,15]. Clinical status. The DHI is used mainly as a measure of handicap in different diseases, but few studies consider its usefulness as a disease indicator. The association between DHI and clinical status of the patients was analyzed by Hansson et al. [13] in subgroups of patients with multisensory dizziness, chronic peripheral vestibular disorder, whiplash-associated disorder, unspecific dizziness, phobic postural vertigo, and dizziness of cervical origin. The group with phobic postural vertigo had the highest total score of DHI, while the vestibular group had the lowest one. Graham et al. [16] investigated the relationship between DHI scores and the presence of the structural, functional, and psychiatric disorders. They found that the categories of illnesses had large effects on total DHI scores. Structural disorders have caused lower scores than functional and psychiatric ones. Whitney et al. [12] proposed using a subscale composed of five DHI items for the diagnosis of benign paroxysmal positional vertigo (BPPV) with a sensitivity of 81% and low specificity of 34%. Two of the five items strongly correlated with the BPPV ("getting out of bed" and "rolling over in bed"). Similar items have been included in the motion-provoked dizziness subscale in the Vestibular Rehabilitation Benefit Questionnaire [17]. Patients showing signs of dizziness often have comorbid mental symptoms. For instance, panic disorder is highly prevalent in patients presenting with vestibular symptoms [18]. Moreover, anxiety and depression are diagnosed with greater frequency in dizzy patients than in the nondizzy population [19]. Testing methods. To date, the association between the objective vestibular tests and DHI scores is poorly understood. Vestibular symptoms and the DHI scores have been demonstrated to be significantly negatively correlated with the scores of the Sensory Organization Test (SOT) of the dynamic posturography [6,20]. Gill-Body [14] showed a correlation between DHI and SOT, which concerned only the third SOT condition (sway-referenced visual surround motion during stable platform condition) and the emotional subscale of DHI. Yip and Strupp [15] could not find a significant correlation between the DHI score and caloric test parameters, video head impulse-test results, or vestibular-evoked potentials measure of otolith function. The aim of our present study was to assess the DHI results obtained from a cohort of patients with vestibular and nonvestibular signs using factor analysis. We reasoned that this type of analysis could potentially identify individual subscales of the DHI, which would correlate with patients' clinical status, e.g., compensation level, positional vertigo, anxiety, and depressive symptoms. In addition, we carried out comparative analysis of the results between the groups of patients with vestibular and nonvestibular vertigo or dizziness complaints. This observational study was approved by the Ethics Committee (No. 17/2014). All patients signed the informed consent. We recruited consecutive patients referred primarily for the diagnosis of vertigo/dizziness. No subjects with acute vestibular loss were recruited. The sample included 628 subjects who underwent the following diagnostic procedures: Collecting detailed clinical history, complete neuro-otological bedside examination, and laboratory tests battery: Tympanometry, pure-tone audiometry, video head impulse test (Interacoustics), and videonystagmography (VNG) tests recorded with an Ulmer device (SYNAPSIS). The following VNG tests were performed: Spontaneous and gaze-evoked nystagmus, oculomotor tests (OMTs)-saccades, pursuit, optokinetic, caloric test by Fitzgerald–Hallpike, and rotational chair tests (sinusoidal pendular rotation at frequencies 0.04, 0.08, 0.1, 0.32, and 0.64 Hz). Neurological consultation and MRI imaging were obtained in patients with neurological signs or for the differential diagnoses. From the initial 628 patients, 285 with signs of two or more confirmed or suspected diseases were excluded (multi-diseases patients), e.g., migraine and positional vertigo, dysfunction of the central and peripheral part of vestibular system. For final analysis, 343 patients were included. The main criterion was persisting vertigo and/or dizziness and only one type of vestibular system dysfunction (peripheral or central), established based on clinical examination and VNG tests results. Peripheral vestibular impairment or loss was diagnosed when the canal paresis was >19% and no abnormalities were found in OMTs. The central vestibular dysfunction was diagnosed when the morphology and caloric responses were in a normal range and OMTs revealed abnormal recordings. The mean age of our cohort was 54.3 ± 14.6 (mean ± SD); range 20–87 years, including 248 women and 95 men. The study groups in the cohort were identified based on the following (Figure 1): 55 BPPV (benign paroxysmal positional vertigo) subjects: Positive Dix–Hallpike test, VNG—no vestibular and central signs. 50 vestibular noncompensated (NC): VNG canal paresis >19% in caloric test, directional preponderance (DP) > 2°/s in rotational tests (for more than one frequency of rotation), phase lead > 20° for low frequencies of rotation. 45 vestibular compensated (C): VNG canal paresis >19%, no DP in rotational tests, phase lead only slightly increased or not at all. 22 bilateral vestibular (BV): VNG caloric reactivity < 10°/s, rotational test's VOR gains absent in low frequencies of rotation (0.04 Hz, 0.08 Hz) 47 migraine (Migr): VNG canal paresis ≤ 19%, headaches that fulfil the criteria of vestibular migraine or migraine with brainstem aura, according to International Headache Classification, version 3. 78 central (Central): VNG caloric canal paresis ≤ 19%, abnormal oculomotor tests (OMTs) results: Latency and precision in saccades, morphology and gain in smooth pursuit, and optokinetic tests and/or high caloric reactivity and abnormal fixation in caloric/rotational tests and/or directional preponderance in rotational chair tests. Patients with neurological diseases but with normal VNG were not included. 46 psychogenic (Psych): VNG—no vestibular or central pathology, increased scoring of Duke anxiety and depression scale (>5), depression and/or anxiety episodes treatment currently or in the past; features of phobic postural vertigo or chronic subjective dizziness; 3 patients fulfilled the criteria of persistent postural-perceptual dizziness (PPPD) [21]. Flowchart of diagnostic procedures and outcomes. BPPV—benign paroxysmal positional vertigo; VNG—videonystagmography; OMT—oculomotor tests; Rcht—rotational chair tests, MRI—magnetic resonance imaging.The BPPV, C, and NC groups were homogenous. The BPPV group included patients with active BPPV confirmed by the Dix–Hallpike test. In the patients with peripheral vestibular dysfunction, the noncompensated and compensated groups had a medical history of vestibular neuritis. The compensation was confirmed by the VNG rotational tests. The patients included in the Central group were inhomogeneous. The Central group included dizzy patients referred to the clinic after neurological examination and brain imaging. They were diagnosed with transient ischemic attacks, stroke, multiple sclerosis, and others. The group of the psychogenic dizziness enclosed patients with no VNG abnormalities, with normal neuro-otological examination and no other vestibular/positional episodes in the last half-year. The most common symptoms in the psychogenic dizziness group were anxiety, fear of falling, hypersensitivity to motion stimuli, long-lasting dizziness, and instability. There were no age differences between the groups, except for those with migraines, who were significantly younger than the remaining ones. The DHI was self-completed by each patient before vestibular testing and medical interview. In addition, patients completed the Duke Anxiety and Depression questionnaire. This scale consists of three items concerning anxiety and four items for depression. The total score ranges from 0 to 14 and an abnormal value is over 5 points (Polish validated version can be found at (accessed on 24 February 2021)). To evaluate different dimensions of the DHI, principal component analysis (PCA) was performed. PCA is concerned with establishing which linear components exist within the data and how a particular variable might contribute to that component. The PCA was conducted with all 25 items with oblique rotation. Rotation was included into analysis to maximize the loadings of the variables onto one factor (the factor that intersects the cluster) and minimize them on the remaining factor(s). The oblique rotation was chosen over orthogonal rotation as there were good reasons to suppose that the underlying factors could be related in theoretical terms. The pre-test assumptions were fulfilled (Bartlett's test was highly significant and the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy >0.75). Bartlett's test tells us whether the analyzed correlation matrix is significantly different from an identity matrix. Therefore, if it is significant, it means that the correlations between variables are significantly different from zero. The KMO can be calculated for individual and multiple variables and represents the ratio of the squared correlation between variables to the squared partial correlation between variables. The KMO statistic varies between 0 and 1. A value of 0 indicates that the sum of partial correlations is large relative to the sum of correlations, indicating diffusion in the pattern of correlations (hence, factor analysis is likely to be inappropriate). A value close to 1 indicates that patterns of correlations are relatively compact and so factor analysis should yield distinct and reliable factors [22]. An initial analysis has been run to obtain eigenvalues for each component in the data. In the analysis, factors >1 (Kaiser's K-1 criterion) were extracted. This criterion is based on the idea that the eigenvalues represent the amount of variation explained by a factor and that an eigenvalue of 1 represents a substantial amount of variation. The factors structure was identified using the oblique Promax rotation with Kaiser normalization. Item loadings were evaluated in line with the proposals from Kurre et al. [7] (>0.6 on four or more variables) and Tamber et al. [8] (loadings ≥ 0.32). Thus, item loadings ≥0.4 on a minimum of 3 variables were included. Exploratory factor analysis was used to check dimensionality; then, Cronbach's alpha was used as a measure of the internal consistency of subscales. It is considered to be a measure of the reliability. A Cronbach's alpha coefficient of 0.70 or higher is considered acceptable. The analysis of the association between the DHI results and the Duke Anxiety and Depression Scale was performed using Pearson's correlation coefficients. One-way ANOVA and Bonferroni post-hoc tests were used to assess the differences in the mean age or the mean DHI total score of the clinical groups. Bartlett's test of sphericity was highly significant (p < 0.0000), indicating that correlations between the items were sufficiently high for PCA analysis. The Kaiser–Meyer–Olkin measure verified the sampling adequacy for the analysis, and KMO resulted in a value of 0.924, which is in agreement with the recommended assumptions ('superb' according to Field [22]). An initial analysis was run to obtain eigenvalues for each component in the data. Five components had eigenvalues over Kaiser's criterion of 1 and this combined explains 58% of the variance. With accordance to the scree plot, this is the number of components that have been retained in the final analysis. Table 1 shows the factor loadings after rotation. As every factor consisted of a minimum of three variables whose loading was above 0.4 (the minimal criterion), this solution has been investigated. Cronbach's alpha for every single factor was acceptable. DHI principal component analysis with oblique rotation factors. Labels and loadings of the corresponding item, the original subscales labels are in the brackets. Items Title Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 restricted participation vestibular Positional handicap Anxiety, depression (F)3 Restriction of travel 0.783 (F)6 Restriction of social activities 0.855 (F)16 Walking by yourself 0.653 (E)20 Afraid of staying home alone 0.618 (E)9 Afraid of leaving home alone 0.589 (E)22 Family relationships 0.486 Cronbach's alpha 0.828 (P)4 Walking through supermarkets 0.790 (P)8 Ambitious activities 0.764 (P)17 Walking down sidewalks 0.593 (F)19 Walking in darkness 0.535 (F)12 Avoiding heights 0.430 Cronbach's alpha 0.777 (P)1 Looking up 0.389 0.384 (F)7 Difficulties reading 0.241 0.242 (F)5 Getting in/out of bed 0.921 (P)13 Turning over in bed 0.960 (P)11 Quick head movements 0.506 (F)14 Strenuous home work 0.353 (P)25 Bending over 0.391 Cronbach's alpha 0.734 (E)15 Afraid of appearing drunk 0.895 (E)10 Feeling embarrassed 0.685 (E)21 handicapped 0.631 Cronbach's alpha 0.728 (E)2 Frustrated 0.709 (E)23 Feeling depressed 0.607 (E)18 Difficulty concentrating 0.543 (F)24 Job/house responsibilities 0.505 Cronbach's alpha 0.715 The items clustering on the same components suggest that Factor 1 (consisting of six items) assesses restriction in participation (travel, walking, staying home alone) with the weak input of family relationships. Factor 2 represents activities aggravating vestibular symptoms (5 items). Factor 3 contains five items characteristic for positional vertigo. Factors 4 and 5 are connected to handicap and depression/anxiety, respectively. There were two items that overlapped F2 and F3 and were excluded from further analysis. The correlation coefficient between total DHI and the Duke anxiety and depression questionnaire was statistically significant but fair (0.37). The Duke questionnaire was correlated to F1–F5 and the highest correlation coefficients were calculated for F2 (0.56) and F5 (0.51), lower being for F3 (0.43), F1 (0.40), and F4 (0.35). The analysis of mean values of the DHI total scores revealed the lowest values in the compensated (C) subgroup. Statistically significant differences were found between mean scores of the C subgroup and the NC and psychogenic dizziness groups (Figure 2). Dizziness Handicap Inventory (DHI) total scores distribution in clinical groups. BPPV—benign paroxysmal positional vertigo. NC—vestibular noncompensated group. C—vestibular compensated group. Migr—migraine group. BV—bilateral vestibular impairment. Psych—psychogenic dizziness. Post-hoc Bonferroni analysis results in the bottom of the figure. The statistically significant differences between groups were mark with asterisk (p < 0.05).The analysis of the intergroup relations in each of the five factors revealed several relationships. There were no intergroup differences in item sets comprising factor 1. In Factor 2, the compensated group revealed markedly lower scoring and statistically significant differences as compared to the noncompensated, psychogenic, and central groups. Factor 3 revealed scoring significantly higher in the BPPV group. Factor 4 differentiated the exclusively compensated and noncompensated vestibular patients, while Factor 5 was the highest scoring in the migraine group (Figure 3a–e). The relationships between clinical groups and DHI factors. (a–e) present the scoring for clinical groups for factors F1, F2, F3, F4, and F5, respectively. Arrows show the statistically significant differences between scores in clinical groups. BPPV—benign paroxysmal positional vertigo. NC—vestibular noncompensated group. C—vestibular compensated group. Migr—migraine group. BV—bilateral vestibular impairment. Psych—psychogenic dizziness. Receiver operating characteristics (ROC) curve analysis was performed to evaluate the clinical meaning of the relationships revealed by the intergroup factor analysis. The ROC analysis confirmed the differences between the noncompensated (NC) and compensated (C) vestibular groups for the DHI total score: Area under curve (AUC) 0.74, p = 0.0000; positive predictive value (PPV) 76%, negative predictive value (NPV) 68%, cut point 52. PCA revealed statistically significant differences between NC and C groups in F2 and F4. The ROC analysis confirmed the relationships: F2—PPV 79%, NPV 62%, cut point 14, AUC 0.75 p = 0.0000; F4: PPV 76% and NPV 60%, AUC 0.70, p = 0.0003, cut point 8. The values of AUC for F1, F3, and F5 were markedly lower (below 0.65) even if the probability of models was statistically significant. The F3 group of items presented the highest scoring in the BPPV subgroup. At the value of 14 points, the sensitivity was 75% but the specificity was 54%, PPV was 23% and NPV was 92%, and AUC was 0.66 (p = 0.0000). The F5 was highly corelated with depression and anxiety. The ROC analysis revealed a high sensitivity of F5 (85%) in the psychogenic group in relation to the remaining population tested; however, the specificity was low (42%, AUC 0.67, p = 0.0000). NPV was 88% and PPV was 36% in that group. The main aim of the present study was to identify the individual subscales of the DHI, which would correlate with clinical tests in a cohort of patients with vestibular and nonvestibular vertigo or dizziness. We were interested in finding whether the subscales of DHI could be used as an indicator of a clinical condition (e.g., compensation, positional vertigo). The DHI results obtained from a cohort of patients with vestibular and nonvestibular diseases were calculated using factor analysis. The first step was to identify individual subscales of DHI; then, we conducted a comparative analysis of the results between the groups of patients with vertigo and nonvestibular dizziness or vertigo. The exploratory factor analysis revealed five factors with eigenvalues >1, which explained 58% of the variance, which is similar to Kurre et al. (54.5%) [7]. Two items that overlapped F2 and F3 factors may lower this percentage. Before rotation, only two factors were obvious; the former included almost all the items and the latter only the P13 and F5. Matching results were reported by Asmundson et al. [23]. After oblique rotation, five factors fulfilling the assumptions were extracted. Factor 1 contains five items connected to restricted participation, such as restriction of travel, social activities, walking, or staying home alone. Of all the factors, F1 reveals the highest Cronbach's alpha. Three of these five items were extracted by Kurre et al. [7] as Factor 4, which has been rejected by the authors. Tamber et al. [8] extracted four of our five items as Factor 3. Perez et al. [10] in Factor 1 named 'vestibular handicap' found all items from our F1 (restriction of participation), adding F4 (handicap/anxiety) and F5 (depression). To some degree, the factors 1, 4, and 5 are comparable in their meaning but, in contrast to Perez et al. [10], we found differences between them during clinical group analysis. Factor 2 contained items that are connected to activities aggravating the vestibular symptoms (walking in darkness, ambitious activities, avoiding heights) and visual overdependence (walking through supermarkets, walking down sidewalks). Two items in this factor are ambiguous. The first ambiguous item is (F)12, which some subjects interpreted as a fear of heights in the mountains. The second item—(P)17 (walking on the sidewalk)—is ambiguous. Most of the healthy subjects were interpreting it as walking on uneven pavement, similarly to Sousa et al. [24], while the vestibular patients underlined the problems with movement when generally walking outside in the traffic. Our Factor 2 is almost completely in agreement with Factor 4.3 (contextual factors or effort provoking dizziness and unsteadiness) reported by Kurre et al. [7] and Factor 3 (visuo-vestibular disability) reported by Perez et al. [10]. Factor 3 encloses items that are characteristic for positional vertigo. These symptoms were also separated by Kurre et al. [7] in Factor 4.2 and Asmundson et al. [23] but not by Perez et al. [10] or Tamber et al. [8]. Kurre et al. [7] added the P1 item to this factor, which in our study, was between the vestibular (F2) and positional (F3) symptoms. Most of the previous analyses were performed for the vestibular subjects, whereas the central and psychological disorders were excluded. In one study by Yip and Strupp [15] in which the peripheral, central, positional, and psychogenic groups of patients were analyzed, the results were closely related to ours. Factors 4 and 5 include the items mainly connected with handicap (F4) and anxiety/depression (F5). F5 was highly correlated to Duke anxiety/depression questionnaire scores. Kurre et al. [7] combined these items into one (effect of dizziness and unsteadiness on emotion). However, in our study, the Cronbach's alphas calculated separately for two factors yielded acceptable results, while after combining them into one, the resultant Cronbach's alpha was