# Prevalence of Diagnosed Dry Eye Disease in the United States Among Adults Aged 18 Years and Older

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- PURPOSE: To provide current estimates of the prevalence of diagnosed dry eye disease (DED) and associated demographics among US adults aged ≥18 years.
- DESIGN: Cross-sectional, population-based survey.
- METHODS: Data were analyzed from 75 000 participants in the 2013 National Health and Wellness Survey to estimate prevalence/risk of diagnosed DED overall, and by age, sex, insurance, and other demographic factors. We weighted the observed DED prevalence to project estimates to the US adult population and examined associations between demographic factors and DED using multivariable logistic regression.
- RESULTS: Based on weighted estimates, 6.8% of the US adult population was projected to have diagnosed DED (~16.4 million people). Prevalence increased with age (18–34 years: 2.7%; ≥75 years: 18.6%) and was higher among women (8.8%; ~11.1 million) than men (4.5%; ~5.3 million). After adjustment, there were no substantial differences in prevalence/risk of diagnosed DED by race, education, or US census region. However, there was higher risk of diagnosed DED among those aged 45–54 years (odds ratio [OR]: 1.95; 95% confidence interval [CI]: 1.74–2.20) and ≥75 years (OR: 4.95; 95% CI: 4.26–5.74), vs those aged 18–34 years. Risk was also higher among women vs men (OR: 2.00; 95% CI: 1.88–2.13) and insured vs uninsured participants (OR: 2.12; 95% CI: 1.85–2.43 for those on government and private insurance vs none).
- CONCLUSIONS: We estimate that >16 million US adults have diagnosed DED. Prevalence is higher among women than men, increases with age, and is notable among those aged 18–34 years. (Am J Ophthalmol 2017;182:90–98. © 2017 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).)

D RY EYE DISEASE (DED) IS A CHRONIC DISEASE OF the ocular surface that is widely encountered in ophthalmic practice.[1,2] A summary of a 1998 workshop, cosponsored by the National Eye Institute, concluded that there were insufficient data available on prevalence of DED and how it is affected by demographic factors.[3] Since then, several studies have evaluated DED prevalence. In the United States (US), estimates have ranged from 4.3% among men aged ≥50 years[4] to 21.6% in men and women aged 48–91 years[5] and 14.5% among those aged ≥21 years.[6] Of the recent DED estimates in large populations, the Women's Health Study (WHS)[7] and the Physicians' Health Studies I and II (PHS I and II)[4] have employed validated DED questionnaires to estimate the prevalence of DED diagnosis and symptoms. The WHS estimated DED prevalence at 7.8% for women aged ≥50 years (1999), and the PHS at 4.3% for men aged ≥50 years (2004). Most published estimates of DED prevalence have focused on older age groups, in which prior research has suggested that DED is more prevalent. However, there is an increasing clinical perception that the prevalence of DED is growing and also that it is increasingly occurring at younger ages (Dana R, et al. Poster presented at the Annual Meeting of the American Academy of Ophthalmology. Oct 15-18, 2016; Chicago, Illinois).

This study was designed to provide current estimates of the prevalence of DED among the adult population in the US, based on a large and diverse study population. Our analysis is intended to fill gaps in published data about DED prevalence, specifically to estimate the prevalence of *diagnosed* DED, and to inform prevalence among younger age groups (18–50 years). This work is also intended to further characterize the US DED population.

## METHODS

- STUDY POPULATION: The study population was derived from the 2013 National Health and Wellness Survey (NHWS) conducted by Kantar Health, USA. The NHWS is an annual self-administered, internet-based questionnaire with a nationwide sample of 75 000 adults (aged ≥18 years) in the US. Individuals self-select into the internet panel by responding to advertisements in e-newsletters and online banners.[8] A random sample,

stratified for sex, age, race/ethnicity, and education, is then invited to participate in the survey to obtain a nationally diverse sample of the US adult population. The NHWS is a general health survey that queries participants on a wide range of diseases and associated factors. For the purpose of this analysis, we focused on dry eye–related questions in the survey. The NHWS was reviewed and approved by the Essex Institutional Review Board (Lebanon, New Jersey, USA) to ensure that the rights of research participants are protected and that the study is carried out in an ethical manner. All survey respondents confirmed their voluntary participation and consent.

- DRY EYE DISEASE ASCERTAINMENT: Participants were asked whether they had ever experienced dry eye. Possible responses were **Yes or No**. Those who answered "**No**" to ever experiencing dry eye were classified as Non-DED and were not asked any other DED-related questions. All participants who said "**Yes**" were asked a series of dry eye–related questions. The first question in the series was whether their dry eye had ever been diagnosed by a physician. Possible responses were **Yes or No**. Those who answered "**yes**" to experiencing dry eye but "**No**" to being diagnosed by a physician were classified as Symptomatic-Undiagnosed. Those who confirmed both experiencing dry eye and physician diagnosis were classified as Diagnosed-DED and were given a list of symptoms (pain, light sensitivity, a gritty sensation, a feeling of a foreign body or sand in the eye, itching, redness, and blurring of vision) and asked to select all that applied. Diagnosed respondents were also asked to specify year of diagnosis, provide details about the physician who made the diagnosis (Primary Care Physician/GP/Internist, Ophthalmologist, Optometrist, Other), and asked about dry eye severity (select 1 of mild, moderate, or severe). In this analysis, we focused on the prevalence of Diagnosed-DED; the Symptomatic-Undiagnosed DED group were excluded from the main analysis. Owing to the limitations of the symptom questionnaire used in the NHWS, this group was likely to have a higher proportion of misclassified subjects and thus our confidence in classifying them as having DED was far lower. However, for completeness, we did use data from the Symptomatic-Undiagnosed group to estimate prevalence of undiagnosed DED.

- STATISTICAL ANALYSIS: Prevalence of Diagnosed-DED was calculated overall and stratified by various demographic and lifestyle factors. We also calculated unadjusted prevalence of Diagnosed-DED by self-reported severity and selected symptoms of DED. We compared categorical variables across groups using the $\chi^2$ test and continuous variables using the 1-way analysis of variance (ANOVA) F test and the Kruskal-Wallis rank sum test. Observed DED prevalence estimates were adjusted using the Horvitz-Thompson estimator and inverse probability weighting on joint strata of sex, age, race, and education to project
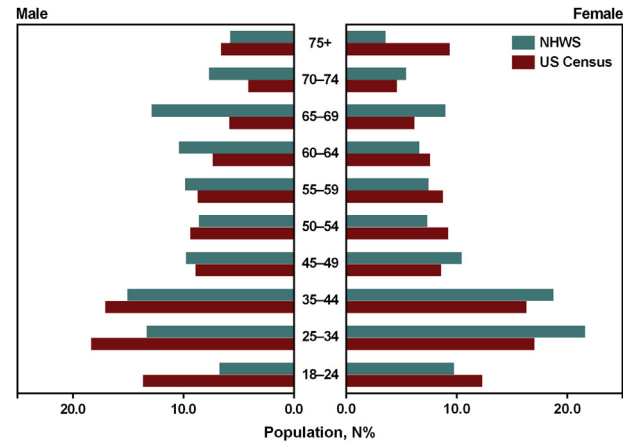


FIGURE 1. Comparison of age and sex distribution in the 2013 National Health and Wellness Survey (NHWS) with the US adult population in the 2013 census.

estimates to the US adult population (US census data for 2013[9] [a total of 242 542 967 adults]). We report prevalence estimates as percentages with 95% confidence intervals (CIs), calculated using Taylor Series linearization. We used multivariate models to estimate and test differences across groups in age, sex, insurance type, and other significant covariates. Odds ratios (ORs), along with Wald $\chi^2$ tests and 95% CIs, are reported for each predictor. The multivariate model's accuracy of classification was measured by the C-statistic value.

## RESULTS

- STUDY POPULATION: Of the 75 000 survey participants, 5051 reported a diagnosis of DED and 68 160 reported no experience of DED or diagnosis (Non-DED). The remaining 1789 participants reported experience of DED, but no DED diagnosis (Symptomatic-Undiagnosed); this group was excluded from the main analysis, but data were used to estimate the prevalence of undiagnosed DED.

Compared with the US population, the NHWS has more women in the younger age groups (18–49 years) and more men in the older age groups (≥55 years). The NHWS age and sex distribution in relation to US census data is shown in Figure 1.

The Diagnosed-DED group was older, with 72% of participants aged ≥50 years compared with 45% in the Non-DED group (Table 1). There was a higher proportion of women (62%) and white race (76%) in the Diagnosed-DED group vs the Non-DED group (51% women and 72% white). Differences between the 2 groups by census region were small but statistically significant ($P = .002$) due to the large sample size. In the unadjusted data, there was a higher proportion of divorced, separated, or widowed respondents and a lower proportion of single respondents in