Full Length Article

Characterizing idiopathic intracranial hypertension socioeconomic disparities and clinical risk factors: A retrospective case-control study

Frances Tiffany Cava Morden a, Charissa Tan a, Enrique Carrazana a,b, Jason Viereck a,b, Kore Kai Liow a,b, Arash Ghaffari-Rafi a,c,d,1

a University of Hawaii at Manoa, John A. Burns School of Medicine, Honolulu, HI, USA
b Hawaii Pacific Neuroscience, Brain Research, Innovation and Translation Lab, Honolulu, HI, USA
c University of California, Davis, School of Medicine, Department of Neurological Surgery, Sacramento, CA, USA

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ABSTRACT

Introduction: Against the backdrop of the diverse minority-majority state of Hawaii, this study seeks to better characterize associations between idiopathic intracranial hypertension (IIH) with sociodemographic variables and medical comorbidities.

Methods: A retrospective case-control study was conducted by utilizing 54 IIH patients and 216 age-, sex-, and race-matched controls, 216 unmatched controls, and 63 age-, sex-, and race-matched migraine patients.

Results: Relative to controls, IIH were 25 years younger (p < 0.0001) and 10.18 kg/m² heavier (p < 0.0001), as well as exhibited greater odds of the following variables (p < 0.05): female (odds ratio [OR]: 8.87), the lowest income quartile (OR: 2.33), Native Hawaiian or other Pacific Islander (NHPI; OR: 2.23), Native American or Alaskan Native (OR: 16.50), obesity class 3 (35.0–39.9 kg/m²; OR: 4.10), obesity class 3 (> 40 kg/m²; OR: 6.10), recent weight gain (OR: 11.66), current smoker (OR: 2.48), hypertensive (OR: 3.08), and peripheral vascular disease (OR: 16.42). Odds of IIH were reduced (p < 0.05) for patients who were Asian (OR: 0.27) or students (OR: 0.30). Unique from Whites, NHPI IIH patients exhibited greater odds (p < 0.05) for being from lower socioeconomic status and currently smoking, as well as potential association with seizures (p = 0.08). Compared to migraineurs, IIH headaches were at increased odds of occurring (p < 0.05) occipitally, for greater than 15 days per month, aggravated by postural changes, and comorbid with dizziness and tinnitus.

Conclusions: These results not only better characterize IIH, but also highlight socioeconomic and racial disparities in diagnosis.

1. Introduction

Without an identified etiology, idiopathic intracranial hypertension (IIH) is defined by an elevated intracranial pressure in the setting of normal ventricles [1]. While IIH presents with insidious headaches, in the absence of intervention, permanent vision loss can develop [2,3]. Hence, efficiently diagnosing IIH is paramount for averting morbidity. One avenue to improve accurate and timely IIH diagnosis is to better characterize the disorder’s associated sociodemographic and medical comorbidities, to therefore increase a clinician suspicion for conducting an IIH diagnostic work-up.

To elucidate the potential socioeconomic, demographic, medical risk factors associated with IIH, we conducted a retrospective case-control study within the minority-majority population in the state of Hawai’i [4]. By utilizing Hawai’i, such enabled the investigation of IIH in relation to Native Hawaiians and other Pacific Islanders (NHPI), a population not only at greater predisposition to obesity—a predictor of IIH—but also traditionally combined in demographic classifications with

Abbreviations: 95% CI, 95% Confidence Interval; BMI, Body Mass Index; NHPI, Native Hawaiian or Other Pacific Islander; HPN, Hawai’i Pacific Neurosciences; IIH, Idiopathic Intracranial Hypertension; IIHTT, Idiopathic Intracranial Hypertension Treatment Trial; ICD-9, International Classification of Diseases 9th Edition; ICD-10, International Classification of Diseases 10th Edition; IQR, Interquartile Range; NAAN, Native American or Alaska Native; OR, Odds Ratio; ZIP, Zone Improvement Plan.

* Correspondence to: University of California, Davis, Department of Neurological Surgery, 4860 Y Street, Suite 3740, Sacramento, CA 95817, USA.

E-mail address: arashgr@hawaii.edu (A. Ghaffari-Rafi).

ORCID ID: 0000-0002-6098-8036

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Asians, who themselves experience lower rates of obesity [5–7]. Furthermore, to better delineate IIH headaches, our investigation also compared headache characteristics between IIH and migraines.

2. Methods

2.1. Study design and setting

University of Hawai‘i at Mānoa, Office of Research Compliance (protocol number: 2020-01010), provided institutional review board exception prior to study initiation. Electronic medical records at Hawai‘i Pacific Neuroscience (HPN; Honolulu, Hawai‘i) were retrospectively searched from January 1, 2009 to January 5, 2021. Patients were identified via the International Classification of Diseases 9th and 10th Editions, Clinical Modification, (ICD-9-CM or ICD-10) codes: 348.2 (ICD-9) and G93 (ICD-10). To meet inclusion, patients required diagnosis of IIH with the modified Dandy diagnostic criteria from the Idiopathic Intracranial Hypertension Treatment Trial (IIHTT) [8,9].

2.2. Outcome variables

Data collected for each IIH case included sociodemographic variables, Zone Improvement Plan (ZIP) code, clinical presentation, and medical comorbidities. Patient ZIP code served as a proxy measure for several socioeconomic variables, as described in a prior investigation [10]. IIH clinical variables included presenting symptoms to clinic (i.e., headache, visual disturbances, dizziness/syncope), symptoms at the time of diagnosis, and headache characteristics (i.e., duration, location, severity, laterality).

2.3. Controls

Four controls were selected for each case (n = 54) to maximize statistical power. Two sets of 216 randomly selected controls were collected from the HPN patient population (n = 29,049). The first set of controls (n = 216) was matched by age, sex, and race. To study differences with regards to age, sex, and race, the second set of controls was unmatched. For comparing headache characteristics of migraines against IIH, matched controls of migraine (n = 63) patients were compared to IIH.

2.4. Statistical analysis

Continuous variables were assessed by the independent Wilcoxon rank sum test, while categorical variables by either the Pearson’s chi-squared test or the Fisher’s exact test of independence, with Haldane-Anscombe correction [11,12]. Univariate and multivariable logistic regression with Firth correction, were conducted to identify variables independently predictive of IIH diagnosis [13]. All tests were two-tailed and used an alpha level of < 0.05 for statistical significance.

3. Results

3.1. Overall prevalence and clinical characteristics of IIH cases

After identifying 63 IIH cases via ICD codes, nine were excluded for not meeting IIHTT modified Dandy diagnostic criteria, leaving 54 cases for analysis (Table 1). The prevalence of IIH amongst the institute’s population was 186 per 100,000 patients. The median incidence between 2010 and 2020 was 105 (Interquartile Range [IQR]: 73.6, 152) and annually static (Kendall’s τ = −0.31, p = 0.21).

The most common initial presentation of IIH patients to clinic (Table 2) was headache alone (57.40%), followed by headache and visual disturbance together (31.38%). At the time of diagnosis (Table 2), 96.20% of IIH patients had a headache, 96.20% a visual disturbance, 25.90% tinnitus, and 20.00% dizziness or syncope.

![Table 1](https://example.com/table1.png)

**Table 1** Number of patients per each variable for idiopathic intracranial hypertension (IIH) and controls.

| variable | IDIOPATHIC INTRACRANIAL HYPERTENSION | Controls |
|----------|--------------------------------------|----------|
| Age at presentation (Unmatched) | 54 | 216 |
| Sex (Unmatched) | | |
| Male | 4 | 90 |
| Female | 50 | 126 |
| Race/Ethnicity (Unmatched) | | |
| White | 20 | 82 |
| NIHPI | 20 | 45 |
| Asian | 6 | 69 |
| Black | 3 | 2 |
| Hispanic | 3 | 18 |
| NAAN | 2 | 0 |
| Median household income (Unmatched) | 54 | 216 |
| Income quartile | | |
| Quartile 1 | 22 | 49 |
| Quartile 2 | 11 | 58 |
| Quartile 3 | 7 | 51 |
| Quartile 4 | 14 | 58 |
| Overall poverty level in municipality | 54 | 216 |
| Poverty level for ages 18–64 | 54 | 216 |
| Poverty level for ages 65 and older | 54 | 216 |
| Insurance type | | |
| Private | 20 | 99 |
| Military | 12 | 33 |
| Medicaid | 20 | 84 |
| Medicare | 1 | 0 |
| Self-Pay | 1 | 0 |
| Employment status | | |
| Employed | 30 | 108 |
| Unemployed | 19 | 61 |
| Student | 4 | 46 |
| Retired | 0 | 1 |
| Marital status | | |
| Single | 23 | 127 |
| Married | 25 | 70 |
| Divorced | 5 | 14 |
| Widowed | 0 | 3 |
| Body mass index | 54 | 216 |
| Weight class | | |
| Underweight | 0 | 13 |
| Normal | 2 | 94 |
| Overweight | 9 | 44 |
| Obesity Class 1 | 10 | 29 |
| Obesity Class 2 | 16 | 20 |
| Obesity Class 3 | 17 | 15 |
| Smoking status | | |
| Current smoker | 11 | 20 |
| Former smoker | 6 | 21 |
| Never smoker | 37 | 173 |
| Hypertension | | |
| Hypertension | 13 | 20 |
| No hypertension | 41 | 195 |
| Blood pressure at diagnosis | | |
| Elevated (Systolic > 140 mmHg or Diastolic > 90 mmHg) | 2 | 17 |
| Normal | 37 | 175 |
| Coronary artery disease or myocardial infarction (CAD/MI) | | |
| CAD/MI | 1 | 1 |
| No CAD/MI | 53 | 214 |
| Peripheral vascular disease (PVD) | | |
| PVD | 2 | 0 |
| No PVD | 52 | 215 |
| Atrial fibrillation (Afib) | | |
| Afib | 1 | 1 |
| No Afib | 53 | 214 |

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Table 1 (continued)

| Associated symptoms                          | Headache laterality | Headache severity | Headache location | Headache duration > 6 months |
|----------------------------------------------|---------------------|------------------|------------------|-----------------------------|
| No                            | 1                  | 1               | 1               | 1                          |
| No稽                                            | 3                  | 10              | 10              | 10                          |
| No                                                   | 51                 | 204             | 204             | 204                         |
| No                                                 | 2                  | 18              | 18              | 18                          |
| No                                                    | 52                 | 196             | 196             | 196                         |
| No                                                       | 2                  | 2               | 2               | 2                           |
| No                                                          | 52                 | 213             | 213             | 213                         |
| Sleep disorder                                        | 24                 | 94              | 94              | 94                          |
| No sleep disorder                                      | 30                 | 120             | 120             | 120                         |
| Musculoskeletal disorder                              | 24                 | 98              | 98              | 98                          |
| No musculoskeletal disorder                          | 30                 | 116             | 116             | 116                         |
| Diplopia                                               | 19                 | 10              | 10              | 10                          |
| No diplopia                                           | 35                 | 204             | 204             | 204                         |
| Papilledema/optic disc blurring                      | 33                 | 0               | 0               | 0                           |
| No papilledema                                        | 21                 | 214             | 214             | 214                         |
| Other visual disturbance                              | 41                 | 49              | 49              | 49                          |
| No other visual disturbance                           | 13                 | 165             | 165             | 165                         |
| Recent weight gain                                     | 17                 | 8               | 8               | 8                           |
| No recent weight gain                                  | 9                  | 15              | 15              | 15                          |
| Current exercise                                       | 24                 | 90              | 90              | 90                          |
| No current exercise                                    | 24                 | 90              | 90              | 90                          |
| Alcohol use screen (AUDIT-C)                          | 19                 | 76              | 76              | 76                          |
| Positive screen                                        | 2                  | 18              | 18              | 18                          |
| Negative screen                                        | 52                 | 195             | 195             | 195                         |
| Alcohol use disorder                                   | 1                  | 1               | 1               | 1                           |
| No alcohol use disorder                                | 53                 | 213             | 213             | 213                         |
| Illicit drug use                                       | 1                  | 14              | 14              | 14                          |
| Drug use                                                | 3                  | 0               | 0               | 0                           |
| Former                                                  | 50                 | 196             | 196             | 196                         |
| HQH-9 score categories                                 | None to minimal     | 42              | 169             | 169                         |
| Mild to moderate                                       | 2                  | 12              | 12              | 12                          |
| Moderate to severe                                     | 6                  | 18              | 18              | 18                          |
| History of psychiatric disorders                       | 14                 | 72              | 72              | 72                          |
| No history of psychiatric disorders                    | 40                 | 140             | 140             | 140                         |

Table 2
Clinical characteristics of idiopathic intracranial hypertension (IIH) patients at first clinic presentation and time of diagnosis.

| Associated symptoms                          | Percentage |
|----------------------------------------------|------------|
| First presenting symptom (s) of IIH patients (n = 54) | 57.40%     |
| Headache alone (n = 31)                       | 1.85%      |
| Visual disturbance alone (n = 1)              | 31.48%     |
| Headache & visual disturbance (n = 17)        | 1.85%      |
| Headache & tinnitus (n = 1)                   | 1.85%      |
| Visual disturbance & dizziness/syncope (n = 1) | 1.85%      |
| Headache, visual disturbance & dizziness/syncope (n = 2) | 3.70%      |
| Headache, tinnitus, & dizziness/syncope (n = 1) | 1.85%      |
| Presence of symptoms at diagnosis (n = 54)    | Percentage |
| Headache (n = 52)                             | 96.20%     |
| Visual disturbance (n = 52)                   | 96.20%     |
| Tinnitus (n = 14)                             | 25.90%     |
| Dizziness or syncope (n = 12)                 | 20.00%     |

3.2. Sex, race, and age

Females were found to have 8.87 (95% CI: 3.09, 35.05; p < 0.0001) fold greater odds of IIH than males (Table 4).

3.3. Socioeconomic variables

Patients with IIH had a median household income of $4610 lower (p = 0.066) than controls. Stratified by income quartiles, IIH patients were at 3.3 (95% CI: 1.18, 5.80) fold greater odds of being from the first income quartile (lowest income strata).

When examining the poverty level in patient’s municipality of origin, IIH patients were found to reside in areas with a greater percentage of residents living below the poverty level (0.0050, 95% CI: 0.000081, 0.0099; p = 0.059). Stratified by age, IIH patients were similarly found to live in areas where a greater percentage of the residents 65 years and older living below the poverty level (0.0040, 95% CI: 0.000032, 0.016; p = 0.04).

Regarding race, NHPI (2.23, 95% CI: 1.10, 4.43; p = 0.02), NAAN (16.50, 95% CI: 1.61, 816.15; p = 0.006), and Black (6.23, 95% CI: 0.70, 76.3; p = 0.056) patients experienced greatest odds of IIH diagnosis, while Asian patients were at 0.27 (95% CI: 0.089, 0.67; p = 0.004) fold reduced odds.

The median age of diagnosis for IIH patients was 32.00 years (IQR: 24.00, 40.75), 25 years younger than the institute’s general population (95% CI: 20.00, 31.00, p < 0.0001).

3.4. Medical comorbidities and clinical presentation

BMI was estimated to be 10.18 kg/m² greater (95% CI: 7.85, 12.61;
Table 4

| Median (25% quartile, 75% quartile) | Wilcoxon Rank Sum Test (estimated difference between groups) |
|------------------------------------|-------------------------------------------------------------|
| **Patient age**                    |                                                              |
| IIH                                | 32.00 (24.00, 40.75)                                          |
| Controls                           | 58.50 (44.00, 74.25)                                          |
| **Patient age by sex**             |                                                              |
| IIH Males                          | 37.00 (31.75, 44.50)                                          |
| IIH Females                        | 32.00 (23.62, 40.00)                                          |
| **Patient age by race**            |                                                              |
| IIH White                          | 35.00 (28.00, 41.50)                                          |
| Control White                      | 62.50 (48.50, 77.00)                                          |
| IIH Black                          | 48.00 (35.50, 50.00)                                          |
| Control Black                      | 41.00 (29.50, 52.50)                                          |
| IIH Asian                          | 35.00 (31.25, 41.00)                                          |
| Control Asian                      | 66.00 (52.50, 81.00)                                          |
| IIH NHPI                           | 29.00 (22.00, 37.25)                                          |
| Control NHPI                       | 51.00 (33.00, 59.00)                                          |
| IIH Hispanic                       | 20.50 (20.25, 21.75)                                          |
| Control Hispanic                   | 45.00 (35.50, 55.25)                                          |
| IIH NAAN                           | 47 (40.5, 53.5)                                               |
| Control NAAN                       | None                                                         |
| **Median household income**        |                                                              |
| IIH                                | 93,433 (68,617, 104,431)                                      |
| Controls                           | 102,242 (85,365, 106,693)                                     |
| **Overall poverty level in municipality** |                                                      |
| IIH                                | 0.056 (0.056, 0.11)                                           |
| Controls                           | 0.056 (0.049, 0.086)                                          |
| Poverty level for ages 18-64       |                                                              |
| IIH                                | 0.059 (0.049, 0.097)                                          |
| Controls                           | 0.059 (0.049, 0.087)                                          |
| Poverty level for ages 65 and older|                                                              |
| IIH                                | 0.065 (0.043, 0.069)                                          |
| Controls                           | 0.044 (0.042, 0.068)                                          |
| **Odds ratio (95% confidence interval)** |                                              |
| Insurance type                     |                                                              |
| Medicare                           | 8.11 (1.42, 480.38)                                           |
| Medicaid                           | 0.92 (0.47, 1.78)                                             |
| Private                            | 0.70 (0.36, 1.34)                                             |
| Military                           | 1.58 (0.68, 3.47)                                             |
| Income quartiles                   |                                                              |
| Quartile 1                         | 2.33 (1.18, 4.58)                                             |
| Quartile 2                         | 0.48 (0.17, 1.16)                                             |
| Quartile 3                         | 0.95 (0.44, 1.95)                                             |
| Quartile 4                         | 0.70 (0.20, 1.49)                                             |
| Sex                                |                                                              |
| Male                               | 0.11 (0.028, 0.32)                                            |
| Female                             | 8.87 (3.09, 35.05)                                            |
| Race                               |                                                              |
| White                              | 0.96 (0.49, 1.85)                                             |
| Black                              | 6.23 (0.70, 76.3)                                             |
| Asian                              | 0.27 (0.089, 0.67)                                            |

Table 4 (continued)

| **Native Hawaiian or Other Pacific Islander** |                                                              |
| Hispanic                                       | 0.65 (0.12, 2.35)                                             |
| Native American                                 | 16.50 (1.61, 161)                                            |
| Alaskan Native                                  | 816.15                                                       |
| Employment status                               |                                                              |
| Employed                                        | 1.30 (0.68, 2.51)                                             |
| Unemployed                                      | 1.38 (0.69, 2.70)                                             |
| Retired                                         | 2.02 (0.034, 39.22)                                           |
| Student                                         | 0.30 (0.075, 0.89)                                            |
| Marital status                                  |                                                              |
| Married                                         | 1.82 (0.95, 3.53)                                             |
| Single                                          | 0.53 (0.27, 1.01)                                             |
| Divorced/Separated                              | 1.46 (0.39, 4.57)                                             |
| Widowed                                         | 0.66 (0.014, 5.56)                                            |
| Medical comorbidies                             |                                                              |
| Median (25% quartile, 75% quartile)             |                                                              |
| Body mass index (kg/m²)                         |                                                              |
| IIH                                             | 36.73 (30.18, 41.30)                                          |
| Matched controls                                | 25.03 (21.42, 31.55)                                          |
| Odds ratio (95% confidence interval)            |                                                              |
| Weight class                                    |                                                              |
| Underweight                                     | 0.15 (0.0037, 0.95)                                           |
| Normal                                          | 0.050 (0.0058, 0.20)                                          |
| Overweight                                      | 0.78 (0.31, 1.78)                                             |
| Obesity class 1                                 | 1.31 (0.53, 3.02)                                             |
| Obesity class 2                                 | 4.10 (1.81, 9.20)                                             |
| Obesity class 3                                 | 6.10 (2.61, 14.42)                                            |
| Smoking status                                  |                                                              |
| Current smoker                                  | 2.48 (1.11, 5.56)                                             |
| Former/never                                    | 0.52 (0.26, 1.02)                                             |
| Hypertension                                    |                                                              |
| Hypertension                                    | 3.08 (1.30, 7.12)                                             |
| No hypertension                                | 0.32 (0.14, 0.77)                                             |
| Coronary artery disease or myocardial infarction|                                                              |
| No PVD                                          | 0.061 (0.0012, 0.62)                                          |
| Peripheral vascular disease (PVD)               |                                                              |
| Atrial fibrillation (AFLb)                      |                                                              |
| Afib                                            | 4.00 (0.050, 318)                                             |
| Congestive heart failure (CHF)                  |                                                              |
| No CHF                                          | 0.49 (0.28, 0.88)                                             |
| Autoimmune disease                              |                                                              |
| No autoimmune disease                           | 0.53 (0.25, 0.98)                                             |
| Thyroid disease                                 |                                                              |
| No thyroid disease                              | 2.38 (0.54, 21.8)                                             |
| Seizure history                                 |                                                              |
| No seizures                                     | 4.15 (0.29, 58.5)                                             |
| Sleep disorder                                  |                                                              |
| No sleep disorder                               | 0.24 (0.017, 3.40)                                            |
| Sleep disorder                                  | 1.00 (0.52, 1.90)                                             |

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Table 4 (continued)

| No sleep disorder | 1.00 (0.52, 1.91) |
| Musculoskeletal disorder | 0.95 (0.49, 1.80) |
| Musculoskeletal disorder | 1.06 (0.56, 2.02) |
| Diplopia | 20.92 (4.41, 28.68) |
| No diplopia | 0.092 (0.035, 0.23) |
| Papilledema/optic disc blurring | 321 (50.0, 12367) |
| No Papilledema/optic disc blurring | 0.0031 (0.000081) |
| Other visual disturbances | 1.05 (5.04, 23.18) |
| No other visual disturbances | 0.095 (0.043, 0.20) |
| Recent weight gain | 11.66 (4.23, 30.82) |
| No recent weight gain | 0.086 (0.032, 0.21) |
| Positive exercise | 0.89 (0.42, 1.93) |
| No exercise | 1.12 (0.52, 2.36) |
| Psychiatric comorbidities | Odds ratio (95% confidence interval) |
| Alcohol use screen (AUDIT-C) | 0.42 (0.046, 1.84) |
| Positive screen | 2.40 (0.54, 21.94) |
| Negative screen | 3.99 (0.050, 316) |
| Alcohol use disorder | 0.25 (0.032, 19.9) |
| Illicit drug use | 0.26 (0.0061, 1.82) |
| No illicit drug use | 3.77 (0.55, 163) |
| Depression categories | None to minimal | 0.93 (0.38, 2.53) |
| Mild to moderate | 0.59 (0.062, 2.78) |
| Moderate to severe | 1.37 (0.42, 3.88) |
| History of psychiatric disorders | Psychiatric history | 0.68 (0.032, 1.8) |
| No psychiatric history | 1.47 (0.72, 3.12) |

p < 0.0001) for IIH patients (36.73 kg/m², IQR: 30.18, 41.30) than controls (25.03 kg/m², IQR: 21.42, 31.55). By weight class, patients with IIH were at 0.15 (95% CI: 0.0037, 0.95; p = 0.04) fold reduced odds of being underweight (BMI < 18.5 kg/m²), 4.10 (95% CI: 1.81, 9.20; p = 0.0002) fold greater odds of obesity class 2 (BMI 35.0–39.9 kg/m²), and 6.10 (95% CI: 2.61, 14.42; p < 0.0001) fold greater odds of obesity class 3 (BMI > 40 kg/m²).

Patients with IIH were also at 3.08 (95% CI: 1.30, 7.12; p = 0.006) fold greater odds of having hypertension than matched controls, with odds of blood pressure being elevated at the time of diagnosis 2.02 (95% CI: 0.96, 4.11; p = 0.06) fold greater. For peripheral vascular disease, odds were 16.42 (95% CI: 1.60, 821.40; p = 0.007) fold greater than controls. Meanwhile, current smokers had a 2.48 (95% CI: 1.11, 5.56; p = 0.04) fold increased odds of IIH, relative to former and never-smokers.

Regarding clinical presentation, IIH patients exhibited greater odds of diplopia (10.92, 95% CI: 4.41, 28.68; p < 0.0001), papilledema or optic disc blurring (321, 95% CI: 50.00, 12367; p < 0.0001), and other visual disturbances (10.50, 95% CI: 5.04, 23.18; p < 0.0001). IIH patients also had a greater odds (11.66, 95% CI: 4.23, 30.82; p < 0.0001) of self-reporting recent weight gain.

3.5. Multivariable analysis of IIH entire cohort

After conducting the multivariable logistic regression (Table 6) with papilledema excluded, the strongest predictors increasing odds of diagnosis included, BMI (p = 0.01), other visual disturbances

Table 5

Crude odds ratios comparing headache variables of idiopathic intracranial hypertension against migraine patients.

| Headache duration > 6 months | Odds ratio (95% confidence interval) | Chi-square test or Fisher exact test |
|-------------------------------|-------------------------------------|------------------------------------|
| No                           | 2.22 (0.27, 18.08)                   |                                    |

3.6. White IIH patients

To analyze the differences between White IIH patients and White controls, univariate logistic regression was performed (Table 6). White IIH patients were younger than controls (p < 0.0001), reduced odds of being male (0.058, 95% CI: 0.0074, 0.45; p = 0.007), but had greater odds of a higher BMI (p < 0.0001). Relative to normal weight (18.5–24.9 kg/m²), Whites were 10.00 (95% CI: 1.69, 59.31; p = 0.01), 35.00 (95% CI: 5.35, 228.86; p = 0.0002), and 40.00 (95% CI: 4.37, 365.76; p = 0.001) folds at greater odds for being from obesity classes 1, 2, and 3, respectively. White IIH patients were also at greater odds of hypertension (6.25, 95% CI: 1.50, 26.04; p = 0.01), diplopia (12.83, 95% CI: 2.27, 72.43; p = 0.004), and other visual disturbances (11.81, 95% CI: 3.73, 37.35; p < 0.0001). Excluding papilledema, after multivariable analysis, higher BMI and other visual disturbances were identified as strongest predictors of IIH amongst Whites.

3.7. Native Hawaiian and other Pacific Islander IIH patients

Univariate logistic regression analysis was also conducted to identify unique association with IIH for NHPI patients. NHPI IIH patients were younger than controls (p < 0.0001) and at reduced odds of being male (0.03, 95% CI: 0.0014, 0.84; p = 0.04). NHPI IIH patients were at increased odds of living in municipalities with higher poverty rates across all age strata (p < 0.05) and having lower median household income (p = 0.03). Relative to the fourth income quartile, odds of IIH

(p = 0.001), and poverty level for those 65 year and older (p = 0.03).
Table 6
Multivariable logistic regression of idiopathic intracranial hypertension relative to controls. Race stratified analysis also included for Whites and NHPI.

|                                | White patients | Native Hawaiian or other Pacific Islander |
|--------------------------------|----------------|------------------------------------------|
| Idiopathic intracranial hypertension vs. General population |                |                                          |
| Unadjusted odds ratios (95% confidence interval) |                |                                          |
| Best fit model: adjusted odds ratios |                |                                          |
| Age                             | 0.93 (0.91, 0.95), p = 1.47 × 10^{-10} | 0.92 (0.88, 0.96), p = 3.20 × 10^{-5} |
| Sex                             |                 |                                          |
| Female                          | Referent        | Referent                                 |
| Male                            | 0.11 (0.040, 0.32), p = 0.000046 | 0.058 (0.0074, 0.45), p = 0.0067 |
| Race/Ethnicity                  |                 |                                          |
| White                           | 1.82 (0.89, 3.74), p = 0.10 | Referent                                 |
| NHPI                            |                 |                                          |
| Hispanic/Latino                 | 0.68 (0.18, 2.55), p = 0.57 | 0.03 (0.0014, 0.84), p = 0.99 |
| Black                           | 6.15 (0.96, 39.30), p = 0.055 |                                          |
| Asian                           | 0.36 (0.14, 0.94), p = 0.037 |                                          |
| Poverty level ages              |                 |                                          |
| First quartile                  | 104.4 (0.35, 3098), p = 0.11 | 4.60 × 10^{-6}, p = 0.029 |
| Second quartile                 | 53.58 (0.16, 18267), p = 0.18 | 1.32 × 10^{-6}, p = 0.026 |
| Third quartile                  | 2374 (3.15, 1.79 × 10^{5}), p = 0.022 | 6.52 × 10^{-10}, p = 0.032 |
| Poverty level 65 and older       | 9423 (3.06, 2.90 × 10^{7}), p = 0.026 | 2.79 × 10^{-10}, p = 0.00039 |
| Income quartiles                |                 |                                          |
| Fourth quartile                 | 2.36 (1.04, 5.36), p = 0.039 | 8.00 (1.21, 52.69), p = 0.031 |
| First quartile                  | 7.24 (0.26, 2.01), p = 0.53 | 1.25 (0.19, 8.13), p = 0.82 |
| Second quartile                 | 1.27 (0.53, 3.04), p = 0.059 | 2.14 (0.36, 12.89), p = 0.40 |
| Third quartile                  |                 |                                          |
| Private                         | 1.18 (0.59, 2.34), p = 0.64 | 0.97 (0.36, 2.64), p = 0.95 |
| Medicaid                        | 1185 (2.94 × 10^{-119}, 4.77 × 10^{-244}, p = 0.099 | N/A |
| Medicare                        | 1.82 (0.51, 6.62), p = 0.36 | N/A |
| Military                        | 1.80 (0.80, 4.07), p = 0.16 | 0.010 (1.14 × 10^{-6}, 93.71), p = 0.99 |
| Self-pay                        | 1185 (2.94 × 10^{-119}, 4.77 × 10^{-244}, p = 0.099 | N/A |
| Employment status              |                 |                                          |
| Employed                       | 11.12 (0.58, 2.16), p = 0.73 | 1.13 (0.35, 3.64), p = 0.84 |
| Unemployed                      | 0.042 (0.00014, 12.4), p = 0.99 | N/A |
| Student                         | 0.31 (0.10, 0.94), p = 0.038 | 0.31 (0.078, 1.23), p = 0.096 |
| Marital status                  |                 |                                          |
| Married                         | 1.00 (0.33, 3.06), p = 1.00 | 0.0055 (1.53 × 10^{-10}, 1.98 × 10^{-6}, p = 0.99 |
| Divorced                        | 0.51 (0.27, 0.96), p = 0.037 | 0.30 (0.10, 0.90), p = 0.032 |
| Single                          | 0.0082 (5.17 × 10^{-6}, 13.04), p = 0.99 | 0.0051 (1.06 × 10^{-10}, 2.46 × 10^{-7}, p = 0.99 |
| BMI                             | 1.12 (1.08, 1.16), p = 1.62 × 10^{-5} | 1.21 (1.10, 1.32), p = 4.45 × 10^{-5} |
| Weight class                    | 0.52 (0.059, 4.60), p = 0.56 | 1.14 (1.07, 1.21), p = 7.84 × 10^{-5} |
| Normal                          | 0.93 (0.23, 3.70) - 0.99 | 0.86 (0.13, 5.69), p = 0.99 |
| Underweight                     | 9.61 (1.99, 46.37), p = 0.0048 | 2.35 (0.30, 18.10), p = 0.41 |
| Overweight                      |                 |                                          |

(continued on next page)
| Table 6 (continued) | Idiopathic intracranial hypertension vs. General population | White patients | Native Hawaiian or other Pacific Islander |
|---------------------|-----------------------------------------------------------|----------------|---------------------------------|
|                     | Unadjusted odds ratios (95% confidence interval)          | Best fit model: adjusted odds ratios | Unadjusted odds ratios (95% confidence interval) | Best fit model: adjusted odds ratios |
| Obesity class 1     | 16.21 (3.36, 78.23), p = 0.00052                          | 10.00 (1.69, 59.31), p = 0.011 | 0.65 (0.090, 4.67), p = 0.39 |
| Obesity class 2     | 37.60 (8.00, 176.65), p = 0.0000043                         | 35.00 (5.35, 228.86), p = 0.00021 | 5.07 (0.19, 134.99), p = 0.13 |
| Obesity class 3     | 53.33 (11.16, 254.30), p = 0.00000062                        | 40.00 (4.37, 365.76), p = 0.0011 | 72.46 (0.00045, 1.16 × 10^7), p = 0.065 |
| Smoking status      | Current 2.48 (1.11, 5.56), p = 0.027                        | 0.85 (0.25, 2.86), p = 0.79 | 5.28 (1.49, 18.78), p = 0.01 |
|                     | No smoking Smokers Referent                               | Referent         | 5.77 (1.15, 28.84), p = 0.033 |
| Hypertension        | No hypertension Referent                                   | Referent         | Referent |
| Type 2 diabetes mellitus | Hyperlipidemia    | Referent      | Referent |
| Blood pressure at diagnosis | No hypertension | Referent      | Referent |
|                         | Hypertension 3.09 (1.42, 6.71), p = 0.0043                  | 6.25 (1.50, 26.04), p = 0.012 | 3.08 (0.78, 12.20), p = 0.11 |
| History of atrial fibrillation or flutter (Afb) | No Afb | Referent      | Referent |
|                         | Afb 4.04 (0.25, 65.61), p = 0.33                           | 0.01 (9.66 × 10^-6, 12.06), p = 0.99 | Referent |
| Congestive heart failure (CHF) | No CHF | Referent      | Referent |
| History of atrial fibrillation or flutter (Afb) | No Afb | Referent      | Referent |
|                         | Afb 4.04 (0.25, 65.61), p = 0.33                           | 0.01 (9.66 × 10^-6, 12.06), p = 0.99 | Referent |
| Coronary artery disease or prior myocardial infarction (CAD/MI) | No CAD/MI | Referent      | Referent |
|                         | CAD/MI 4.04 (0.25, 65.61), p = 0.33                        | 0.01 (9.66 × 10^-6, 12.06), p = 0.99 | Referent |
| Peripheral vascular disease (PVD) | No PVD | Referent      | Referent |
|                         | PVD 1065 (1.53 × 10^{-83}, 7.41 × 10^-9), p = 0.99         | Referent         | 1077 (1.76 × 10^{-119}, 6.60 × 10^{-124}), p = 0.99 |
| Autoimmune disease    | No autoimmune disease Referent                            | Referent         | Referent |
|                         | Autoimmune disease 1.20 (0.32, 4.52), p = 0.79             | 2.08 (0.35, 12.28), p = 0.42 | 0.010 (9.41 × 10^-6, 11.67), p = 0.99 |
| Thyroid disease       | No thyroid disease Referent                                | Referent         | Referent |
|                         | Thyroid disease 0.42 (0.094, 1.86), p = 0.25                | 0.86 (0.17, 4.36), p = 0.86 | Referent |
| Seizure history       | No seizure history Referent                                | Referent         | Referent |
|                         | Seizure history 4.10 (0.56, 29.76), p = 0.16                | 0.010 (8.96 × 10^-6, 12.06), p = 0.99 | Referent |
| Sleep Disorder        | No sleep disorder Referent                                | Referent         | Referent |
|                         | Sleep disorder 1.02 (0.56, 1.86), p = 0.94                 | 1.03 (0.38, 2.81), p = 0.95 | 0.73 (0.26, 2.02), p = 0.54 |
| Musculoskeletal disturbance | No musculoskeletal disturbance | Referent      | Referent |
|                         | Musculoskeletal disturbance 0.95 (0.52, 1.73), p = 0.86    | 0.64 (0.23, 1.78), p = 0.40 | 1.05 (0.39, 2.82), p = 0.92 |
| Diplopia              | No diplopia Referent                                       | Referent         | Referent |
|                         | Diplopia 11.07 (4.75, 25.79), p = 2.49 × 10^3             | 12.83 (2.27, 72.43), p = 0.0038 | 12.75 (3.94, 41.22), p = 2.13 × 10^-5, 44.19, p = 0.0011 |
| Papilledema/ optic disc blurring | No papilledema | Referent      | Referent |

(continued on next page)
Table 6 (continued)

|                          | Idiopathic intracranial hypertension vs. General population | White patients | Native Hawaiian or other Pacific Islander |
|--------------------------|------------------------------------------------------------|----------------|------------------------------------------|
|                          | Unadjusted odds ratios (95% confidence interval)            | Best fit model: adjusted odds ratios | Unadjusted odds ratios (95% confidence interval) | Best fit model: adjusted odds ratios |
| Papilledema              | 105.70 (0.28, 39.926), p = 0.99                            | 106.55 (0.0084, 1.36 × 10^1), p = 0.99 | 106.65 (0.0084, 1.35 × 10^1), p = 0.99 |
| Other visual disturbances|                                                            |                |                                          |
| No other visual          | Referent                                                   | Referent       | Referent                                 | Referent |
| disturbance              |                                                            |                |                                          |
| Other visual            | 10.62 (5.27, 21.40), p = 3.85 × 10^11                       | 7.05 (5.55, 896), p = 0.0010       | 11.81 (3.73, 37.25), p = 2.63 × 10^5       | 7.43 (1.98, 27.88), p = 0.0030         |
| disturbance              |                                                            |                |                                          |
| Recent weight gain       | Referent                                                   | Referent       | Referent                                 | Referent |
| Weight gain              | 3.54 (1.09, 11.51), p = 0.036                               | 6.52 (0.79, 53.70), p = 0.081     | 2.00 (0.31, 12.84), p = 0.46              | Referent |
| Current exercise         | Referent                                                   | Referent       | Referent                                 | Referent |
| No current exercise      | Referent                                                   | Referent       | Referent                                 | Referent |
| Current exercise         | 0.90 (0.42, 1.89), p = 0.77                                 | 1.73 (0.43, 7.03), p = 0.44       | 0.71 (0.21, 2.38), p = 0.58              | Referent |
| Alcohol use screen (AUDIT-C) | Referent                                               | Referent       | Referent                                 | Referent |
| Negative screen          | Referent                                                   | Referent       | Referent                                 | Referent |
| Positive screen          | 0.42 (0.094, 1.85), p = 0.25                               | 0.40 (0.048, 3.39), p = 0.40     | 0.65 (0.074, 5.72), p = 0.70              | Referent |
| Alcohol use disorder     | Referent                                                   | Referent       | Referent                                 | Referent |
| No alcohol use disorder  | Referent                                                   | Referent       | Referent                                 | Referent |
| Alcohol use disorder     | 4.02 (0.25, 65.31), p = 0.33                               | 4.10 (0.24, 68.65), p = 0.33     | Referent                                 | Referent |
| I illicit drug use       | Referent                                                   | Referent       | Referent                                 | Referent |
| Drug use                 | Referent                                                   | Referent       | Referent                                 | Referent |
| Drug use                 | 6.59 (1.18 × 10^5, 3.69 × 10^1), p = 0.98                  | 2.03 (0.34, 11.95), p = 0.44     | 2.06 (0.35, 12.11), p = 0.43              | Referent |
| PHQ-9 score categories   |                                                            |                |                                          |
| None to minimal          | Referent                                                   | Referent       | Referent                                 | Referent |
| Mild to moderate         | 0.67 (0.14, 3.11), p = 0.61                                | 9.59 (4.60 × 10^17), p = 0.99    | 1.29 (0.12, 13.26), p = 0.83              | Referent |
| Moderate to severe       | 1.34 (0.50, 3.59), p = 0.56                                | 1.24 (0.23, 6.68), p = 0.81     | 0.97 (0.19, 5.01), p = 0.97              | Referent |
| History of psychiatric disorders | Referent                        | Referent       | Referent                                 | Referent |
| No history of psychiatric disorders | Referent                        | Referent       | Referent                                 | Referent |
| History of psychiatric disorders | 0.68 (0.35, 1.33), p = 0.26                              | 0.40 (0.13, 1.21), p = 0.10     | 0.80 (0.24, 2.69), p = 0.72              | Referent |

were 8.00 (95% CI: 1.21, 52.69; p = 0.03) fold greater for patients from the first quartile. NHPI IIH patients were also at greater odds of having a higher BMI (p < 0.0001), being an active smoker (5.28, 95% CI: 1.49, 18.78; p = 0.01), and having a history of seizures (8.78, 95% CI: 0.75, 102; p = 0.08). NHPI IIH patients were at a 0.30 (95% CI: 0.10, 0.90; p = 0.032) fold reduced odds of being single. Regarding symptoms, IIH patients were also increased with diplopia (12.75, 95% CI: 3.94, 41.22; p < 0.0001) and other visual disturbances (6.15; 95% CI: 2.10, 18.92; p = 0.001). Excluding papilledema, multivariable analysis identified higher BMI, being a current smoker, and diplopia as the strongest predictors of IIH diagnosis amongst NHPI.

3.8. Migraine headaches compared to IIH

Seven variables defining headaches were compared between migraines and IIH (Tables 3 and 5). IIH patients were at increased odds of experiencing headaches greater than 15 days per month (5.31, 95% CI: 1.58, 23.32; p = 0.002) and in the occipital region (5.46, 95% CI: 1.00, 56.14; p = 0.04). Relative to migraines, IIH patients were at reduced odds of defining the headaches as severe (0.33, 95% CI: 0.085, 1.17; p = 0.096) or characterizing them as throbbing (0.32, 95% CI: 0.086, 1.08; p = 0.07) and dull (6.76, 95% CI: 0.69, 338; p = 0.09). Regarding associated symptoms, IIH patients were at greater odds of also noting headaches aggravated by postural changes (38.99, 95% CI: 5.55, 1699; p < 0.0001), as well as headaches present with tinnitus (84.66, 95% CI: 13.89, 3405; p < 0.0001), dizziness (3.40, 95% CI: 1.06, 12.16; p = 0.04), loss of functionality (4.59, 95% CI: 0.77, 48.80; p = 0.07), and numbness (3.61, 95% CI: 0.77, 23.00; p = 0.09). Meanwhile, IIH patients were at reduced odds of having headaches comorbid with nausea or vomiting (0.28, 95% CI: 0.11, 0.68; p = 0.004), photophobia (0.058, 95% CI: 0.010, 0.22; p < 0.0001), and phonophobia (0.28, 95% CI: 0.11, 0.68; p < 0.004), relative to patients with migraine headaches.

4. Discussion

4.1. Clinical characteristics of idiopathic intracranial hypertension

Within our institution, over a 12-year period (2009–2021) the prevalence of IIH was determined to be 186 per 100,000 patients with neurological disorders. Since 2009, the annual number of IIH diagnoses has remained stable (r = −0.31, p = 0.21). However, nationally diagnoses of IIH have been increasing between 1997 and 2017 [14]. Consistent with literature, our study identified headache as the most common initial presentation [15–19]. By the time of diagnosis, 96.20% of our IIH cohort were experiencing headaches, in relation previous studies have found headache rates in the range of 75–90% [15,16,18,20].
4.2. Age at diagnosis

Patients with IIH had a median age of diagnosis at 32.00 years (IQR: 24.00, 40.75), which corroborated reports of individuals 18–44 years old most likely to have IIH [6,14,20,24]. While differences in age of diagnosis by sex are yet to be reported, upon stratification by sex, median age of diagnosis was older amongst male IIH patients (37 years) than females (32 years); albeit, a low male number (n = 4) precluded identification of statistical significance (p = 0.28) [25].

When stratifying age of IIH diagnosis by race/ethnicity, Hispanic patients were found to have the youngest median age of diagnosis at 20.50 years (IQR: 20.25, 21.75), followed by NHPI at 29.00 years (IQR: 22.00, 37.25), Asians at 35.00 years (IQR: 31.25, 41.00), Whites at 35.00 years (IQR: 28.00, 41.50), NAAN at 47 years (IQR: 40.50, 53.50), and Blacks at 48 years (IQR: 35.50, 50.00); yet, insufficient sample sizes prevented meaningful statistical analysis. Notwithstanding, the absence of comparable studies examining age of diagnosis by race, our observed trends may be explained by the strong association between IIH and obesity [26]. The earlier age of diagnosis amongst Hispanics and NHPI, may arise secondary to higher rates of youth (2–19 years old) obesity amongst Hispanics and NHPI [27–29]. However, given Blacks and NAAN have greater prevalence of childhood obesity than Whites, yet older age of IIH diagnosis, there are potentially other environmental factors at play (i.e., disparities in healthcare access for timely diagnosis) contributing to the different ages of diagnosis per each racial strata [29].

4.3. Sex

The observation that females are at 8.87 greater odds of IIH diagnosis, with a female-to-male ratio of 12.5:1, corresponds with earlier studies, including one United States nationwide report finding females to have an incidence 5.47 times greater than males [14–20,24,30]. Given the female predisposition for IIH does not occur until puberty, some hypothesize sex hormones may contribute to the pathogenesis and female predilection for IIH [14,31].

4.4. Race

Hawai’i’s diverse minority-majority population enabled our investigation to examine disparities in IIH amongst NHPI, NAAN, Asians, and Blacks—historically marginalized populations which are often understudied [32,33]. The racial groups experiencing the greatest odds of IIH included NAAN (odds ratio [OR]: 16.50; p = 0.006), Blacks (OR: 6.23; p = 0.004), and NHPI (OR: 2.23; p = 0.02); while Asians (OR: 0.27; p = 0.004) experienced the lowest odds. Observed trends for Blacks and Asians corresponded with US nationwide data on IIH, yet for NAAN and NHPI comparable data was not available [14,21]. The greater odds of IIH amongst NAAN, Blacks, and NHPI, may be explained by the higher rates of obesity these populations experience relative to Whites [5–7]. Similarly, lower rates of IIH amongst Asians, could be attributed to Asians having one of the lowest rates of obesity in the US and internationally [5,6,14,30,34,35].

4.5. Socioeconomic variables

Upon examining several markers of socioeconomic status, patients in our IIH cohort were found to be at greater odds of having a lower median household income (in particular having greater odds of being from the lowest income quartile) and to reside in areas with a greater proportion of the residents living below the poverty line. The association with lower socioeconomic status is not confined to Hawai’i, as nationwide an increased incidence of IIH in the lowest income quartile was also identified [14]. Internationally, in England and Wales, areas with higher deprivation have also been noted to have greater rates of IIH, with the trend subsisting in females even after controlling for obesity—parallel our finding of poverty level amongst those 65 years and older remaining an independent predictor of IIH diagnosis after multivariable analysis [36,37]. Hence, the link between lower socioeconomic status and increased rates of obesity may only explain part of the association between IIH and higher deprivation, with other variables tied to lower socioeconomic status playing a greater role (i.e., diet, employment, education, social support, and environmental hazards) [14,36–38].

When examining marital and occupational status, despite matching to age, higher odds of IIH diagnosis were noted for patients who were married (OR: 1.82; p = 0.07), while lower odds for those single (OR: 0.53; p = 0.05) or students (OR: 0.30; p = 0.02). With marriage, women have been noted to gain weight, while with increasing education level obesity prevalence decreases, hence potentially accounting for the IIH diagnosis trends [5,39].

4.6. Cardiovascular risk factors

Overall, several cardiovascular comorbidities were found associated with IIH, including BMI, smoking status, hypertension, hyperlipidemia, and peripheral vascular disease. Regarding the established association of obesity, our IIH patients were 10.18 kg/m² heavier than controls, and at greater odds of being in obesity class 2 (35.0–39.9 kg/m²; OR: 4.10; p = 0.0002) and class 3 (> 40 kg/m²; OR: 6.10; p < 0.0001), as well as at greater odds of reporting recent weight gain (p < 0.0001) [15,16,20,24,36]. The association with obesity likely also accounts for the greater odds of hypertension (OR: 3.08; p = 0.006) in IIH patients, notwithstanding prior investigations having found that even after matching for age and BMI, IIH patients continue to have a 55% greater risk of hypertension [38,40–42]. Other variables, including hyperlipidemia (OR: 2.09; p = 0.12), peripheral vascular disease (OR: 16.42; p = 0.007), and being a current smoker (OR: 2.48; p = 0.04) associated with IIH diagnosis; previous studies have also reported increased rates of smoking in patients with IIH [42,43]. Provided the association with cardiovascular variables in addition to BMI, IIH patients may benefit from not only weight management, but also hypertensive control, lipid management, and smoking cessation [42,44].

4.7. White and NHPI IIH patients

Subgroup analysis for White and NHPI patients was also conducted. For White patients, IIH was not associated with a lower socioeconomic status, but did retain correlations with greater BMI and hypertension. However, NHPI patients did present an association between lower socioeconomic status and IIH diagnosis. Moreover, for NHPI IIH patients, the strongest predictors of diagnosis included being a current smoker, in addition to higher BMI. NHPI IIH patients also exhibited increased odds of seizure history (OR: 8.78; p = 0.08), an association only rarely reported [45]. While seizure may be secondary to severe IIH disproportionally impacting NHPIs, seizures arising due to elevated intracranial pressure is uncommon and a controversial [46].

4.8. Comparison of migraines against IIH

Given the similarities between migraine and IIH headaches, as well as potential for permanent vision loss secondary to untreated IIH, there is impetus to efficiently distinguish IIH headaches to expedite correct treatment [1,17,37]. Our investigation identified that IIH, relative to migraine patients, were at greater odds of experiencing headaches in the occipital region (OR: 5.47; p = 0.04) and at a frequency of more than 15 days per month (OR: 5.31; p = 0.002). Similarly, IIH patients in the IIHTT reported constant/daily headache or intermittent headaches occurring for 12 days per month [6]. IIH headaches were also at greater odds of association with dizziness, tinnitus, loss of functionality, and to be exacerbated by postural changes, while migraine headaches were associated with nausea/vomiting, photophobia, and phonophobia. Prior investigations have also found these symptoms associated with IIH headaches, with increased intracranial pressure the suspected culprit.
Loss of functionality in particular has been noted to decrease quality of life for IIH patients [48]. Overall, by eliciting specific questions to better characterize headaches, a correct diagnosis of IIH may be expedited.

4.9. Limitations

The results should be considered in the context of several limitations. As a retrospective investigation there remains uncertainty in how consistently clinical history was elicited from patients. The relatively low sample size—including for the stratified race analysis of NPHI patients—significantly limits statistical power and the ability to appreciate many of the other associations which may exist within the IIH populations. Additionally, while this study utilized the modified Dandy criteria for IIH diagnosis, there is no international consensus for a gold-standard diagnostic protocol. Moreover, the accuracy of certain variables may be influenced by recall bias, such as recent weight gain, regular exercise, headache characterization, smoking history, drug use, and alcohol consumption. Finally, ICD codes themselves are susceptible to administrative errors in data input, which could yield in omitted patients.

5. Conclusion

The investigation identified several unique associations amongst IIH patients (Tables 7 and 8). Racial disparities were recognized, in that NHPI, NAAN, and Blacks were all disproportionately affected by IIH, with Asians at reduced odds. Additionally, the consistent correlation with lower socioeconomic status and cardiovascular risk factors (i.e., obesity, active smoking, hypertension, peripheral vascular disease) emphasize IIH patients are a vulnerable population, who may not have the means to follow-up with resource-intensive treatments. In particular, NHPI patients were found to have a much stronger association with lower socioeconomic status and smoking, relative to Whites, as well as exhibit a possible association with seizures. Meanwhile, when examining the clinical presentation, IIH headaches were found to be distinguished from migraines by occurring predominantly in the occipital region, greater than 15 days per month, exacerbated by postural changes, and linked with tinnitus, dizziness, and loss of functionality. In summary, by better characterizing IIH and recognizing the disparities within the disorder, these results not only may help expedite diagnosis, but also improve the quality of life for subsets of the IIH population.

Declarations

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CRediT authorship contribution statement

Frances Tiffany Cava Morden: Conceptualization, Methodology, Software, Validation, Data curation, Writing – original draft, Writing – reviewing & editing. Charissa Tan: Conceptualization, Methodology, Software, Validation, Data curation. Jason Viereck: Validation, Resources, Writing – reviewing & editing. Korei Kai Liow: Validation, Resources, Writing – reviewing & editing. Enrique Carrazana: Validation, Resources, Writing – reviewing & editing. Arash Ghaffari-Rafi: Conceptualization, Methodology, Software, Validation, Investigation, Writing – original draft, Writing – reviewing & editing.

Conflicts of interest/Competing interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Table 7
Summary of variables associated with idiopathic intracranial hypertension compared to general controls and ischemic stroke. *Variables determined to be statistically significant after multivariable analysis. Variables with marginal significance (p < 0.1) also presented, as low sample size likely limited attainment of significance.

Table 8
Summary of headache variables associated with idiopathic intracranial hypertension relative to migraines.
Code availability
Software application or custom code: Not applicable.

Authors’ contributions
AGR, FTCM, CT, EC, JV, KKL: Manuscript approval/editing.

Ethics approval
Institutional review board exemption; University of Hawai’i at Mānoa, Office of Research Compliance (protocol number: 2020-01010).

Consent to participate
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Consent for publication
All authors approved the submitted manuscript version.

Availability of data and material (data transparency)
The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

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