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Research Article

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Posted Date: November 19th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11434743/v1

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Additional Declarations: No competing interests reported.

Nationwide Patterns, Geographic Distribution, and Altitude-Related Variation in Vertigo and Dizziness Consultations in Ecuador

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Abstract

Background. Vertigo and dizziness are common reasons for outpatient consultation, but nationwide evidence on related healthcare utilization in Ecuador is limited.

Aims. To characterize demographic, temporal, diagnostic, and geographic consultation patterns within the Ministry of Public Health (MSP) network and examine their ecological association with elevation.

Methods. We analyzed PRAS outpatient records from 2021–2024 with a primary diagnosis of benign paroxysmal positional vertigo (BPPV; H81.1), vestibular neuronitis (H81.2), central vertigo (H81.4), or dizziness and giddiness (R42). Crude rates per 100,000 population used official population projections; average annual rates (AARs) represented the mean of four annual rates. Canton-level negative binomial models examined elevation associations, adjusting for geographic and population characteristics.

Results. We identified 64,007 consultations (AAR, 88.2 per 100,000). R42 accounted for 68.5% and BPPV for 27.1%; 47.9% of diagnoses were presumptive. Women had higher rates than men (118.9 vs 56.9; rate ratio, 2.09), with the largest female-to-male rate ratio at ages 20–24 years. The highest age-specific AAR occurred at ≥80 years (328.2). The national rate increased by 39.6% between 2021 and 2024. Regional AARs were highest in the Amazon and Galápagos, whereas Guayas had the lowest provincial AAR. Canton-level rates were inversely associated with population size. Adjusted analyses provided no clear evidence of an elevation association (rate ratio per 1,000 m, 1.07; 95% CI, 0.96–1.20).

Conclusions. Recorded consultations within the MSP network increased during 2021–2024 and varied substantially by age, sex, and geography. Symptom-based coding and presumptive diagnoses limited etiological characterization. These findings describe service utilization rather than disease frequency and provide a baseline for strengthening targeted clinical assessment, documentation, and health-service planning.

Keywords: vertigo; dizziness; benign paroxysmal positional vertigo; vestibular diseases; health services; epidemiology; Ecuador; altitude.

Introduction

Vertigo and dizziness are symptoms that may occur across a broad spectrum of peripheral vestibular, central neurological, cardiovascular, metabolic, and psychological disorders. Their etiological assessment relies on medical history and targeted clinical examination, including positional tests when benign paroxysmal positional vertigo (BPPV) is suspected [1,2]. BPPV is the most common peripheral vestibular disorder and results from the displacement of otoconia into the semicircular canals; diagnosis is established using positional maneuvers, such as the Dix–Hallpike and supine roll tests [3]. Other causes of vestibular symptoms include vestibular neuritis, Ménière's disease, and vestibular migraine, while the differential diagnosis also encompasses central disorders, such as cerebrovascular disease [4–6]. The diversity of underlying mechanisms is summarized in Figure 1. In healthcare records, these consultations may be documented using specific diagnoses or symptom-based categories, such as "dizziness and giddiness" (ICD-10 R42), which alone do not identify a specific etiology [7,8].

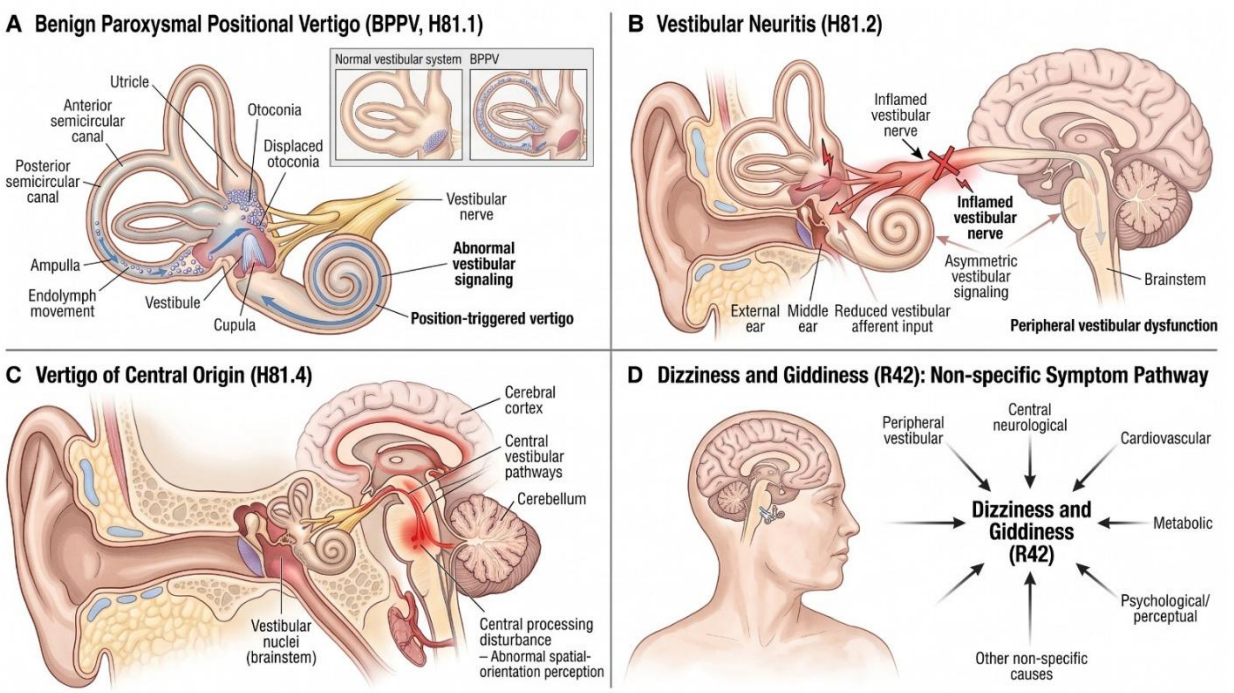


Figure 1. *Pathophysiological mechanisms underlying vertigo and dizziness. (A) Benign paroxysmal positional vertigo (BPPV) results from displacement of otoconia from the utricle into a semicircular canal, most commonly the posterior canal. Head movement causes abnormal otoconial displacement within the endolymph, producing inappropriate cupular deflection and transient vestibular signaling that generates positional vertigo and nystagmus. (B) Vestibular neuronitis is characterized by acute unilateral dysfunction of the vestibular nerve, resulting in asymmetric afferent*

input between the two vestibular systems and a mismatch in central vestibular processing. (C) Vertigo of central origin arises from dysfunction within central vestibular pathways, including the vestibular nuclei, brainstem, and cerebellum, despite preserved peripheral labyrinthine input. (D) Dizziness and giddiness represent a non-specific symptom complex that may originate from peripheral vestibular, central neurological, cardiovascular, metabolic, or psychological mechanisms rather than from a single defined disease process.

Epidemiological evidence indicates that the frequency of BPPV varies by age, study population, and case identification method. In a population-based study conducted in Germany, lifetime prevalence was 2.4%, and annual prevalence was 1.6% [9,10], Estimates ranging from 4% to 11% have been reported among older adults in Sweden [11], whereas 23.9% of a Brazilian sample of community-dwelling adults aged 60 years or older tested positive when the Dix–Hallpike maneuver was systematically administered [12]. These estimates reflect different populations and diagnostic procedures and should not be interpreted as direct comparisons between countries. Studies involving individuals with dizziness or patients hospitalized following falls have also identified a substantial proportion of BPPV, although their findings pertain to clinically selected groups [8,13]. Clinical cohorts also describe a female predominance and increasing frequency with age [14]. In primary care, BPPV is an important vestibular diagnosis, but it coexists with a substantial proportion of consultations recorded as nonspecific dizziness [15,16].

Population prevalence estimates and findings from clinical samples provide information on the frequency of these disorders but do not directly describe the volume or distribution of consultations within health services. Analyses of healthcare records can complement this evidence by characterizing utilization patterns and the diagnostic composition of consultations, provided that recorded encounters, individual patients, and disease episodes are distinguished. In Latin America, population-based evidence on BPPV and other vestibular disorders remains limited, and the available literature is concentrated primarily in Brazil, Mexico, Argentina, and Chile [12,17–20]. In Ecuador, we identified no nationwide studies that jointly described consultation rates, demographic patterns, and the geographical distribution of care for vertigo and dizziness.

This gap is particularly relevant given Ecuador's regional and altitudinal diversity and the coexistence of multiple health subsystems. PRAS outpatient consultation records allow the examination of care provided by the Ministry of Public Health (MSP) network, although they do

not represent all healthcare services in the country. Using these records and official population projections, this study aimed to characterize the temporal, demographic, diagnostic, and geographical patterns of consultations recorded under codes H81.1, H81.2, H81.4, and R42 during 2021–2024. As a secondary objective, we examined the ecological association between consultation rates and the altitude of the canton of residence.

Methods

Study design

We conducted a nationwide descriptive study of consultation-level administrative data, with secondary ecological analyses of geographic and elevation-related variation. The unit of observation was an outpatient consultation, not an individual patient or incident disease episode. Because PRAS does not contain a persistent patient identifier, outcomes were expressed as consultation counts and population-based consultation rates rather than estimates of disease incidence or prevalence. Demographic and temporal analyses were descriptive, whereas comparisons across regions, provinces, cantons, and altitude bands were ecological. The study was reported in accordance with the STROBE recommendations for observational research (supplementary material) [21].

Setting and data source

Ecuador has approximately 18.5 million inhabitants and is organized into 24 provinces and 221 cantons across four natural regions: Coastal, Highland, Amazon, and Insular. The Ministry of Public Health (MSP) operates the country's largest public healthcare network [22]. PRAS records outpatient consultations delivered within MSP facilities, including consultation date, patient demographics, nationality, ethnic self-identification, priority-group status, consultation type, province and canton of residence, and up to three ICD-10 diagnoses with diagnostic status. Consultations provided by the Ecuadorian Social Security Institute (IESS), military and police health services, and private providers are not captured in PRAS. We included all eligible records registered between 1 January 2021 and 31 December 2024.

Study population

A total of 64,007 outpatient consultations met the study inclusion criteria. We included encounters with a primary diagnosis of benign paroxysmal positional vertigo (ICD-10 H81.1), vestibular neuronitis (H81.2), vertigo of central origin (H81.4), or dizziness and giddiness (R42). The three H81 codes were grouped as vestibular vertigo syndromes and compared with the symptom category R42. Ménière disease (H81.0), other peripheral vertigo (H81.3), unspecified vestibular-function disorders (H81.8–H81.9), vertiginous syndromes in diseases classified elsewhere (H82), and other inner-ear diseases (H83) were not included in the data extraction and therefore fall outside the scope of this analysis. All age groups were included.

Variables

Variables extracted were year of attention; sex (female, male, intersex); age in completed years, grouped into 18 categories (<1, 1–4, 5–9, 10–14, 15–19, 20–24, 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, ≥80 years) and three broad life-course groups (0–14, 15–64, ≥65 years); nationality (Ecuadorian, foreign); self-identified ethnicity, recoded from the original PRAS field into Mestizo, Indigenous, Montubio, Afro-Ecuadorian (Afro-Ecuadorian/Afro-descendant and Black categories combined), White, Mulatto, not applicable (used for foreign nationals) and other/unknown; membership of priority groups (persons with disability, persons deprived of liberty, pregnant women, catastrophic and rare diseases and other categories, as registered in PRAS); province and canton of residence, from which natural region and altitude band were assigned; type of consultation (first or subsequent); diagnostic status; and the four-character ICD-10 code.

Population denominators

Annual populations at risk for 2021–2024 were obtained from the official projections of the National Institute of Statistics and Censuses (INEC), based on the 2010 Population and Housing Census, by year, sex and 18 age groups at provincial level and by year at canton level [23]. National denominators (17,751,277 in 2021 to 18,460,936 in 2024) equal the sum of the sex- and age-specific provincial projections. Regional denominators were obtained by summing the provincial projections of member provinces for each year, and altitude-band denominators by summing the canton projections of member cantons; the Insular region corresponds to the province of

Galápagos. Canton denominators missing for single years in three cantons and one canton with an inconsistent value were completed by linear interpolation between adjacent years; canton-level projections for three cantons of Guayas absent from the primary file were taken from the INEC canton projection series. Canton-by-sex projections are not published; for the cartographic representation of canton rates by sex, sex-specific canton denominators were approximated by multiplying each canton's annual population by the corresponding provincial sex proportion from the INEC provincial projections for the same year.

Altitude classification

Cantons were classified into four altitude bands using the research group's canton reference table: low (<1,500 m), moderate (1,500–2,500 m), high (2,500–3,500 m), and very high (>3,500 m). Because individual residential elevation was unavailable and cantons can span wide elevation ranges, altitude bands were treated as ecological geographic characteristics rather than individual exposures. Mean canton elevation from the same reference table was used as a continuous variable in regression models.

Rate calculations

For every stratum (year × sex × age group × geographic unit × diagnostic group), the annual consultation rate was computed as the number of consultations divided by the corresponding population at risk for the same year, sex, age group and geographic unit, expressed per 100,000 population. The primary summary measure was the average annual rate (AAR) for 2021–2024, defined as the arithmetic mean of the four annual rates. As a sensitivity measure, the pooled population-time rate (total consultations divided by the sum of the four annual populations, per 100,000) was also computed and compared with the AAR. Sex-specific rates used sex-specific denominators, and the female-to-male rate ratio was computed as the ratio of the sex-specific AARs. Age–sex-specific AARs were derived from year × age × sex rates. Temporal change was quantified as the absolute (rate 2024 minus rate 2021) and relative (percentage) change in the annual rate. The single consultation registered with intersex sex was retained in totals and excluded from sex-specific rates. Consultations without a registered canton of residence were retained in national, sex, age and diagnostic analyses and excluded from geographic and altitude analyses. Ethnicity-specific rates were computed only for categories with an INEC group denominator; the

Afro-Ecuadorian denominator, available for 2021 only, was projected to 2022–2024 using the national growth ratio and is flagged as approximate.

Geographic and ecological analysis

Consultations were analyzed sequentially by natural region, province and canton of residence, reporting absolute counts and crude average annual consultation rates per 100,000 residents. Canton rates based on populations below 5,000 in any year or on fewer than five consultations were flagged as unstable. To examine whether canton rates varied with elevation independently of region and population size, we fitted negative-binomial regression models to the four-year canton consultation counts with the logarithm of the four-year person-time as offset. Models included mean canton elevation (per 1,000 m) or altitude band, natural region, the logarithm of mean canton population, and, in a further model, province fixed effects; a sensitivity model excluded unstable cantons. Results are reported as rate ratios with 95% confidence intervals. The Spearman rank correlation between mean elevation and canton AAR was computed among stable cantons. These analyses are ecological and describe associations between canton characteristics and consultation rates; they do not estimate individual-level effects. Canton AARs by sex were mapped using the 2024 cantonal boundaries of the official territorial organization (DPA) of Ecuador, joined by canton name within province; classes were common to both sexes.

Statistical analysis

Descriptive analyses summarize counts, percentages, annual rates, AARs, pooled population-time rates, rate ratios, and temporal changes. All descriptive outputs were generated from a master analytical dataset containing the relevant combinations of year, geographic unit, altitude band, sex, age group, ICD-10 code, consultation type, consultation count, and population denominator. Confidence intervals and hypothesis tests were not applied to descriptive rates. Inferential analyses were restricted to the secondary canton-level negative-binomial models and the Spearman correlation. Analyses were performed in Python 3.12 using pandas and statsmodels, with graphical outputs generated using matplotlib and Prism.

Ethical considerations

The PRAS research framework was approved under project MED.EOP.23.01, and the present analysis was conducted as an approved extension of that project. The study used secondary, de-identified administrative health records; informed-consent requirements were addressed in accordance with the approved protocol.

Artificial intelligence declaration

The authors report the use of generative artificial intelligence tools during the preparation of this manuscript. ChatGPT (OpenAI) was used to assist with language editing, including improvements in writing, semantics, grammar, and typographical corrections. Claude (Anthropic) was used to support data organization, data aggregation, and the development and execution of analytical code in Python and R. Gemini (Google) was used, together with BioRender, to assist in refining the visual presentation of the figures. All AI-assisted outputs were reviewed, verified, and, when necessary, modified by the authors, who take full responsibility for the accuracy, integrity, and final content of the manuscript.

Results

General characteristics

Between 2021 and 2024, 64,007 outpatient consultations with a primary diagnosis coded as H81.1, H81.2, H81.4, or R42 were recorded in Ecuador's Ministry of Public Health (MSP) network. The average annual consultation rate (AAR) was 88.2 per 100,000 population. Women accounted for 43,588 consultations (68.1%), men for 20,418 (31.9%), and one consultation was registered as intersex. Adults aged 15–64 years accounted for 72.1% of consultations, followed by those aged ≥65 years (20.2%) and children and adolescents aged 0–14 years (7.8%). Canton of residence was available for 60,443 consultations (94.4%); the remaining 3,564 (5.6%) were excluded from geographic and altitude analyses (Table 1).

Table 1. General characteristics of vertigo and dizziness consultations (ICD-10 H81.1, H81.2, H81.4, R42), Ecuador public health system, 2021–2024.

Characteristic	Consultations (n)	%	AAR per 100,000
Total consultations	64,007	100.0	88.2
Sex			
Female	43,588	68.1	118.9
Male	20,418	31.9	56.9
Intersex	1	<0.1	—
Age group (years)			
0–14	4,975	7.8	24.9
15–64	46,129	72.1	98.6
≥65	12,903	20.2	223.5
Diagnostic group			
Dizziness and giddiness (R42)	43,868	68.5	60.5
Benign paroxysmal vertigo (H81.1)	17,369	27.1	23.9
Vertigo of central origin (H81.4)	2,618	4.1	3.6
Vestibular neuronitis (H81.2)	152	0.2	0.21
Type of consultation			
First	54,862	85.7	—
Subsequent	9,145	14.3	—
Natural region of residence			
Coastal	28,028	43.8	74.4
Highland	24,590	38.4	80.2
Amazon	7,384	11.5	183.1
Insular (Galápagos)	441	0.7	316.1
Not registered	3,564	5.6	—
Year			
2021	12,483	19.5	70.3
2022	16,253	25.4	90.3
2023	17,144	26.8	94.1
2024	18,127	28.3	98.2

AAR, average annual consultation rate 2021–2024 (mean of the four annual rates), computed with year-, sex-, age- and region-specific INEC population projections. Percentages use all consultations as denominator. Regional rates use the population of residents in each region; consultations without a registered canton of residence are excluded from regional rates. For the year rows the rate is the annual rate. Source: PRAS, Ministry of Public Health of Ecuador; denominators: INEC population projections (2010 census base).

Ecuadorian nationality was recorded in 59,157 consultations (92.4%) and foreign nationality in 4,850 (7.6%). Mestizo was the most frequently recorded ethnic category (77.7%), followed by

Indigenous (4.9%) and Montubio (3.0%). Ethnicity was classified as not applicable in 6.3% of consultations and as other or unknown in 5.8%. A priority-group designation was recorded in 3,798 consultations (5.9%), most commonly disability (2,390; 3.7%) or deprivation of liberty (919; 1.4%). The distributions of these characteristics and administrative consultation categories are presented in Table 2.

Table 2. Type of consultation, diagnostic status, nationality, ethnicity and priority groups among vertigo and dizziness consultations, Ecuador, 2021–2024.

Characteristic	n	%	AAR per 100,000
Type of consultation by diagnosis			
Benign paroxysmal vertigo (H81.1): subsequent	4,498	25.9 of code	—
Dizziness and giddiness (R42): subsequent	3,981	9.1 of code	—
Vertigo of central origin (H81.4): subsequent	602	23.0 of code	—
Vestibular neuronitis (H81.2): subsequent	64	42.1 of code	—
Diagnostic status (all codes)			
Presumptive	30,632	47.9	—
Definitive, initial	26,661	41.7	—
Definitive, control	6,599	10.3	—
Definitive, confirmed by laboratory	115	0.2	—
Nationality			
Ecuadorian	59,157	92.4	—
Foreign	4,850	7.6	—
Self-identified ethnicity			
Mestizo	49,739	77.7	95.4
Indigenous	3,148	4.9	61.8
Montubio	1,936	3.0	60.6
Afro-Ecuadorian	984	1.5	25.6[a]
Mulatto	259	0.4	18.8[b]
White	215	0.3	4.9[b]
Not applicable (foreign nationals)	4,036	6.3	—
Other/unknown	3,690	5.8	—
Priority group			
None registered	60,209	94.1	—
Person with disability	2,390	3.7	—
Deprived of liberty	919	1.4	—
Pregnant	330	0.5	—

Catastrophic and rare diseases	101	0.2	—
Other categories (12)	58	0.1	—

Percentages use all 64,007 consultations as denominator unless stated. AAR, average annual consultation rate 2021–2024 with INEC ethnic-group denominators. [a] Group denominator available for 2021 only; 2022–2024 denominators projected with the national growth ratio (approximate). [b] Rate not interpretable: census-based ethnic denominators for these groups greatly exceed the number of persons self-identifying in these categories at the point of care. Ethnicity recoded from the original PRAS field; Afro-Ecuadorian combines the Afro-Ecuadorian/Afro-descendant and Black categories. Source: PRAS, Ministry of Public Health of Ecuador.

Variation in consultation rates by age and sex

The female AAR was 118.9 per 100,000 population, compared with 56.9 in males, yielding a female-to-male rate ratio of 2.09. Female rates exceeded male rates in each age group below 75 years. The largest difference occurred at 20–24 years, when the female-to-male rate ratio reached 3.34 (124.4 versus 37.3 per 100,000). The ratio subsequently narrowed and reversed at 75–79 years and ≥80 years, when male rates exceeded female rates (Table 3; Figure 2).

Overall rates generally increased with age, with a modest decline in early adulthood followed by a sustained increase across older age groups. The AAR was 2.2 per 100,000 at 1–4 years, 82.8 at 15–19 years, and 328.2 at ≥80 years, the highest rate observed. In contrast, the largest number of consultations occurred at 15–19 years (5,473; 8.6%). Across the broader age categories, the AAR among adults aged ≥65 years was 223.5 per 100,000, compared with 98.6 among those aged 15–64 years and 24.9 among those aged 0–14 years.

Table 3. Consultation counts and average annual consultation rates by age and recorded sex in Ecuador's Ministry of Public Health outpatient network, 2021–2024.

Age group, years	Female, n (%)	Female AAR	Male, n (%)	Male AAR	Total, n (%)	Total AAR	Female-to-male rate ratio
<1	1 (<0.1)	0.2[a]	1 (<0.1)	0.1[a]	2 (<0.1)	0.2[a]	1.05[a]
1–4	67 (0.2)	2.6	48 (0.2)	1.8	115 (0.2)	2.2	1.46
5–9	522 (1.2)	16.0	469 (2.3)	13.8	991 (1.5)	14.9	1.16
10–14	2,381 (5.5)	72.4	1,486 (7.3)	43.2	3,867 (6.0)	57.5	1.68

15–19	3,743 (8.6)	115.9	1,730 (8.5)	51.2	5,473 (8.6)	82.8	2.26
20–24	3,819 (8.8)	124.4	1,184 (5.8)	37.3	5,003 (7.8)	80.1	3.34
25–29	3,532 (8.1)	122.5	1,097 (5.4)	37.5	4,629 (7.2)	79.7	3.27
30–34	3,471 (8.0)	128.9	1,129 (5.5)	42.3	4,601 (7.2)[b]	85.8	3.05
35–39	3,475 (8.0)	137.7	1,200 (5.9)	49.3	4,675 (7.3)	94.3	2.79
40–44	3,453 (7.9)	146.9	1,176 (5.8)	53.7	4,629 (7.2)	101.9	2.73
45–49	3,276 (7.5)	154.7	1,200 (5.9)	62.1	4,476 (7.0)	110.6	2.49
50–54	3,058 (7.0)	164.6	1,282 (6.3)	76.2	4,340 (6.8)	122.6	2.16
55–59	3,018 (6.9)	186.7	1,390 (6.8)	95.5	4,408 (6.9)	143.5	1.95
60–64	2,493 (5.7)	182.5	1,402 (6.9)	115.4	3,895 (6.1)	150.9	1.58
65–69	2,122 (4.9)	193.6	1,383 (6.8)	144.8	3,505 (5.5)	170.9	1.34
70–74	1,762 (4.0)	211.2	1,286 (6.3)	183.3	3,048 (4.8)	198.4	1.15
75–79	1,462 (3.4)	246.9	1,218 (6.0)	256.6	2,680 (4.2)	251.2	0.96
≥80	1,933 (4.4)	302.7	1,737 (8.5)	361.8	3,670 (5.7)	328.2	0.84
Total	43,588 (100.0)	118.9	20,418 (100.0)	56.9	64,007 (100.0)	88.2	2.09

Notes: AAR, average annual consultation rate per 100,000 population, calculated as the arithmetic mean of the annual rates for 2021–2024 using the corresponding year-, age-, and sex-specific INEC population denominators. Counts represent consultations, not unique individuals. Percentages in the female and male columns use 43,588 and 20,418 consultations as denominators, respectively; percentages in the total column use 64,007. Percentages may not sum to 100% because of rounding. Female-to-male rate ratios represent the ratio of sex-specific AARs.

[a] Based on two consultations (one female, one male); rates and the rate ratio are shown for completeness and are not interpretable. [b] Includes one consultation registered as intersex, retained in totals but excluded from female- and male-specific calculations.

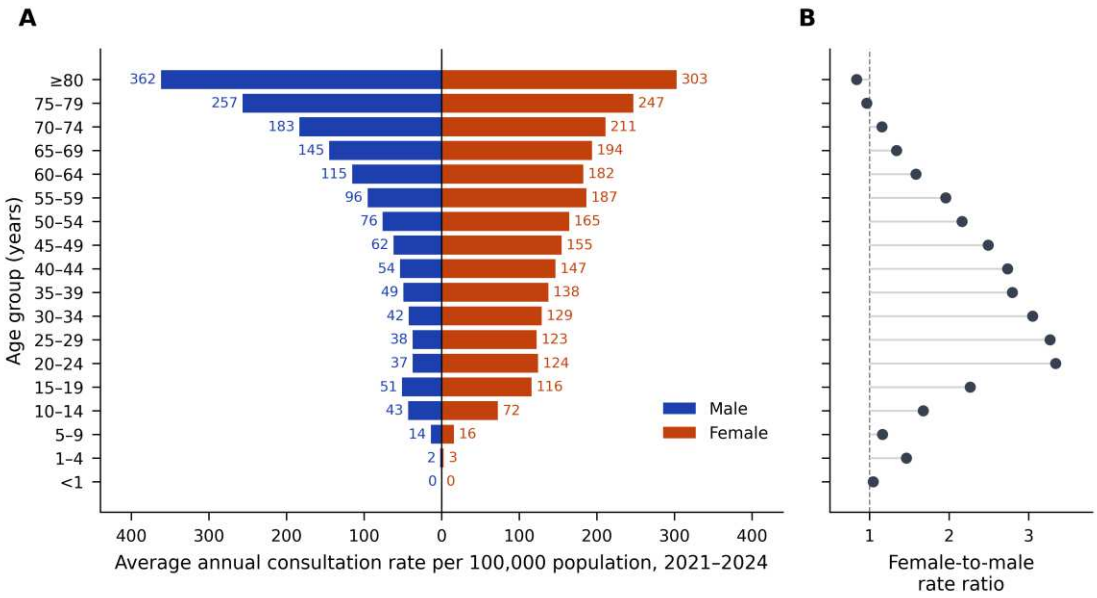
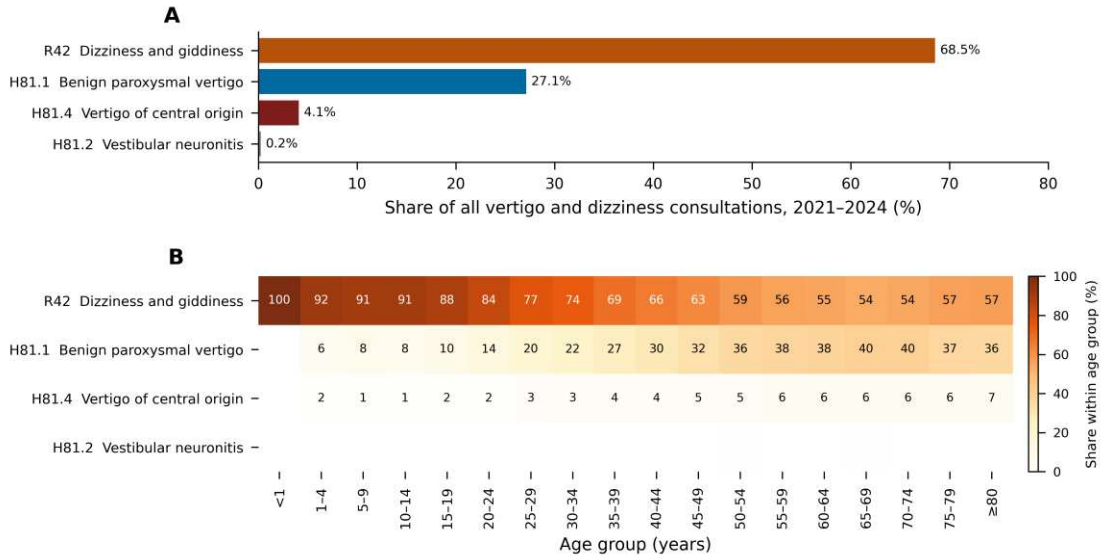


Figure 2. Age- and sex-specific average annual consultation rates for vertigo and dizziness (ICD-10 H81.1, H81.2, H81.4, R42) in Ecuador's public health system, 2021–2024. (A) Rate pyramid of average annual consultation rates per 100,000 population by 18 age groups for men (left, blue) and women (right, orange); numbers indicate the rate. (B) Female-to-male rate ratio by age group; the dashed line marks a ratio of 1. Rates are the mean of the annual rates for 2021–2024, each computed with the corresponding year-, sex- and age-specific INEC population projection. Abbreviations: AAR, average annual rate.

Diagnostic composition and characteristics of care

Dizziness and giddiness (R42) accounted for 43,868 consultations (68.5%), followed by benign paroxysmal positional vertigo (BPPV; H81.1) with 17,369 (27.1%), vertigo of central origin (H81.4) with 2,618 (4.1%), and vestibular neuronitis (H81.2) with 152 (0.2%). Together, the three selected H81 diagnoses accounted for 20,139 consultations (31.5%).

Diagnostic composition varied across age groups. R42 accounted for 90.8% of consultations at 10–14 years and 88.5% at 15–19 years, compared with 56.6% at ≥80 years. Conversely, the proportion coded as BPPV was 9.9% at 15–19 years, 39.7% at 65–69 years, and 36.5% at ≥80 years (Figure 3).



295

296 **Figure 3.** Distribution of ICD-10 codes among vertigo and dizziness consultations in Ecuador's
297 public health system, 2021–2024. (A) Share of each four-character code among all 64,007
298 consultations. (B) Share of each code within each 18-level age group (column percentages); cell
299 values are percentages and cells with values below 1% are unlabelled. R42, dizziness and
300 giddiness; H81.1, benign paroxysmal vertigo; H81.4, vertigo of central origin; H81.2, vestibular
301 neuronitis. Source: PRAS, Ministry of Public Health of Ecuador.

302

303 Age-specific consultation rates also varied by diagnosis. The AAR for R42 was 73.3 per 100,000
304 at 15–19 years and reached 186.0 at ≥80 years. Rates for BPPV and vertigo of central origin were
305 also higher in older age groups (Figure 4A). Female rates exceeded male rates in all four diagnostic
306 categories. For BPPV, the AARs were 33.1 and 14.6 per 100,000 in females and males,
307 respectively; corresponding rates were 81.0 and 39.6 for R42 and 4.6 and 2.6 for vertigo of central
308 origin (Figure 4B).

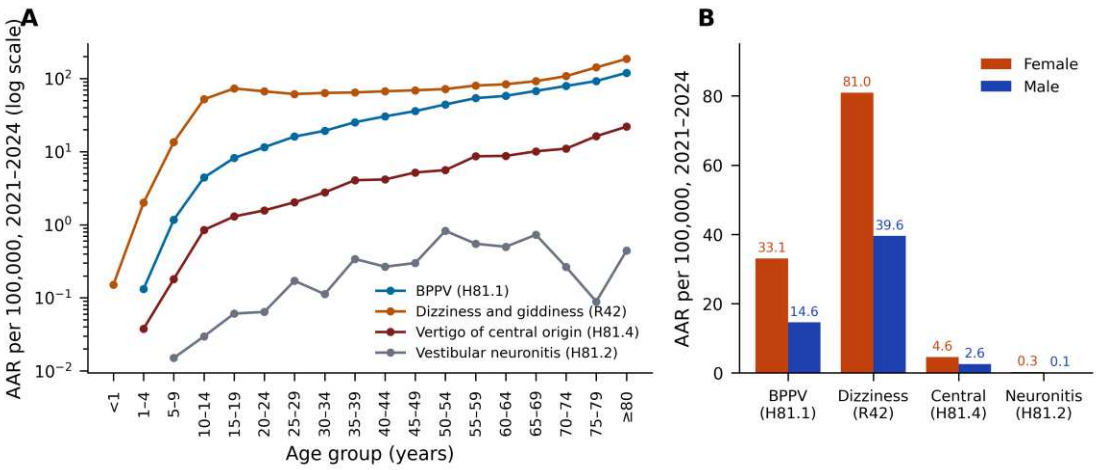


Figure 4. Average annual consultation rates by diagnostic code, age and sex, Ecuador, 2021–2024. (A) Age-specific average annual consultation rates per 100,000 population (logarithmic scale) for each ICD-10 code; age groups with zero consultations are not plotted. (B) Sex-specific average annual consultation rates per 100,000 by code, computed with sex-specific INEC denominators; numbers indicate the rate. BPPV, benign paroxysmal positional vertigo; AAR, average annual rate.

Overall, 54,862 consultations (85.7%) were recorded as first consultations and 9,145 (14.3%) as subsequent consultations. The proportion recorded as subsequent increased across the broad age groups, from 7.4% at 0–14 years to 13.2% at 15–64 years and 20.8% at ≥65 years. This proportion also differed by diagnostic code: 42.1% for vestibular neuronitis, 25.9% for BPPV, 23.0% for vertigo of central origin, and 9.1% for R42 (Table 2).

Diagnostic status was recorded as presumptive in 30,632 consultations (47.9%), definitive initial in 26,661 (41.7%), definitive control in 6,599 (10.3%), and definitive confirmed by laboratory in 115 (0.2%). The proportion registered as presumptive was 49.1% for R42, 43.1% for BPPV, and 59.1% for vertigo of central origin.

Temporal variation in consultation rates

The annual consultation rate increased from 70.3 per 100,000 population in 2021 to 90.3 in 2022, 94.1 in 2023, and 98.2 in 2024. The absolute increase between 2021 and 2024 was 27.9 per

100,000, corresponding to a relative increase of 39.6%. The largest year-to-year increase occurred between 2021 and 2022 (+28.5%), with smaller increases thereafter. The pooled population-time rate for the four-year period was 88.4 per 100,000, compared with an AAR of 88.2 (Table 4).

The relative increase between 2021 and 2024 was greater in males (+45.4%; 45.2 to 65.7 per 100,000) than in females (+36.9%; 94.9 to 130.0). Across age groups, the largest relative increase occurred among children and adolescents aged 0–14 years (+130.0%; 13.1 to 30.2 per 100,000), compared with 31.4% among adults aged 15–64 years and 34.4% among those aged ≥65 years. By diagnosis, consultation rates increased by 43.1% for R42, 29.3% for BPPV, and 58.2% for vertigo of central origin. Rates for vestibular neuronitis remained approximately 0.2 per 100,000 annually. The proportion of consultations recorded as subsequent varied little over the period, ranging from 14.0% to 14.6%.

Table 4. Annual consultations, population and consultation rates for vertigo and dizziness by year and sex, Ecuador, 2021–2024.

Year	N	Population	Rate	Female n	Female rate	Male n	Male rate	First	Subsequent	Subseq. %
2021	12,483	17,751,277	70.3	8,514	94.9	3,969	45.2	10,708	1,775	14.2
2022	16,253	17,989,912	90.3	11,117	122.3	5,135	57.7	13,970	2,283	14.0
2023	17,144	18,226,512	94.1	11,829	128.4	5,315	58.9	14,648	2,496	14.6
2024	18,127	18,460,936	98.2	12,128	130.0	5,999	65.7	15,536	2,591	14.3
AAR 2021–2024	64,007	18,107,159	88.2	43,588	118.9	20,418	56.9	54,862	9,145	14.3
Pooled rate	—	72,428,637 person-years	88.4	—	119.1	—	57.0	—	—	—
Absolute change 2021→2024	—	—	27.9	—	35.1	—	20.5	—	—	—
Relative change 2021→2024 (%)	—	—	39.6	—	36.9	—	45.4	—	—	—

Rates per 100,000 population use year-specific (and sex-specific) INEC projections. AAR, mean of the four annual rates (population shown is the mean of the four annual denominators); pooled rate, total consultations divided by the sum of the four annual populations. Source: PRAS, Ministry of Public Health of Ecuador.

Geographic distribution

Among consultations with a recorded canton of residence, the Coastal region accounted for the largest proportion (46.4%), followed by the Highland (40.7%), Amazon (12.2%), and Insular regions (0.7%). The distribution of rates differed from that of consultation counts. The highest regional AAR was observed in Galápagos (316.1 per 100,000), followed by the Amazon region (183.1), compared with 80.2 in the Highland and 74.4 in the Coastal region. Between 2021 and 2024, rates increased by 61.6% in the Amazon, 44.5% in the Highland, and 29.6% in the Coastal region, while changing little in Galápagos (331.7 to 330.6 per 100,000).

At the provincial level, Manabí, Pichincha, and Guayas together accounted for 42.6% of consultations with a recorded canton of residence. Their AARs nevertheless differed substantially: 150.5 per 100,000 in Manabí, 68.9 in Pichincha, and 37.9 in Guayas. The highest provincial rates occurred in Galápagos (316.1), Morona Santiago (248.1), Napo (207.5), and Sucumbíos (201.5), whereas Guayas had the lowest rate. The ratio between the highest and lowest provincial AARs was 8.3. The largest relative increases between 2021 and 2024 occurred in Orellana (+129.5%) and Morona Santiago (+87.8%) (Table 5; Supplementary Figure S1).

Table 5. Regional and provincial distribution of vertigo and dizziness consultations and average annual consultation rates, Ecuador, 2021–2024 (canton of residence).

Region / province	Region	n	%	2021 rate	2024 rate	AAR	Δ 2021–2024 (%)	AAR rank	n rank
Coastal region		28,028	46.4	63.3	82.0	74.4	30		
Highland region		24,590	40.7	64.3	92.9	80.2	45		
Amazon region		7,384	12.2	136.4	220.5	183.1	62		
Insular region (Galápagos)		441	0.7	331.7	330.6	316.1	-0		
Provinces									
Galápagos	Insular	441	0.7	331.7	330.6	316.1	-0	1	24
Morona Santiago	Amazon	2,063	3.4	165.9	311.6	248.1	88	2	10
Napo	Amazon	1,169	1.9	179.6	230.3	207.5	28	3	17
Sucumbíos	Amazon	1,967	3.3	168.1	248.9	201.5	48	4	11
Manabí	Coastal	9,580	15.8	131.8	167.6	150.5	27	5	1
Carchi	Highland	1,079	1.8	133.9	154.3	141.9	15	6	20
Orellana	Amazon	913	1.5	77.9	178.7	137.5	130	7	21
Bolívar	Highland	1,148	1.9	111.6	164.2	134.3	47	8	18

Pastaza	Amazon	637	1.1	93.0	118.9	130.7	28	9	22
Zamora Chinchipe	Amazon	635	1.1	98.4	158.0	124.8	60	10	23
El Oro	Coastal	3,403	5.6	95.3	135.4	115.3	42	11	4
Imbabura	Highland	2,196	3.6	81.3	137.2	111.5	69	12	9
Esmeraldas	Coastal	2,729	4.5	79.8	117.9	102.6	48	13	5
Cañar	Highland	1,126	1.9	80.1	93.8	96.1	17	14	19
Tungurahua	Highland	2,244	3.7	77.9	107.7	92.4	38	15	8
Cotopaxi	Highland	1,655	2.7	62.1	109.7	81.9	77	16	12
Santo Domingo de los Tsáchilas	Coastal	1,525	2.5	57.2	90.7	79.6	58	17	14
Loja	Highland	1,651	2.7	70.2	86.3	77.4	23	18	13
Azuay	Highland	2,689	4.4	55.5	77.1	73.2	39	19	7
Santa Elena	Coastal	1,210	2.0	54.2	74.1	71.4	37	20	16
Los Ríos	Coastal	2,700	4.5	58.0	76.2	71.1	31	21	6
Chimborazo	Highland	1,491	2.5	50.0	89.1	69.7	78	22	15
Pichincha	Highland	9,311	15.4	54.9	79.2	68.9	44	23	2
Guayas	Coastal	6,881	11.4	34.5	40.0	37.9	16	24	3
Residence not registered		3,564	—	—	—	—	—		

Rates per 100,000 population with year- and province-specific INEC projections; regional denominators are the sums of member provinces. Percentages use the 60,443 consultations with a registered canton of residence as denominator. AAR, average annual consultation rate 2021–2024. Source: PRAS, Ministry of Public Health of Ecuador.

Consultation rates were available for all 221 cantons. Fourteen cantons had populations below 5,000 in at least one study year and were excluded from the ranking based on the population threshold. Across all cantons, the median AAR was 112.5 per 100,000, with an interquartile range of 72.3–180.6. Quito and Guayaquil together accounted for 19.2% of consultations with a recorded canton of residence, with AARs of 66.2 and 35.1 per 100,000, respectively. Portoviejo combined a relatively large consultation count (2,606) with an AAR of 198.7.

Among cantons retained in the ranking, the highest AARs occurred in Santiago, Morona Santiago (508.3 per 100,000), and Palora, Morona Santiago (497.1), whereas the lowest occurred in Daule, Guayas (21.6). Ten of the 20 highest-ranking cantons were in the Amazon region, six in the Coastal region, three in the Highland region, and one in Galápagos (Supplementary Table S1). The female predominance was geographically consistent: the female AAR exceeded the male AAR in 219 of 221 cantons, and among the 204 cantons with stable estimates for both sexes the median female-

to-male rate ratio was 2.14 (interquartile range 1.78–2.54). Thirty cantons had female AARs of 300 per 100,000 or higher, compared with four cantons for males, with the highest female rates in Palora (762.0), Santiago (711.4), and San Vicente (612.0) (Figure 5).

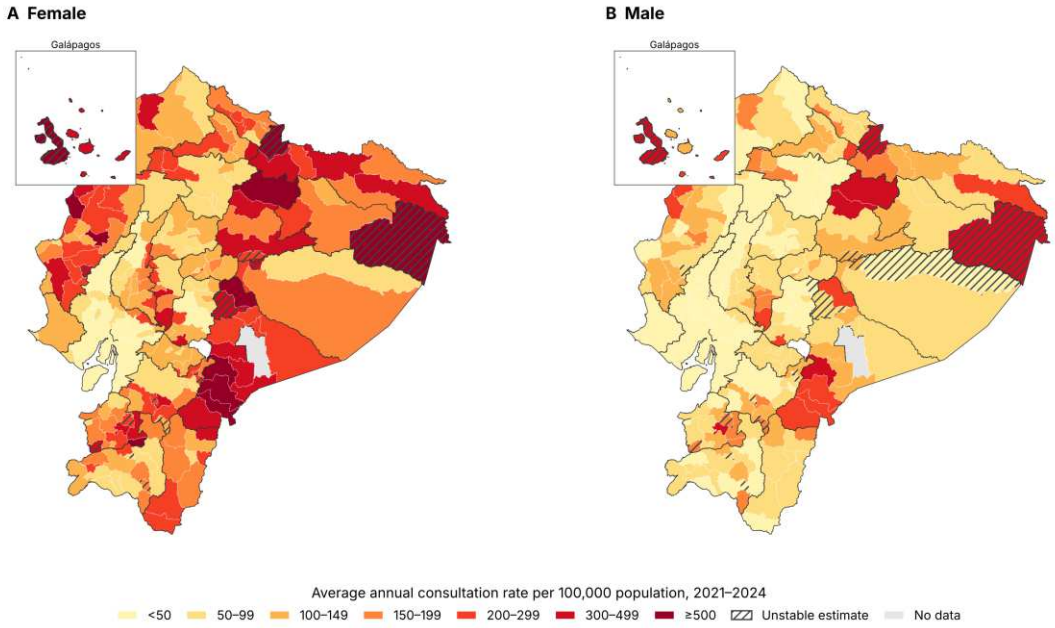


Figure 5. Canton-level average annual consultation rates for vertigo and dizziness (ICD-10 H81.1, H81.2, H81.4, R42) by sex, Ecuador, 2021–2024. (A) Women; (B) men. Average annual rate per 100,000 population (mean of the 2021–2024 annual rates) by canton of residence, with Galápagos shown in the inset; class intervals are identical in both panels and province boundaries are outlined. Sex-specific canton denominators were approximated as the canton INEC population projection multiplied by the provincial sex proportion for each year. Hatched cantons have unstable estimates (population below 5,000 in any year or fewer than five consultations for that sex); the canton shown in grey (Sevilla Don Bosco, created in 2024) has no consultation or population data. Consultations without a registered canton of residence (n = 3,564) are excluded. Boundaries: 2024 cantonal DPA, Ecuador.

Canton altitude and consultation rates

Of the 60,443 consultations with a recorded canton of residence, 61.5% corresponded to cantons classified in the low-altitude band, 8.9% in the moderate band, 28.3% in the high band, and 1.3%

in the very-high band. The corresponding AARs were 87.1, 76.4, 80.5, and 69.5 per 100,000, respectively, with no monotonic pattern across altitude bands (Table 6; Figure 6).

Diagnosis-specific patterns differed. The BPPV AAR was highest in the high-altitude band (27.7 per 100,000), whereas the R42 AAR was highest in the low-altitude band (63.3). Rates for vertigo of central origin ranged from 2.9 per 100,000 in the low-altitude band to 4.8 in the very-high band. Between 2021 and 2024, overall consultation rates increased in the low, moderate, and high bands and changed little in the very-high band.

Table 6. Vertigo and dizziness consultations and average annual consultation rates by altitude band of the canton of residence, Ecuador, 2021–2024.

Altitude band	Elevation (m)	Cantons	n	%	Mean population	2021	2024	AAR	BPPV	R42	Central	Neuronitis
Low	<1,500	141	37,164	61.5	10,651,963	72.6	98.1	87.1	20.8	63.3	2.9	0.14
Moderate	1,500–2,500	27	5,396	8.9	1,761,121	58.3	88.7	76.4	22.5	49.8	4.0	0.18
High	2,500–3,500	45	17,110	28.3	5,305,158	64.2	93.6	80.5	27.7	48.1	4.3	0.34
Very high	>3,500	8	773	1.3	277,919	65.3	64.6	69.5	15.7	48.9	4.8	0.18

Band denominators are the sums of the annual populations of member cantons. Ecological analysis; rates describe residents of cantons in each band, not individual exposure. Bands from the research group's canton altitude reference table. AAR, average annual consultation rate per 100,000, 2021–2024. Source: PRAS, Ministry of Public Health of Ecuador.

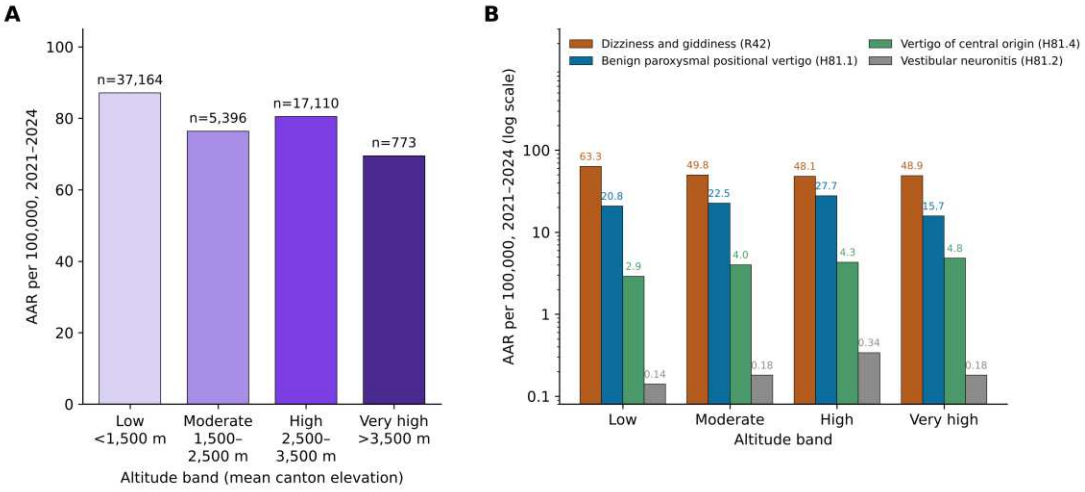


Figure 6. Average annual consultation rates for vertigo and dizziness by altitude band of the canton of residence, Ecuador, 2021–2024. (A) All codes combined; numbers above bars are total consultations 2021–2024. (B) Rates by diagnostic code: dizziness and giddiness (R42), benign paroxysmal positional vertigo (H81.1), vertigo of central origin (H81.4) and vestibular neuronitis (H81.2); the vertical axis is logarithmic and numbers indicate the rate. Rates per 100,000 population are means of the 2021–2024 annual rates, each with band-specific denominators obtained by summing the INEC projections of member cantons. Consultations without a registered canton of residence (n = 3,564) are excluded. AAR, average annual rate.

In the principal canton-level negative-binomial model, adjusted for natural region and population size, the rate ratio per 1,000-m increase in elevation was 1.07 (95% CI 0.96–1.20). The adjusted estimates did not provide clear evidence of an association between elevation and recorded consultation rates. Compared with the low-altitude band, adjusted rate ratios were 1.23 (95% CI 0.92–1.62) for the moderate band, 1.12 (0.84–1.48) for the high band, and 0.97 (0.62–1.51) for the very-high band (Supplementary Table S2; Figure 7).

In the principal model, canton-level consultation rates were higher in the Amazon region (RR 1.45; 95% CI 1.16–1.80) and Galápagos (RR 2.34; 95% CI 1.25–4.40) than in the Coastal region. The estimate for the Highland region was 0.79 (95% CI 0.60–1.05). Larger canton population size was associated with lower consultation rates, with an RR of 0.79 (95% CI 0.74–0.84) per one-unit increase in the natural logarithm of mean population, equivalent to an RR of approximately 0.85 for a doubling of population.

The elevation estimate was 1.04 (95% CI 0.93–1.16) in the model incorporating province fixed effects and 1.09 (0.97–1.22) after excluding cantons classified as unstable. In the latter analysis, the estimate for Galápagos was less precise and its confidence interval included the null (RR 1.93; 95% CI 0.89–4.16). Among the 207 retained cantons, the unadjusted Spearman correlation between elevation and AAR was weakly positive ($\rho = 0.18$; $p = 0.010$).

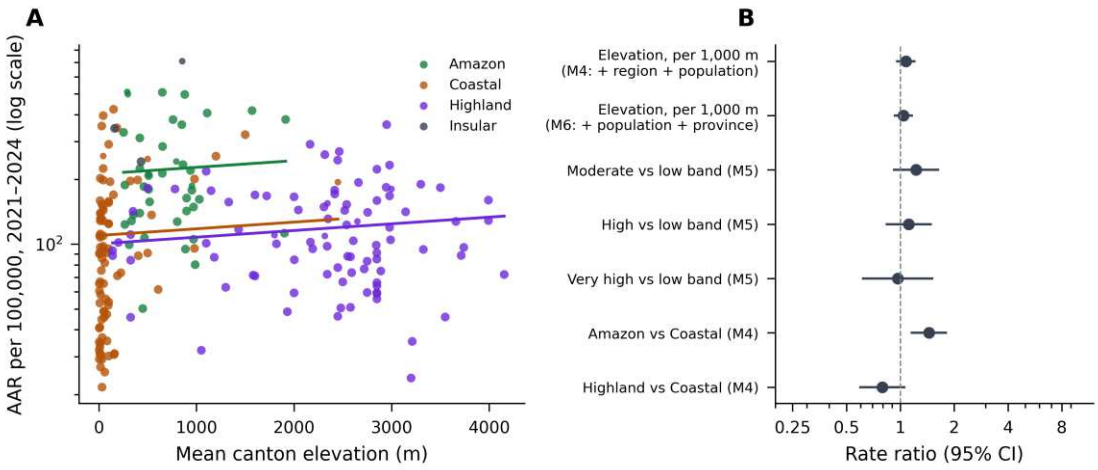


Figure 7. Canton-level ecological association between elevation and vertigo and dizziness consultation rates, Ecuador, 2021–2024. (A) Average annual consultation rate per 100,000 (logarithmic scale) of each of the 221 cantons against mean canton elevation, coloured by natural region (smaller markers: unstable cantons with population below 5,000); lines show predicted rates from the negative-binomial model adjusted for region and population size (Model 4, Supplementary Table S2) at the mean population of each region. (B) Rate ratios with 95% confidence intervals from the adjusted models for elevation, altitude bands and region. Offset: log canton person-time. AAR, average annual rate.

Discussion

This analysis of Ministry of Public Health (MSP) records characterizes the demographic, temporal, and geographic distribution of consultations for vertigo and dizziness in Ecuador during 2021–2024. To our knowledge, this is the first nationwide study of these patterns of care in the country. Consultation rates increased over the study period and differed by age and sex, with female predominance throughout most of adulthood and the highest rates among older adults. The predominance of R42 and the frequency of diagnoses recorded as presumptive limited the identification of specific etiologies using this source. Substantial geographic heterogeneity was also observed, whereas the adjusted models provided no clear evidence of an association between canton-level altitude and overall consultation rates. These findings describe recorded utilization of MSP services and should be interpreted in light of both the diverse causes of vertigo and dizziness and the characteristics of healthcare access, delivery, and documentation.

The observed rates are not equivalent to community prevalence or disease incidence, as PRAS records consultations and may include multiple encounters involving the same individual. As historical context, a study of newly diagnosed benign positional vertigo identified in 1984 in Olmsted County, United States, estimated an age- and sex-adjusted incidence of 64 per 100,000 population per year [24]. This estimate is not directly comparable with our crude consultation rates because of differences in the unit of observation, demographic adjustment, study period, and healthcare coverage. Community studies of older adults that applied positional tests documented an appreciable frequency of BPPV [10–12], while other investigations identified previously unrecognized cases among older individuals and patients hospitalized following falls [13,25]. These findings show that BPPV identification depends, among other factors, on the population assessed and the diagnostic procedure used. However, comparisons with our rates cannot quantify underdiagnosis or unmet healthcare needs. The rates of 88.2 per 100,000 for all included codes and 23.9 for BPPV are indicators of recorded MSP utilization, and comparisons between groups depend on demographic composition and the coverage of services and records.

Differences by age and sex were particularly pronounced. The overall rate among women was 2.09 times that among men, with the highest female-to-male ratio at ages 20–24 years and a reversal of the pattern from age 75 onward. Female predominance has been described in clinical BPPV cohorts [14], while an association between age and the incidence of benign positional vertigo has also been documented in population-based studies [24]. However, these findings alone do not explain our results: R42 accounted for most consultations and was particularly predominant among adolescents and young adults. Consequently, overall sex differences cannot be attributed exclusively to BPPV epidemiology. Although associations of BPPV with migraine, anxiety, and depression have been described [26,27], our data cannot determine their contribution to the observed patterns. Differences in diagnostic composition, healthcare-seeking behavior, and the frequency of repeat consultations are other possible explanations that require specific evaluation. The reversal of the female-to-male ratio in the oldest age groups should be regarded as a descriptive finding requiring confirmation and further investigation.

The predominance of symptom-based coding is relevant to the interpretation of these records. R42 accounted for 68.5% of consultations, while 47.9% of diagnoses were recorded as presumptive. These categories describe different dimensions and do not, in themselves, indicate inadequate care:

a symptom code does not demonstrate an incorrect diagnosis, and a presumptive status may reflect clinical uncertainty during assessment. Nevertheless, both limit etiological characterization using administrative data. A series of patients referred to an otoneurology unit found differences between initial and specialist diagnoses and infrequent prior use of provocative maneuvers among those ultimately diagnosed with BPPV [28]. Similarly, a Colombian series described longstanding symptoms and frequent use of vestibular suppressants before specialist assessment [29]. These findings provide context regarding potential difficulties in assessment and management but do not establish that the same practices explain the distribution of codes in PRAS.

The 39.6% increase in the national consultation rate between 2021 and 2024, concentrated mainly between 2021 and 2022, should be interpreted in the context of the study beginning during the COVID-19 pandemic. Changes in healthcare presentations for BPPV during pandemic restrictions have been described in other settings [30], but the absence of pre-pandemic information prevents us from determining whether our findings represent a return to previous levels. The increase could be related to changes in symptom frequency, healthcare access, facility activity, coding, or PRAS completeness. Although the literature recognizes the occurrence of BPPV and other vestibular syndromes in children and adolescents [31–33], these references do not demonstrate increased recognition in Ecuador during the study period. Furthermore, the predominance of R42 in younger groups prevents interpretation of the pediatric increase as specific evidence of improved BPPV detection. Analyzing these records alongside the total volume of MSP consultations would help distinguish changes specific to these codes from broader changes in service utilization.

Geographic differences should be interpreted in light of the healthcare coverage represented by the numerator. The Amazon region and Galápagos had high rates relative to their populations, whereas some areas with large consultation counts had comparatively low rates. The organization of Ecuador's healthcare system into distinct subsystems and the influence of socioeconomic factors on service utilization have been described previously [22,34]. In this context, the observed differences could be related to geographic variation in the use of MSP services versus other providers, as well as healthcare supply, coding practices, and record completeness. These explanations are plausible but were not directly evaluated. Crude rates may also differ because of the age and sex composition of each area. The inverse association between canton population size and consultation rates likewise does not identify a specific effect of urbanization or access. In

Galápagos, the greater uncertainty of the estimate after excluding cantons according to the sensitivity criterion reinforces the need for caution. Geographic contrasts should therefore not be interpreted as direct estimates of differences in disease frequency.

The altitude analysis did not show a monotonic pattern in overall consultation rates. The higher BPPV rate in the 2,500–3,500 m band was not reproduced in the higher band, and the adjusted estimate per 1,000 m increase was 1.07, with a 95% confidence interval of 0.96–1.20. This finding provides no clear evidence of an association but does not demonstrate the absence of an effect. Experimental evidence provides a different physiological context: a study of healthy young adults observed changes in vestibular perceptual thresholds during acute exposure to normobaric hypoxia [35]. That experiment assessed functional responses under controlled conditions, rather than chronic residential exposure or consultations for vertigo or dizziness. Its findings are therefore not directly comparable with our ecological associations. Canton-level measurement of altitude, the combination of heterogeneous diagnoses, and residual confounding could limit the identification of specific associations. Studies incorporating individual exposure, residential histories, and clinically confirmed diagnoses would allow this hypothesis to be evaluated more precisely.

The implications for health services center on strengthening targeted clinical assessment and the quality of documentation. For patients with suspected BPPV, the clinical guideline recommends appropriate positional testing and repositioning maneuvers, while avoiding routine use of vestibular suppressants and unnecessary ancillary testing [3]. These recommendations should be applied according to the clinical presentation and should not be extended indiscriminately to all consultations coded as R42. Linking PRAS to information on prescribing, referrals, tests performed, and clinical outcomes would also allow assessment of whether improvements in care and documentation translate into patient benefits. The objective should not be to reduce the use of symptom codes in itself, but to improve alignment between the assessment performed, the diagnosis documented, and the care provided.

Strengths and limitations

The study's strengths include the inclusion of more than 64,000 consultations over four consecutive years, coverage of all 24 provinces and 221 cantons, and the use of annual population denominators. Distinguishing counts from rates allowed us to describe both the volume of care

and its distribution relative to the population. In addition, descriptive and ecological analyses provided complementary perspectives on geographic variation in consultations.

The limitations of the data source constrain the scope of inference. PRAS records consultations and does not allow unique individuals to be identified longitudinally; therefore, incidence, prevalence, recurrence, and individual trajectories could not be estimated. The frequency of repeat encounters could vary between groups and contribute to the observed differences. The selection of H81.1, H81.2, H81.4, and R42 also does not encompass the full diagnostic spectrum of vertigo and dizziness; conversely, some conditions not selected through their specific codes could be represented among consultations recorded as R42. Care provided by IESS, military or police health services, and private providers was not included. Diagnoses were not independently validated, and the analytical dataset contained no information on positional testing. The administrative classification of ethnicity may also differ from that used in census denominators, limiting comparisons between categories. Finally, 5.6% of consultations lacked information on canton of residence; if this missingness was not random, geographic estimates could be biased.

The comparisons and models also have limitations. The rates are crude and are not standardized by age and sex, while some canton-level denominators required interpolation. The altitude assigned to a canton does not necessarily represent individual exposure, particularly in areas with wide elevation ranges. The models cannot rule out residual confounding by demographic structure, healthcare supply, use of other subsystems, urbanization, or other contextual factors. Spatial dependence between cantons could affect the uncertainty of the estimates if not adequately represented in the models. The four-year study period and the absence of a pre-pandemic baseline also limit the interpretation of long-term changes. Changes in PRAS coverage and completeness could not be separated from changes in recorded service utilization.

Conclusions

This nationwide analysis provides a baseline for vertigo- and dizziness-related outpatient healthcare utilization within Ecuador's Ministry of Public Health network. Recorded consultation rates varied markedly by age and sex, with the highest rates among older adults and female predominance throughout most of adulthood. Most consultations were coded as nonspecific dizziness, and nearly half of diagnoses were recorded as presumptive, limiting etiological

characterization. Geographic variation was substantial, with higher crude rates in the Amazon and Galápagos, whereas adjusted analyses provided no clear evidence of an association between canton-level elevation and overall consultation rates. These patterns describe recorded service utilization and cannot establish differences in underlying disease frequency. Strengthening targeted clinical assessment and documentation in primary care, including positional testing when BPPV is suspected, could support appropriate diagnosis and management. Linking administrative records with clinical and health-system information would help clarify the contributions of disease occurrence, access to care, and recording practices to the observed variation and inform health-service planning.

Lists of abbreviations

BPPV: benign paroxysmal positional vertigo

MSP: Ministry of Public Health

IESS: Ecuadorian Social Security Institute

INEC: National Institute of Statistics and Censuses

AAR: average annual rate

Declarations

Ethics approval and consent to participate

The research was conducted under the institutional research protocol entitled "Global Impact of Epidemiological Diseases in Ecuador: A Nationwide Sociodemographic Analysis of Morbidity and Mortality." The protocol was reviewed by the Human Research Ethics Committee of Universidad de Las Américas (CEISH-UDLA), which formally determined that the study was exempt from ethics committee evaluation under the applicable Ecuadorian regulatory framework (Exemption No. 2026-EXC-021, dated June 16, 2026).

Consent for publication

Not Applicable

Availability of data and materials

The aggregated datasets, summary tables, and analytical materials supporting the findings of this study are publicly available through the One Health Research Group at Universidad de Las Américas (UDLA), Ecuador, in the following GitHub repository: https://github.com/OneHealthUDLA/Vertigo. The underlying individual-level data were obtained from the Plataforma de Registro de Atención en Salud (PRAS), administered by the Ministry of Public Health of Ecuador. These microdata are not publicly available due to institutional data-governance, confidentiality, and access restrictions. Requests for access to the original data must follow the applicable authorization procedures established by the Ministry of Public Health of Ecuador.

Conflict of interest

The authors declare no conflicts of interest.

Funding

This work was funded by Universidad de Las Américas (UDLA) through research project MED.EOP.23.01.

Author contributions

E.O.-P.: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Validation, Visualization, Writing – original draft, Writing – review and editing, Supervision, Project administration. J.V.-G.: Investigation, Resources, Writing – original draft, Writing – review and editing. JS.I.-C.: Methodology, Investigation, Resources, Data curation, Formal analysis, Validation, Visualization, Writing – review and editing.

Acknowledgements

None

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