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Methodological approaches to identify frequent emergency department users: a population-based study

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Key words: frequent users, emergency department, emergency department utilization, population-based observational study, healthcare utilization.

Abstract

Frequent users (FUs) represent a small patient group accounting for a large share of Emergency Department (ED) visits. We compared a traditional calendar-year approach with a rolling 12-month approach for identifying FUs. We conducted a population-based observational study using regional ED records from the Veneto Region, Italy, between 2010 and 2023. FUs were defined as patients with ≥ 4 ED visits and identified using either a Traditional calendar-year Approach (TA) or a Rolling 12-month Approach (RA). Patients were classified as mild (4–5 visits), moderate (6–11), or high (≥ 12). Descriptive analyses and univariate logistic regressions were used to compare FUs with non-FUs. The RA identified substantially more FUs than the TA, with FUs accounting for 26.3% versus 16.8% of annual ED visits and 12.4% versus 5.0% of patients per year. Most FUs were mild (70.7%) or moderate (27.0%). Compared with non-FUs, FUs were older (50.2 vs. 44.7 years), were more likely to have co-payment exemptions (OR 1.52, 95%CI 1.51-1.53), to arrive via ambulance (OR 1.42, 95%CI 1.41-1.42), had higher triage priority (OR 1.21, 95%CI 1.21-1.21), and hospitalization risk (OR 1.34, 95% CI 1.33-1.34). Minor conditions were the leading cause of ED visits in both FUs (46.1%) and non-FUs (38.9%). The 12-month rolling approach identifies substantially more FUs compared to the traditional calendar-year approach. These findings

highlight the importance of the method used to define FUs, as different yield significant differences in the estimates.

Introduction

Over the past decade, there has been a worldwide increase in demand for Emergency Department (ED) visits. A small share of patients accesses the ED frequently leading to a substantial increase in the overall number of ED visits,^{1,2} contributing to ED overcrowding, reducing efficiency of health care services³ and representing a disproportionate amount of healthcare costs.⁴⁻⁶ This overcrowding has prompted calls for structural reform of the Italian emergency care system, including the reorganisation of territorial pathways to redirect non-acute demand away from the ED,⁷ and the development of advanced nursing roles and validated triage systems to more effectively manage low-acuity presentations.⁸

Frequent Users (FU) of healthcare services are categorised as ‘heavy-cost patients’ and it is known that between 2% and 10% of the population accounts for 15%–80% of healthcare costs.⁹

The characteristics of patients with frequent utilization of EDs are widely described in literature^{10,11} and they must be considered a complex population, often characterized by greater vulnerability and multiple needs, often not only arising from medical conditions.¹²⁻¹⁶

Because of the disproportionate use of ED services by FUs, to the detriment of all users and the healthcare service itself, analyzing this phenomenon more in detail, in order to plan targeted solutions, is of great public health interest.¹⁷⁻¹⁹ Despite numerous studies on the frequent use of EDs, there is no single definition of a FU and the selection of threshold values to identify this type of user largely depends on the objective of the study or on the distribution of ED attendance in a given period and setting, and shows overall substantial variability.²⁰⁻²³

A FU is often considered a user with ≥ 4 ED visits with thresholds ranging from 2 to 12 admissions per year or 6-month period.^{10,24,25}

The most commonly used definition of FUs is ≥ 4 visits per year, a threshold that defines a small proportion of patients accounting for up to 25% of all ED visits.²⁶⁻²⁸

This study aimed to compare two methodological approaches to identify FUs: a traditional calendar-year approach and a rolling 12-month approach. In addition, we also examined the number of FUs based on the two approaches, their demographic characteristics, and the number and characteristics of their ED visits.

Materials and Methods

Study design

The Italian National Healthcare Service is universalistic and Regional Authorities plan and organize healthcare facilities and activities in accordance with National health plans to guarantee a uniform provision of comprehensive care nationwide.

This population-based observational study was conducted in the Veneto Region Italy, which has approximately 4.9 million inhabitants and is organized in 9 Local Health Units. Each Local Health Unit includes at least one acute-care hospital equipped with an ED, resulting in a total of 48 EDs distributed across the Region.

Setting and data source

We included all patients with at least one ED visit between January 1st, 2009 and December 31st, 2024 in one of the EDs of the Veneto Region.

All information on ED visits were retrieved from the regional archive, which collects information on all admissions to EDs in the Region. The database includes demographic information such as the patient's municipality of residence, age, sex, healthcare co-payment exemptions and information on the visit such as the date and hour of the visit, the referring provider, the means of arrival to the ED, the reason for the visit and the outcome.

ED visits are anonymized by assigning a unique anonymous code. This allows for the reconstruction of the ED visit history for each patient without the possibility to trace the patient's identity.

Records with invalid anonymous codes and duplicates were excluded from the analysis.

Two approaches were used to identify FU patients and ED visits (Figure 1). The first, traditional approach, involved calculating the number of ED visits each patient made within a calendar year and defined FUs as patients with four or more visits in that year. The second, a rolling approach, used a 12-month look-back window, considering the number of ED visits that occurred in the 365 days preceding each index ED visit. ED visits were classified as FU visits if the patient had made four or more ED visits, including the index visit, within the preceding 365 days. Throughout this manuscript, these methods are referred to as the Traditional Approach (TA), and Rolling Approach (RA), respectively. The first (2009) and last year (2024) of analysis were used exclusively to allow complete ascertainment of frequent users at the boundaries of the study period (2010–2023).

Specifically, 2009 data were used to evaluate ED visits occurring during the 365 days preceding index visits in 2010, while 2024 data were used to identify 2023 ED visits that belonged to frequent users whose index visit occurred in 2024.

For both approaches, even the first three ED visits preceding the index ED visit were classified as FU visits.

Unlike previous methods, our approach does not focus on a single index ED visit to identify FUs, but evaluates each ED visit, thereby increasing the likelihood of identifying a FU patient.

Two separate archives were created for the statistical analyses: one containing data on ED visits, categorized into visits by FU and non-FU, and the second containing, for each year, data on patients classified as FU and non-FU. For each calendar year, FU patients were identified as those who had at least one visit classified as an FU visit during the year under consideration. The two methods were compared by analysing the annual percentage of FU visits and FU patients, and calculating the relative percentage difference.

Using the datasets resulting from the rolling approach, univariate and bivariate descriptive analyses were conducted separately on patients and visits, comparing the characteristics of patients categorized as FU and non-FU, and further distinguishing the latter into mild FU (4-5 ED visits), moderate FU (6-11 ED visits), and high FU (12 or more ED visits). The threshold adopted to define the different types of FU was derived by calculating the number of visits made by each patient in each calendar year and determining the 90th, 95th, and 99th percentiles of the distribution.

Explanatory variables

For patient characteristics, age at admission was categorized into seven groups: under 1 year, 1-5 years, 6-17 years, 18-44 years, 45-64 years, 65-74 years, and 75 years or older. Citizenship was categorized as Italian, European Union, or non-European Union, while residence was categorized as in Veneto Region, outside Veneto Region, but within Italy, or abroad.

For ED visit characteristics, the time of the visit was categorized as daytime (8:00 AM-7:59 PM) and night-time (8:00 PM-7:59 AM).

The reason for the visit was grouped into 9 categories as follows: trauma, cardiac conditions, neurological conditions, psychiatric conditions, respiratory conditions, gastrointestinal conditions, fever, minor conditions, or other. Minor conditions included low-acuity symptoms or non-severe disorders.

An analysis of healthcare co-payment exemptions for inappropriate visits in ED was also conducted but as a limit, it should be considered that exemption may arise not only from clinical conditions but also from age and low income.

Statistical methods

Annual prevalence rates of FU, together with the 95% confidence interval (CI), have been calculated per 100 ED visits and per 100 patient/year as denominator. Time trends were analyzed in terms of Annual Percentage Change (APC), calculated using the Joinpoint software from the National Cancer Institute (version 4.8.0.1, <https://surveillance.cancer.gov/joinpoint/>), which detects changes in trends and identifies the beginning and end years of these trend changes.

Univariate and bivariate analyses were performed to summarize data with respect to the patient demographics and ED visits characteristics. Continuous variables were presented with descriptive statistics (mean and standard deviation).

Univariate logistic analyses with robust variance estimates were conducted separately on the two distinct datasets (patients-year and ED visits) to predict the odds of a patient being a FU or of an ED visit being made by a FU patient, based on the explanatory variables. The unit of analysis was a single user for the investigated demographic characteristics or an ED visit for the investigated characteristics of the attendances. To account for the non-independence of repeated ED visits, standard errors were estimated using the Huber–White sandwich estimator with clustering defined by a composite patient-year identifier. Users or ED visits with missing values were excluded from the regression model. All statistical analyses were conducted using SAS (Statistical Analysis System) software version 9.4 (SAS Institute Inc., Cary, NC, USA) and STATA/BE 18.0 (StataCorp LLC, College Station, TX, USA).

Results

During the analyzed period, a total of 25,315,318 ED visits were recorded, with an average of 1,808,237 visits per year. The number of ED visits remained stable over the years, except during 2020 and 2021, for the COVID-19 pandemic. Specifically, a sharp decrease was observed in 2020 (-29.1% compared to the previous year), consistent with national and international trends due to the spread of SARS-CoV-2.

Supplementary materials, Table 1 reports, both overall and by year, the number of ED visits and patients, categorized as occasional users and FU, identified through both approaches. Between 2010 and 2023, the Traditional Approach (TA) identified 4,252,461 FU visits, accounting for 16.8% of all ED visits, while the Rolling Approach (RA) identified 6,666,726 visits, corresponding to 26.3%. The distance between the two estimates remained consistent over time (Figure 2), with the proportion of FU visits ranging from 16.5% in 2010 to 17.5% in 2023 for the TA, and from 25.9% to 27.6% for the RA, in the same years.

Joinpoint analysis did not reveal significant changes over time in the proportion of FUs calculated using the TA (APC: 0.17%, 95%CI -0.69; 1.07, $p = 0.668$). In contrast, the proportion estimated

using the RA showed a significant increase between 2010 and 2018, rising from 25.9% to 27.5% (APC: 0.77%, 95% CI: 0.28; 2.03, $p = 0.019$), followed by a decrease until 2021 (25.1%; APC: -3.31 95% CI: -5.42%; -0.84; $p = 0.023$), and a subsequent increase thereafter (APC: 6.43%, 95%CI: 1.86; 10.12, $p = 0.022$).

Regarding the number of patients who had at least one ED visit, the difference between the two methodologies is even more pronounced. Using the TA, the yearly number of FUs from 2010 to 2023 amounted to 819,655 patients-year, representing 5% of the total ED user population, while using the RA, the number was as high as 2,044,283, corresponding to 12.4% of users, which mean 149.4% more FU patients were identified compared to the traditional approach.

Supplementary materials, Table 2 shows that out of all patients-year that access the ED, FU patients-year identified with Rolling Approach were classified as mild in 8.8% of cases, followed by moderate (3.4%) and a small proportion as high FU (0.3%).

Such distribution is also reflected in the analysis of ED visits: mild FUs accounted for 15.5% of the FU ED visits, moderate FUs for 9.1%, and high FUs for just 1.8%. These proportions remained stable throughout the observed period. The sociodemographic and clinical characteristics of FUs compared with those of occasional users is reported in Supplementary materials, Table 3 and in Supplementary materials, Table 4.

Patients in the FU group are significantly older (mean age: 50.2 years vs. 44.7; $p < 0.0001$), with the highest FU proportion observed among those aged 75 years or older (19%; 538,622 FU visits out of 2,786,179 total visits), followed by infants (17%), whereas the lowest proportion is observed in the 6–17-year age group (7%).

With respect to gender distribution, no significant overall disparities were observed, although a slight male predominance was evident among high FUs (52.6% vs 50.8% OR: 1.08 95%CI: 1.06–1.10 $p < 0.0001$; Supplementary materials, Table 4). In addition, Italian citizenship and residence in the Veneto Region are significantly more common among FUs ($p < 0.0001$). Another distinguishing factor is the presence of an healthcare co-payment exemption, which is more common among FUs compared to occasional users (13.7% vs. 9.4%; OR: 1.52, 95% CI: 1.51–1.53, $p < 0.0001$).

The distribution of ED visits on a monthly basis was found to be relatively stable across all FU categories, apart from a significant increase observed in August and September (Supplementary materials, Table 4) among high FUs. Among high FU, who account for 2.2% of the total FU patients, the proportion of visits made during nocturnal hours (specifically, those occurring between 8:00 p.m. and 7:59 a.m.) was significantly higher than that observed among occasional users (30.3% vs. 24.7%; OR: 1.33, 95% CI: 1.30–1.35; $p < 0.0001$).

Furthermore, FUs were found to be more likely to access the ED following a medical referral (21.4% vs. 17.8%; OR: 1.25, 95% CI: 1.25–1.26) and via ambulance (18.8% vs. 14.1%; OR: 1.42, 95% CI: 1.41–1.42; $p < 0.001$).

Overall, a higher proportion of ED visits of FU patients (23.6%) received a high-priority triage classification, compared to occasional users (20.4% OR: 1.21; 95%CI: 1.21–1.21; $p < 0.0001$).

Furthermore, the proportion of access that resulted in hospitalization was also higher among FUs (16.5% vs. 12.9%; OR: 1.34, 95% CI: 1.33–1.34; $p < 0.0001$). However, when analyzing hospitalization by FU subgroups, a higher proportion of hospitalizations are observed among mild and moderate FU (about 17% in both groups), while the proportion among high FU is comparable to that among occasional users (11.8% vs 12.9%).

Despite this, minor conditions remain the most frequent reason for ED visits among FUs (46.1% vs. 38.9% among occasional users), with a higher prevalence also of cardiac conditions (6.4% vs. 6.0%), respiratory problems (5.8% vs. 3.6%), and psychiatric disorders (1.1% vs. 0.4%).

Discussion

The comparison between the RA and the TA to identify frequent ED users has shown substantial differences. The RA, by tracking patients beyond calendar year limits, captures a larger proportion of FUs, showing a likely higher sensitivity linked to the fact that the period of intense ED use pivots around the individual and not the calendar year. In contrast, the TA, limited to single calendar-year data, likely underestimates the phenomenon by missing repeated patterns spread over time beyond calendar-year limits. While the RA provides richer insights for targeted interventions, the TA remains useful for national comparisons due to its simplicity. These methodological differences should be carefully considered when interpreting data and designing policy responses, in view of the significant difference in patients and visits attributable to frequent users. Our findings highlight the need for standardized approaches to defining FUs and greater awareness when selecting one method over the other, given the substantial differences in estimates generated by different methods. Similarly, the thresholds used to define FUs warrant further discussion, as defining a FU by 4 or more visits versus 6 or more visits defines a substantially different number of patients and visits. Notably, a rolling 365-day look-back window analogous to the one adopted here has already been implemented at a national level by the Canadian Institute for Health Information (CIHI), whose official indicator on frequent emergency room use for mental health and substance use identifies individuals with ≥ 4 visits within a 12-month period preceding their most recent visit.²⁹ This precedent supports the feasibility and validity of a rolling approach as a robust alternative to calendar-year methods for routine, large-scale monitoring of ED frequent use. An advantage of the

traditional approach is the simplicity with which it is calculated, but those using this methodology should be aware their estimates are significantly different compared to those obtained with a RA. In addition to these methodological considerations, our results highlight that a relatively small number of patients generates a substantial workload for EDs, thus contributing significantly to the well-known issue of ED overcrowding, which can compromise the efficiency and the quality of care provided, increase the risk of human error, and ultimately undermine public trust in the healthcare system. Of particular note is the relative stability of the phenomenon over the long period analyzed, that showed even a slight increase in the trend in the pre-pandemic period, with more than a quarter of admissions, according to the RA method, attributable to FUs, corresponding to 12.4% of the subjects who accessed EDs.

FUs differ significantly from occasional users by demographic, clinical, and social characteristics. The findings suggest that frequent ED use is linked to older age, Italian citizenship, and medical vulnerability, as suggested by the higher prevalence of people with healthcare co-payment exemption.

FUs also exhibited a distinct clinical profile, with higher rates of chronic conditions, such as psychiatric, cardiac, and respiratory diseases, as well as a greater likelihood of ambulance arrivals and hospitalizations. Consistent with previous studies,^{4,30,31} these findings suggest greater medical complexity and potentially unmet health needs that may not be adequately addressed in other healthcare settings, including primary care. Supporting this interpretation, patients presenting to the ED with trauma-related conditions, where the clinical course is often more predictable and structured, are less frequently classified as frequent users.

Interestingly, while high-priority triage and hospital admissions were more common among frequent users, a large share of visits still concerned minor conditions, suggesting a part of these visits were linked to health issues that may have been managed in non-hospital based settings, and may represent potentially avoidable ED use. The subgroup of high FU (≥ 12 visits/year), although small, exhibited the highest rates of ambulance arrival, night-time visits, and psychiatric presentations. Consistent with existing literature³² on the association of social risks with ED utilization, these findings reinforce the need for targeted interventions for this particularly vulnerable population. Moreover, with regard to high FU, they exhibit a comparatively lower assignment of high-priority triage codes and a reduced rate of hospital admission (which is even lower than that observed among occasional users). Our study also shows that not only FUs have higher percentages of healthcare co-payment exemption codes, as reported in previous literature,³³ but this proportion is particularly elevated among high FUs. Overall, these findings underscore the importance of integrating ED data into broader public health and primary care strategies to identify

and manage FU patients through coordinated care, especially for those with chronic conditions and socioeconomic fragility, while being aware of the differences in the approaches to define FUs.

Conclusions

The rolling approach identified substantially more patient-year FUs and FU visits than the traditional calendar-year approach. In our study, the proportion of frequent users remained stable or slightly increasing over time, suggesting that the need to monitor this population is unlikely to diminish. While rolling-window approaches have been adopted in some settings, their application has largely been limited to specific populations or clinical conditions. By extending this methodology to all ED-visits, our study provides a more comprehensive framework for monitoring frequent ED use across the entire patient population.

The two approaches offer different advantages. The traditional calendar-year approach is straightforward to implement and does not require information beyond the observation period. By contrast, the rolling approach aligns the definition of frequent ED use with patients' actual patterns of healthcare utilisation rather than arbitrary calendar boundaries, identifying a substantially larger proportion of frequent users and ED visits. Accurate identification of FUs is important for epidemiological surveillance, healthcare service planning, and the development of targeted interventions to reduce avoidable ED use. Our findings highlight the importance of defining standardized methodological approaches to define FUs, as different definitions produce substantially different estimates. The rolling approach may therefore represent a valuable complementary tool for public health surveillance and policy planning.

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Traditional Vs Rolling Approach

study period: 2009-2024

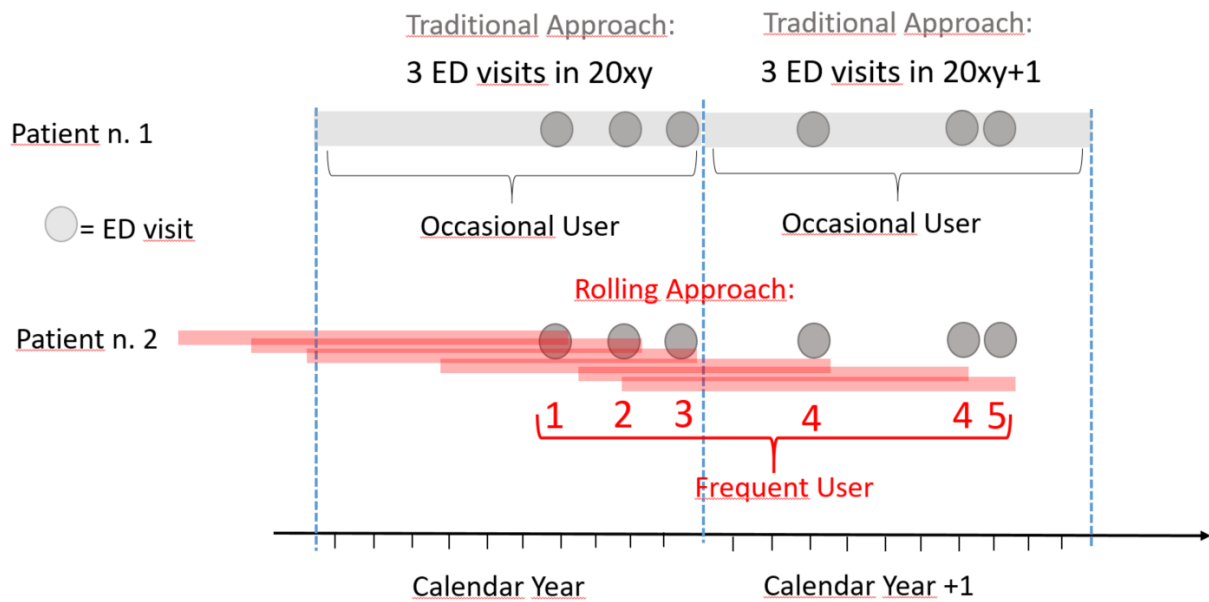
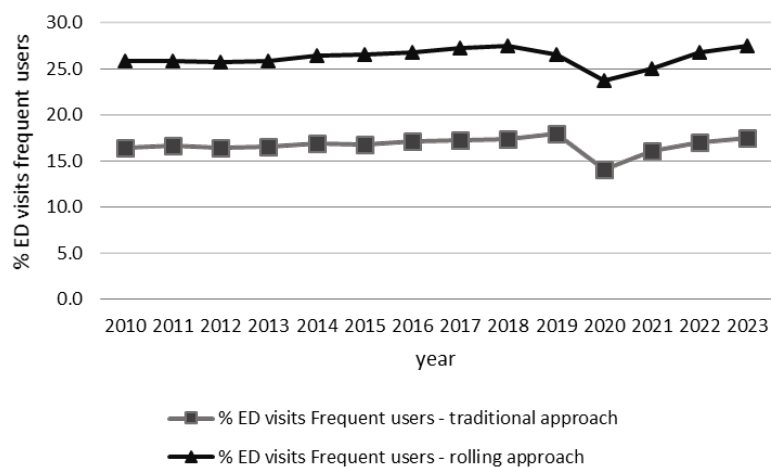


Figure 1. Methodology of traditional vs. rolling approach.

a)



b)

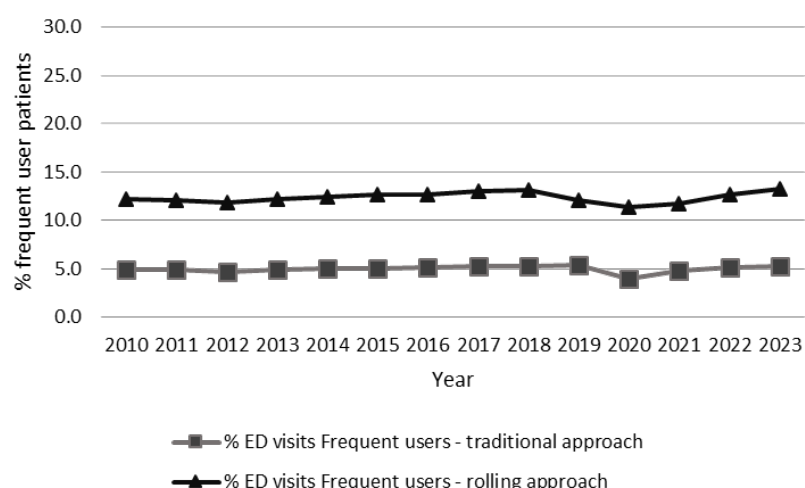


Figure 2. Percentage of total ED visits accounted for by frequent users, by traditional and rolling approach, and by year, Veneto Region, 2010-2023.

Contributions: Laura Salmaso, conceptualization, investigation, Data curation, formal analysis, writing – original draft; Marta Zanovello, conceptualization, investigation, writing – original draft; Claudio Barbiellini Amidei, Ugo Fedeli, data curation, writing – review and editing; Mario Saia, data curation, methodology, writing – review and editing.

Conflict of interest: the authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article

Ethics approval: this study used routinely collected, pseudonymized health records. All data in the Local Health Authority registries are recorded with the patient's consent and can be used as aggregate data for scientific studies without further authorization. The study is conformed with the Helsinki Declaration of 1964, as revised in 2013, concerning human and animal rights.

Data availability: the data that support the findings of this study are not publicly available. Aggregated data can be accessed by contacting to the corresponding author upon reasonable request.

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Online supplementary materials

Table 1. Number of ED visits and patients/year, distinguished into occasional and frequent users: comparison between the traditional calendar-year and the 12-month rolling approach by year, Veneto Region, 2010-2023.

Table 2 Rolling approach: number of visits and patients/year distinguished into occasional and frequent users, further divided in mild, moderate, and high frequent users, by year, Veneto Region, 2010-2023.

Table 3 Sociodemographic characteristics of patients/year and features of ED visits by occasional and frequent users (overall, mild, moderate and high). Veneto Region, 2010–2023.

Table 4 Logistic Regression Analysis: Crude Odds Ratio (OR) for being a frequent user (FU) compared to occasional users based on patients and visits characteristics. The analysis was stratified according to the intensity of emergency department use.