Research Square

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Ambulatory Care Sensitive Hospitalizations in Switzerland: national trends and U.S. benchmarking using AHRQ Prevention Quality Indicators

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Abstract

Background

Ambulatory care sensitive hospitalizations are widely used to monitor potentially avoidable hospital use and aspects of primary care and health system performance. Nationwide evidence on their burden and temporal trends in Switzerland remains limited, and standardized comparisons across a range of acute and chronic conditions are lacking.

Methods

We conducted a nationwide retrospective observational study of inpatient data from January 2014 through December 2023. Hospitalizations meeting indicator definitions (version 2022) were identified using a definition-driven translation of diagnosis and procedure codes to the Swiss coding system with annual updates. Age- and sex-standardized annual rates per 100,000 population were calculated for Switzerland. Rates for the United States (2016–2022) were reconstructed from benchmark parameter tables and standardized using the same population.

Results

Among 14,570,864 hospitalizations, 604,007 (4.15%) met criteria for at least one indicator. Among adult non-obstetric hospitalizations, 5.21% met Prevention Quality Indicator criteria, and 85.0% of cases were treated in internal medicine units (13.7% of all internal medicine hospitalizations). For the overall composite, 463,899 (76.8%) occurred in patients aged ≥ 65 years. The largest condition-specific indicator was heart failure (174,042 hospitalizations). Median length of stay was 6 days (interquartile range 4–10); 6.5% included intensive care unit admission, 4.2% resulted in in-hospital death, and 9.8% had 30-day readmissions. From 2014 to 2019, composite rates changed modestly (overall, 907 to 934; acute, 376 to 372; chronic, 531 to 562; diabetes, 63 to 70). In 2020, rates declined compared with 2019 by 20.1% (overall), 24.0% (acute), 17.5% (chronic), and 9.6% (diabetes). Compared with United States benchmarks, Switzerland had lower overall, chronic, and diabetes composite rates, whereas acute composite rates were similar.

Conclusions

Ambulatory care-sensitive hospitalization rates in Switzerland were stable before the COVID-19 pandemic, declined markedly in 2020, and differed from U.S. benchmarks primarily for chronic and diabetes-related conditions, whereas acute composite rates were similar. These heterogeneous patterns suggest that ACSC hospitalization rates reflect an interplay between underlying disease burden, outpatient management, hospital admission practices, and broader health-system characteristics. The AHRQ PQI framework provides a transparent and reproducible approach for monitoring potentially avoidable hospitalizations in Switzerland and for contextual international benchmarking.

Background

Measuring the quality of outpatient care is important but challenging [1–3]. Ambulatory care sensitive conditions (ACSC), introduced by Billings et al. in 1993,[4] identify potentially avoidable hospitalizations and underpin many outcome-based indicators of outpatient care.

The Agency for Healthcare Research and Quality (AHRQ) defines ACSC as “conditions for which good outpatient care can potentially prevent the need for hospitalization or for which early intervention can prevent complications or more severe disease” and introduced the Prevention Quality Indicators (PQIs) in 2001 [5,6]. PQIs quantify

hospitalizations for ACSCs as age- and sex-standardized rates per 100,000 and include ten condition-specific and four composite indicators (cf. S1). Although developed in the United States (U.S.), PQIs have also been applied in other health systems to describe variation and to benchmark against U.S. rates [7–10].

In Switzerland, two main approaches have been used. Several studies relied on OECD Healthcare Quality and Outcomes (HCQO) indicators [11], which cover a limited set of chronic conditions and are designed for high-level monitoring [12–14]. Eggli et al. proposed an expanded ACSC framework with additional exclusions and broader use of secondary diagnoses; however, these definitions are proprietary and not publicly reproducible [15]. Thus, Switzerland lacks a nationwide, openly reproducible PQI-based implementation covering both acute and chronic ACSCs.

By contrast, AHRQ PQIs provide an openly accessible, fully specified framework with transparent logic [6]. Compared with the OECD HCQO indicators, PQIs capture a broader spectrum of ACSCs, including the acute conditions community-acquired pneumonia and urinary tract infection. Applying PQIs to Swiss inpatient data therefore enables more reproducible estimates across a wider range of conditions.

To our knowledge, no previous study has applied the full AHRQ PQI framework to nationwide Swiss inpatient data using transparent and reproducible translation to the Swiss coding environment. The primary objective of this study was to characterize the national burden and temporal trends of AHRQ PQI-defined ambulatory care sensitive hospitalizations in Switzerland from 2014 through 2023. Secondary objectives were to assess the feasibility of operationalizing the AHRQ PQI framework in Swiss inpatient data, to examine changes in PQI rates associated with the onset of the COVID-19 pandemic, and to compare age- and sex-standardized Swiss rates with corresponding AHRQ benchmark-derived U.S. comparator rates.

Methods

Study Design, Setting, Data Sources

This retrospective observational study used routinely collected, fully anonymized inpatient data from the Swiss Medical Statistics of Hospitals dataset, [16] provided by the Swiss Federal Statistics Office (SFSO). The study period started on January 1, 2014, and ended on December 31, 2023. Annual Swiss resident population data, including counts of males and females by age group, were used for age and sex-standardization.

The Swiss Medical Statistics of Hospitals dataset includes demographic variables (age, sex, place of residence, insurance status), administrative information (mode of arrival, patient location before admission, month of admission, diagnosis-related groups (DRG)) medical information coded using the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, German Modification (ICD-10-GM), [17] which are grouped into one primary diagnosis and up to 50 secondary diagnoses. Procedure codes are coded using the Swiss classification of surgical interventions (CHOP) [18]. They are grouped into a primary procedure and up to 99 secondary procedures. The dataset also includes hospitalization outcomes and utilization variables, including in-hospital mortality, length of stay, intensive care unit (ICU) admission and ICU length of stay, and a derived variable indicating the number of days to the next inpatient hospitalization.

U.S. comparative data were obtained from the archived AHRQ PQI benchmark parameter tables, which were available for the year 2016 through 2022 [6]. These tables provide age- and sex-specific regression coefficients required to calculate standardized PQI rates for the U.S.

This study used fully anonymized routinely collected administrative data and was conducted in accordance with applicable Swiss data protection legislation and ethical research regulations. Reporting followed the REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) statement [19].

Identification of PQI Hospitalizations

Hospitalizations meeting the definitions of the AHRQ PQIs v2022 [6] were identified within the Swiss inpatient dataset. The PQIs include condition-specific indicators for diabetes complications, chronic obstructive pulmonary disease (COPD), heart failure, hypertension, community-acquired pneumonia and urinary tract infection, as well as four composite measures summarizing overall, acute, chronic, and diabetes-related potentially avoidable hospitalizations (eTable 1). The diabetes composite contains four indicators covering short-term complications (ketoacidosis, hyperosmolarity, or coma), long-term complications (renal, eye, neurological, circulatory, other specified, or unspecified), uncontrolled diabetes, and lower-extremity amputation among patients with diabetes, excluding toe amputation admissions and traumatic lower-extremity amputations.

To operationalize these indicators for Switzerland, the AHRQ ICD-10-CM diagnosis and procedure code definitions were systematically mapped to the corresponding ICD-10-GM diagnosis and CHOP procedure codes (cf. eFigure 1). Because identical codes may differ in meaning across ICD versions (e.g., ICD-10-CM “T86.5 Complications of stem cell transplant” versus ICD-10-GM “T86.5 Complications of skin graft”), mapping was conducted using a multistep logical translation procedure that prioritized code definitions over numerical similarity. Codes that could not be mapped automatically were reviewed and assigned by a physician; in ambiguous cases, a medical coding expert reviewed the original codes and determined the appropriate ICD-10-GM or CHOP codes. To account for classification changes over time, all ICD-10-GM and CHOP updates were systematically tracked and incorporated into the PQI definitions using official transition tables.

Statistical Methods and Data Processing

Hospitalizations classified as PQI cases were summarized descriptively at both the individual indicator and composite levels. For each PQI, patient demographics (age, sex, mode of arrival at the hospital, insurance status) and hospitalization outcomes (in-hospital mortality, length of stay (LOS), ICU admission, ICU LOS, 30-day readmission) were described. Comorbidities were derived from secondary diagnoses and coded according to the Elixhauser comorbidity framework described by Quan et al. [20]. Categorical variables are reported as counts and percentages, normally distributed continuous variables as means with standard deviations, and non-normally distributed variables as medians with interquartile ranges (IQRs).

Age- and sex-standardized PQI rates per 100,000 population were calculated for adults aged 18 years and older using direct standardization for both Switzerland and the United States. For Switzerland, age-sex–specific hospitalization rates were computed within 10-year age bands for each calendar year and weighted using the corresponding age- and sex-distribution of the Swiss 2020 standard population. Weighted stratum-specific rates were summed to obtain yearly standardized rates, with 95% confidence intervals estimated using a delta-method approximation, assuming Poisson-distributed age-sex-specific counts [21]. We used the Swiss 2020 population as the standard population to (1) apply a single consistent reference distribution across all years and both countries, enabling valid comparisons of standardized rates over time and between settings, and (2) align with the AHRQ benchmark age-sex strata used for U.S. estimates.

U.S. benchmark rates were reconstructed from the AHRQ PQI benchmark parameter tables (model-based predicted probabilities by age and sex) rather than calculated from U.S. hospitalization microdata. For each age-sex-year stratum, published logistic regression coefficients were applied to compute predicted probabilities, which were converted to rates per 100,000 population and weighted using the same Swiss 2020 standard population. Annual standardized U.S. rates were obtained by summing the weighted stratum-specific rates across all age and sex categories [6]. For the U.S. benchmark series, confidence intervals were not calculated because the benchmark parameter tables provide model coefficients for predicted probabilities but do not provide sufficient information to propagate uncertainty for annual standardized rates in this reconstruction.

One researcher (JDS) had full access to the dataset. The unit of analysis was hospitalizations (inpatient stays/admissions); individuals could contribute more than one hospitalization during the study period. We did not perform new patient-level linkage across hospitalizations. Readmission within 30 days was defined using a dataset-provided derived linkage variable indicating the number of days to the next inpatient hospitalization; hospitalizations ending in in-hospital death were not eligible for readmission. Aside from predefined eligibility/exclusion criteria required to apply the PQI specifications (e.g. excluding transfers) and routine checks needed to implement code mappings and yearly coding updates, no additional data cleaning or linkage was performed. Data processing was conducted using Structured Query Language (SQL), and statistical analyses were performed using R version 4.3.1 (R Foundation for Statistical Computing, Vienna, Austria).

Results

Study Population and PQI Hospitalizations

The patient flow chart is summarized in Fig. 1. Among 14,570,864 inpatient hospitalizations recorded between 2014 and 2023, 11,582,145 were adult non-obstetric hospitalizations eligible for PQI assessment. Of these, 5.21% (604,007/11,582,145) met the diagnostic, procedural and extended criteria for at least one PQI. The remaining hospitalizations did not qualify primarily because their principal diagnosis and associated procedures did not correspond to any PQI-defined ACSC, in accordance with AHRQ specifications. Among PQI cases, 85.0% were admitted to internal medicine units (513,526), and among all adult non-obstetric hospitalizations in internal medicine (3,751,539), 13.7% (513,526) met PQI criteria.

Characteristics of Swiss PQI Hospitalizations

The characteristics and outcomes of the composite PQI hospitalizations are summarized in Table 1 (for hospitalization outcomes and individual PQIs, cf. eTable 2–3). Over three quarters (*n* = 463,899 [76.8%]) of overall composite [PQI 90] hospitalizations occurred in patients who were aged ≥ 65. The largest individual PQI by number of hospitalizations was heart failure [PQI 08] with 174,042 (1.28%) hospitalizations. Physician referral led to hospitalizations in 38.9% (*n* = 235,131) of overall composite [PQI 90] patients. The most common comorbidities among overall composite [PQI 90] patients were hypertension (*n* = 317,408 [52.6%]), cardiac arrhythmias (*n* = 199,363 [33.0%]) and renal failure (*n* = 188,410 [31.2%]). Overall composite [PQI 90] patients had a median LOS of 6 (IQR 4–10) days; 38,990 (6.5%) were admitted to the ICU, and 25,304 (4.2%) died in the hospital.

Trends in Swiss PQI Rates, 2014–2019

The PQI rates are visualized in Figs. 2–4. From 2014 to 2019, the overall composite [PQI 90] rate increased by 3.03%. The acute composite [PQI 91] rate decreased by 1.02%. The chronic composite [PQI 92] rate increased by 5.90% and the diabetes composite [PQI 93] increased by 11.06%. The largest individual PQI rate percentage increase was in the

diabetes long-term complications [PQI 03] rate, which increased by 21.65%. The largest individual PQI rate percentage decrease was in the asthma in younger adults [PQI 15] rate, which decreased by 24.65%.

Impact of COVID-19 on Swiss PQI Rates

At the start of the pandemic, comparing 2019 to 2020, all Swiss PQI rates decreased. The overall composite [PQI 90] rate decreased by 20.12%, the acute composite [PQI 91] rate decreased by 24.02%, the chronic composite [PQI 92] rate decreased by 17.5% and the diabetes composite [PQI 93] decreased by 9.61%. The largest individual PQI rate percentage decrease was in community-acquired pneumonia, which decreased by 34.09%. The asthma in younger adults [PQI 15] rate and lower extremity amputation among patients with diabetes [PQI 16] rate showed the smallest decreases with 1.48% and 2.97% respectively.

Comparison with U.S. PQI Rates

Compared with U.S. benchmark rates, Switzerland had lower overall (PQI 90), chronic (PQI 92), and diabetes (PQI 93) composite rates across all benchmark years. Acute component indicators showed different patterns: community-acquired pneumonia (PQI 11) rates were similar, whereas urinary tract infection (PQI 12) rates were higher in Switzerland. When combined into the acute composite (PQI 91), rates were similar between countries, with only small year-to-year differences.

Discussion

Using nationwide inpatient data, 4.15% of Swiss hospitalizations between 2014 and 2023 were classified as PQI hospitalizations, mainly driven by heart failure, COPD/asthma in older adults, pneumonia, and UTI, and concentrated among older adults. Before the COIVD-19 pandemic, composite rates changed only modestly, although trends varied across individual indicators. In 2020, all composite indicators and most condition-specific PQIs declined markedly. Compared with U.S. benchmark rates, Switzerland had lower overall, chronic and diabetes composite rates, whereas acute composite rates were similar.

In 2020, all composite indicators and most condition-specific PQIs declined sharply with the onset of the COVID-19 pandemic. This pattern likely reflects pandemic-related changes in care-seeking and service delivery, together with an unusually low influenza season [22,23]. In the U.S., emergency department visits decreased by approximately 40% early in 2020 [24], and hospitalizations for community-acquired pneumonia and non-COVID respiratory infections fell by 30–50% across settings [25,26]. Several analyses also documented marked reductions in COPD-related hospitalizations during 2020 to 2021 [27,28].

Interpretation of Swiss–U.S. differences

The comparison with U.S. benchmark rates showed consistently lower Swiss rates for the overall, chronic, and diabetes composites, whereas acute composite rates were similar. Differences in underlying disease burden likely explain part of this pattern. Hypertension, diabetes and chronic respiratory diseases are less prevalent in Switzerland than in the U.S. [29–34], broadly corresponding to lower hospitalization rates for related PQIs. However, disease prevalence alone does not account for all observed differences. Heart failure provides an illustrative example: despite broadly similar prevalence estimates in Switzerland and the U.S. [35,36], U.S. heart failure [PQI 08] hospitalization rates are nearly twice those observed in Switzerland. Heart failure hospitalization is influenced not only by underlying disease severity but also by admission thresholds, local practice patterns, outpatient management and transitional care [37]. International comparisons have likewise shown particularly high heart failure

hospitalization rates in the U.S. relative to other high-income countries, alongside shorter lengths of stay and higher readmission rates [38]. Thus, differences in healthcare delivery and hospital utilization likely contribute alongside epidemiological differences to the observed PQI rates.

The broader health-system context is therefore important when interpreting these comparisons. Age- and sex-standardization accounts for differences in demographic composition but not for socioeconomic conditions, organization and accessibility of ambulatory care, insurance coverage, hospital supply, admission thresholds, or other factors that influence whether deterioration of an ambulatory care sensitive condition ultimately results in inpatient admission [12,15,39,40]. Access to care and geographic remoteness have been associated with ACSC hospitalization rates internationally, whereas Swiss analyses have not consistently shown strong associations with geographic remoteness, suggesting that geographic access may be a less important driver of hospitalization differences within Switzerland [12,15,41–43]. The condition-specific findings further suggest that broader health-system differences alone do not determine ACSC hospitalization rates. Despite substantial differences in healthcare organization between Switzerland and the U.S., acute composite rates were similar between countries. At the same time, the individual acute indicators showed different patterns, with similar community-acquired pneumonia rates but higher urinary tract infection rates in Switzerland, while chronic and diabetes composite rates were consistently lower. This heterogeneity indicates that ACSC hospitalization rates reflect an interplay between condition-specific disease burden, outpatient management, admission practices, and broader health-system characteristics. International comparisons may therefore be informative not only as measures of health-system performance, but also for identifying which components of potentially avoidable hospital use differ across healthcare systems.

Comparison with other Swiss and international approaches

In Switzerland, ACSC hospitalizations have primarily been studied using two existing approaches: OECD Healthcare Quality and Outcomes (HCQO) primary care indicators and a Swiss ACSC approach described by Eggli et al. The OECD HCQO indicators [11] provide publicly available definitions for a limited set of chronic conditions and are designed for high-level international monitoring. Several chronic AHRQ PQIs overlap conceptually with OECD indicators (e.g. heart failure, hypertension, COPD/asthma-related indicators, diabetes related admissions and amputations) [44], and the overall levels and temporal patterns are broadly consistent with OECD-reported Swiss trends, including pre-pandemic stability and marked declines during the COVID-19 period [44].

Eggli et al. [15] described a Swiss ACSC approach (based on Purdy et al [45]) with detailed diagnosis- and procedure-based exclusions, and broader use of secondary diagnoses. While methodologically rich and tailored to the Swiss context, these definitions are not fully publicly reproducible, limiting transparency and comparability. The AHRQ PQIs complement prior Swiss work by providing a fully specified, openly accessible framework that supports reproducible estimation of a broader range of acute and chronic conditions and facilitates international benchmarking.

Strengths and limitations

This study has several strengths. It used nationwide data on all Swiss inpatient hospitalizations over a 10-year period, enabling population-level estimates and robust characterization of PQI hospitalizations. As the first nationwide operationalization of the AHRQ PQIs in Switzerland, application of this widely used international indicator framework (AHRQ PQIs) provides transparent logic and facilitates reproducible monitoring and benchmarking against established monitoring systems.

Several limitations should be considered. First, operationalizing U.S.-developed PQI definitions in the Swiss coding environment required translation across coding systems and time, and some differences in diagnostic and procedural structure are unavoidable. Although we applied a systematic, definition-driven translation process with physician review and tracking of coding changes, the resulting Swiss implementation should be viewed as a pragmatic operationalization rather than a perfect one-to-one replication of the AHRQ framework. Second, the translated indicator definitions were not formally validated against clinical records; accordingly, PQIs are best interpreted as a standardized measurement framework for monitoring potentially avoidable hospitalizations, rather than definitive clinical classifications. Third, cross-country comparisons reflect a combination of disease burden and healthcare system characteristics (e.g. admission thresholds and outpatient care pathways) and should therefore be interpreted as descriptive benchmarks rather than causal estimates of primary care performance.

Because the analysis is based on nationwide inpatient data, findings are representative of hospital care in Switzerland. Transferability to other countries is most plausible for high-income settings with comparable hospital-based care systems and coding practices; differences in health system organization, admission thresholds, and documentation should be considered when extrapolating absolute levels or trends.

Conclusion

Nationwide application of AHRQ PQIs in Switzerland showed stable pre-pandemic ambulatory care sensitive hospitalization rates, a sharp decline in 2020, lower overall, chronic and diabetes composite rates than in the U.S., and similar acute composite rates. The heterogeneous patterns across individual conditions suggest that ACSC hospitalization rates reflect an interplay between underlying disease burden, outpatient management, hospital admission practices, and broader health-system characteristics rather than differences in health-system organization alone. The AHRQ PQI framework provides a transparent and reproducible approach for monitoring potentially avoidable hospitalizations in Switzerland and for identifying condition-specific differences in hospital use across healthcare systems.

Declarations

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Conflicts of interest: Dr. Beeler reports having received fees and funding from AstraZeneca for matters unrelated to the present study. All other authors have no relevant conflicts of interest to disclose.

Ethics approval and consent to participate: This study used fully anonymized routinely collected administrative data provided by the Swiss Federal Statistical Office. According to Article 2 paragraph 2(c) of the Swiss Federal Act on Research involving Human Beings (Human Research Act, HRA; SR 810.30)[46], research involving anonymously collected or anonymized health-related data falls outside the scope of the HRA. Therefore, ethics committee approval and individual informed consent to participate were not required under Swiss law. No ethics committee

waiver was sought or obtained. The study was conducted in accordance with applicable Swiss legislation and relevant guidelines and regulations, including the principles of the Declaration of Helsinki.

Consent to participate: Not applicable.

Consent for publication: Not applicable.

CRediT authorship contribution statement:

- **Schramm:** Methodology, Data curation, Investigation, Software, Formal analysis, Visualization, Writing – original draft
- **Havranek:** Methodology, Writing – review & editing
- **Hug:** Writing – review & editing
- **Beeler:** Conceptualization, Project administration, Methodology, Supervision, Writing – review & editing

Data Sharing Statement: Supplementary tables are available online with this publication. The data used in this study may be obtained from third parties but cannot be shared by the authors due to licensing issues and data protection requirements.

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Table 1

Table 1 is available in the Supplementary Files section.

Figures

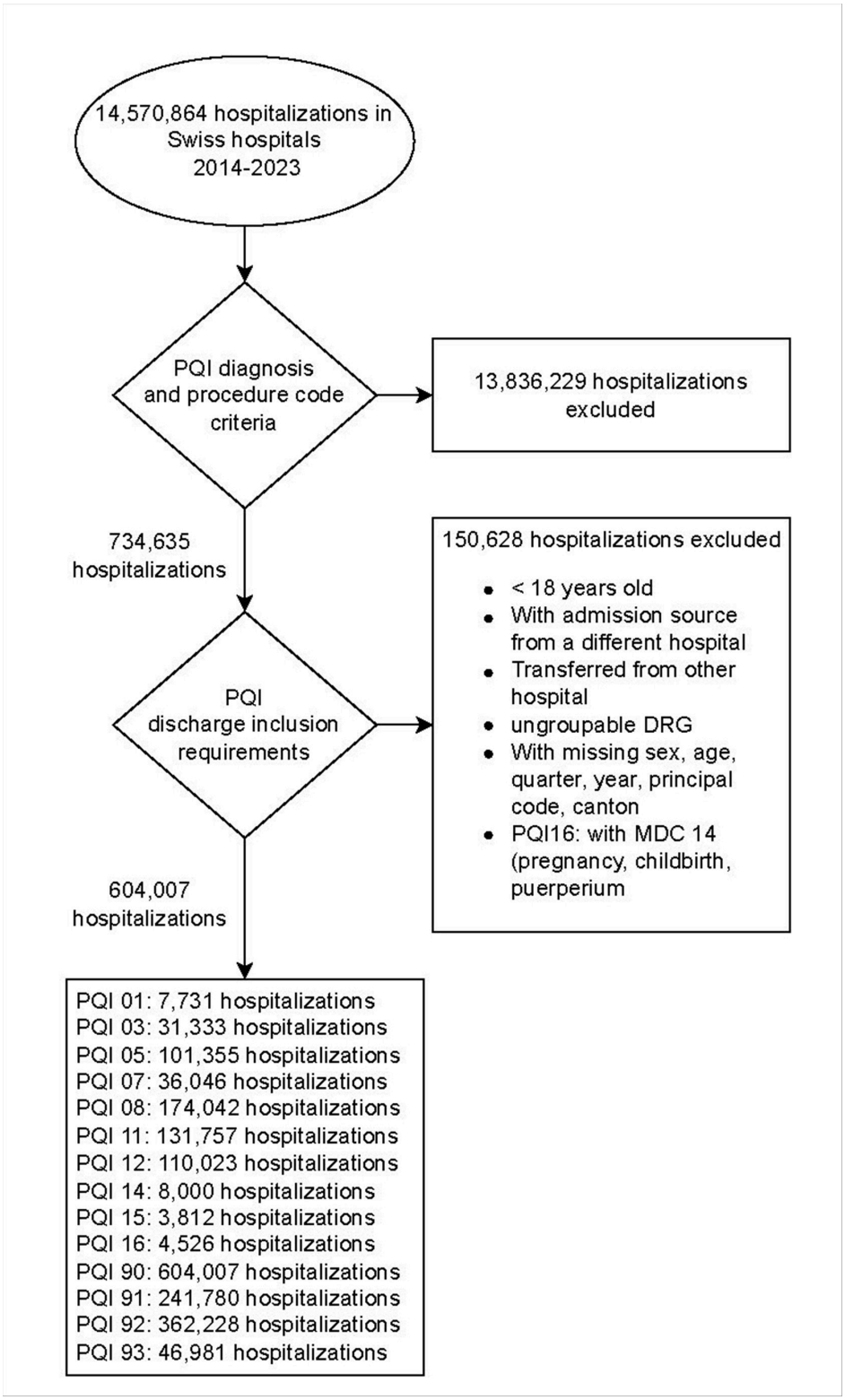


Figure 1

Patient Flow Chart

PQI 01: Diabetes Short-Term Complications Admission Rate
PQI 03: Diabetes Long-Term Complication Admission Rate
PQI 05: Chronic Obstructive Pulmonary Disease (COPD) or Asthma in Older Adults Admission Rate
PQI 07: Hypertension Admission Rate

PQI 08: Heart Failure Admission Rate
PQI 11: Community-Acquired Pneumonia Admission Rate
PQI 12: Urinary Tract Infection Admission Rate
PQI 14: Uncontrolled Diabetes Admission Rate
PQI 15: Asthma in Younger Adults Admission Rate
PQI 16: Lower-Extremity Amputation among Patients with Diabetes Admission Rate
PQI 90: Prevention Quality Overall Composite
PQI 91: Prevention Quality Acute Composite
PQI 92: Prevention Quality Chronic Composite
PQI 93: Prevention Quality Diabetes Composite
AHRQ: Agency for Healthcare Research and Quality
DRG: Diagnosis-related group
Stays with an ungroupable DRG had the DRG code “960Z”; 5 Stays over the study period were excluded for this reason

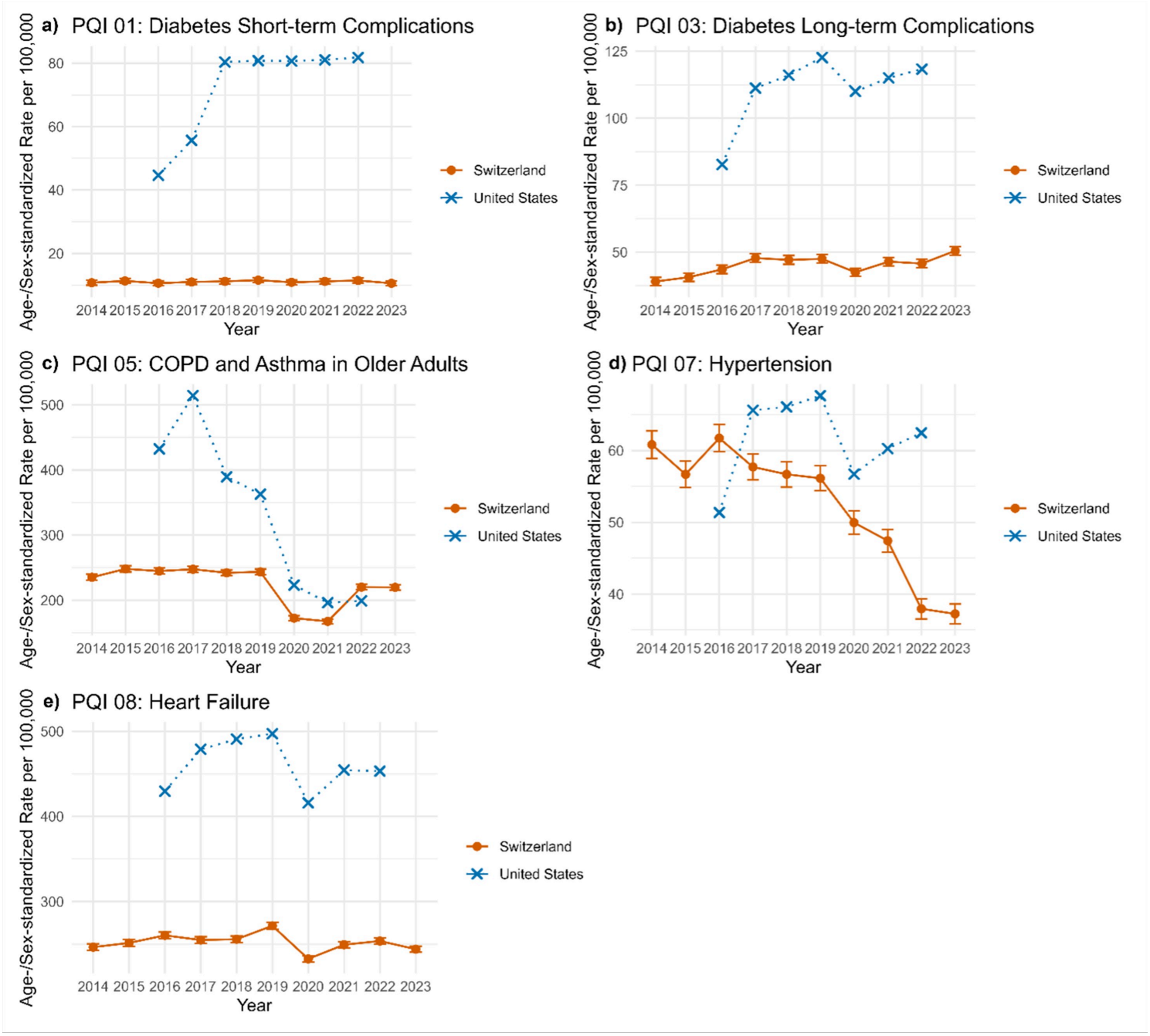


Figure 2

Age-/sex-standardized PQI 01, PQI 03, PQI 05, PQI 07, PQI 08

Abbreviations: COPD (chronic obstructive pulmonary disease)

Rates are age-/sex-standardized among adults aged 18 years and older using the Swiss 2020 standard population.

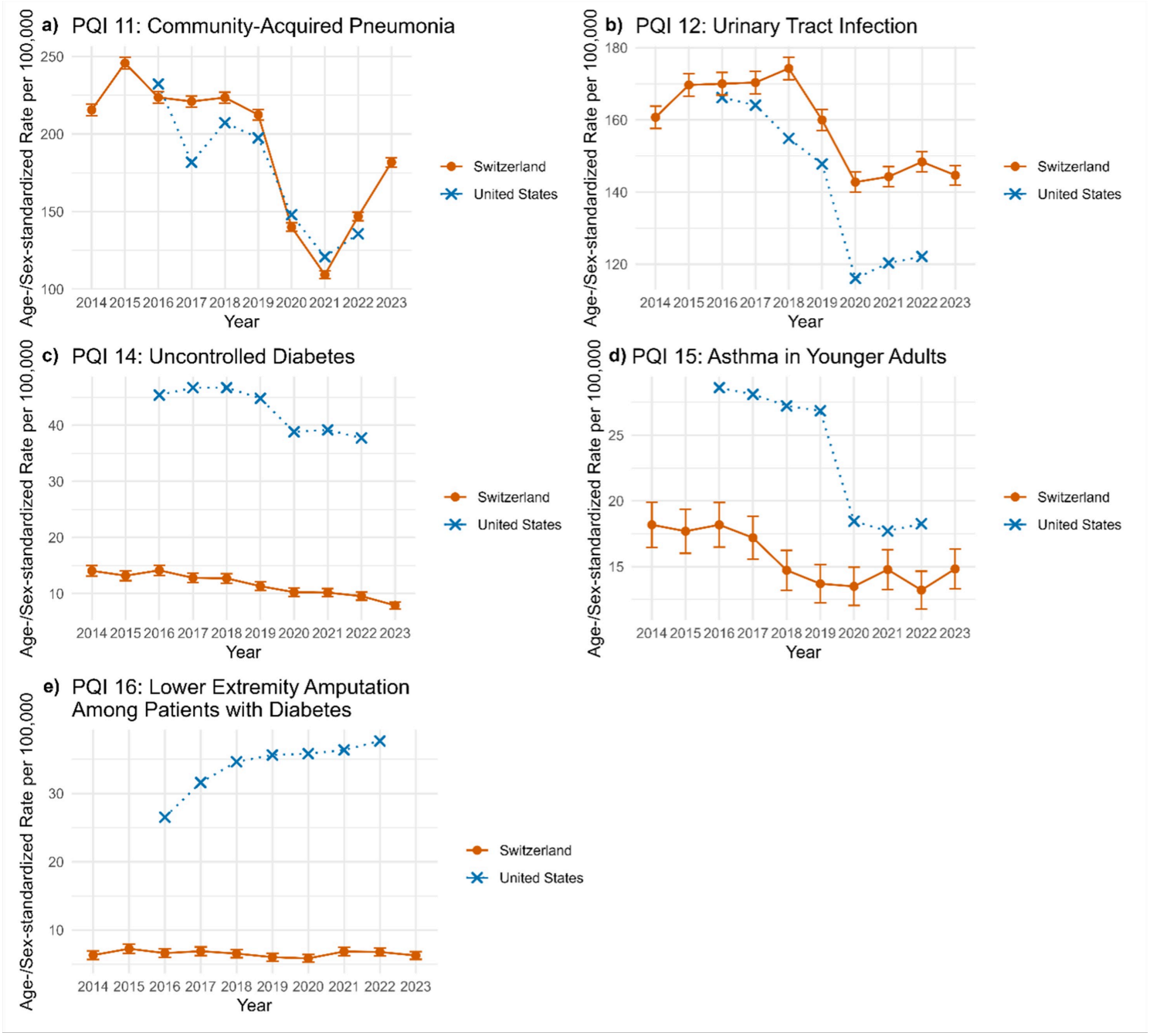


Figure 3

Age-/sex-standardized PQI 08, PQI 11, PQI 12, PQI 14

Rates are age-/sex standardized among adults aged 18 years and older using the Swiss 2020 standard population.

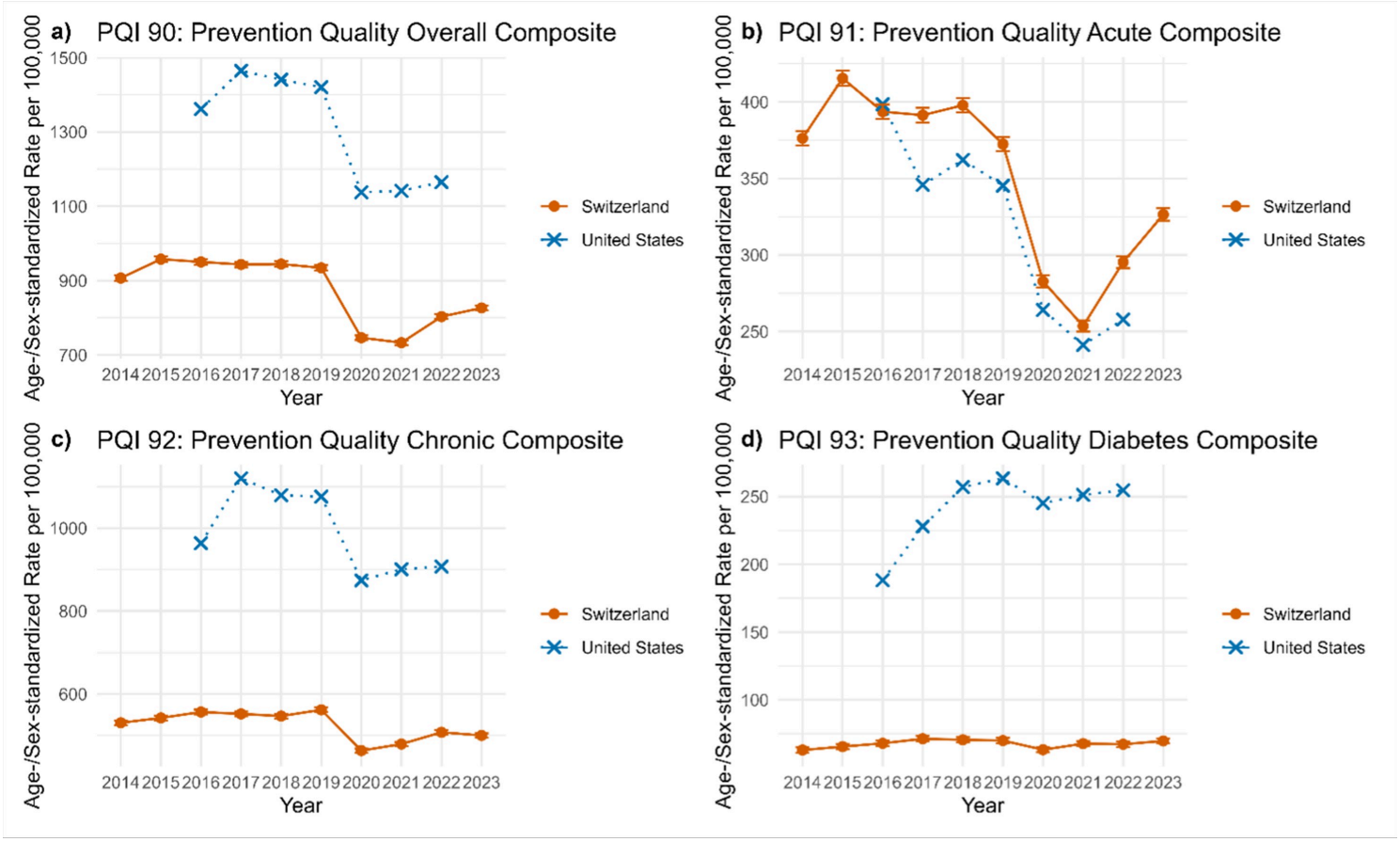


Figure 4

Age-/sex-standardized PQI 90, PQI 91, PQI 92, PQI 93

Rates are age-/sex-standardized among adults aged 18 years and older using the Swiss 2020 standard population.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementBMCHealthServicesResearch.docx
- Table1.docx