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Assessing Mexico's prison health system: access, care processes, resources, accountability and longitudinal mortality indicators

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Abstract

Background: Mexico lacks a national assessment integrating reported prison healthcare pathways and processes with prison resources, oversight and repeated administrative indicators. We assessed these domains across complementary national sources.

Methods: We performed a multi-source secondary analysis of public observational data. ENPOL 2021 measured chronic-care pathways, care processes and equity. Independent ENSANUT samples provided age-sex-standardised treatment benchmarks. State-clustered models assessed prison occupancy, staffing and general-system capacity. CNSIPEE 2021–2025 and monthly PRS reports through May 2026 supplied retrospective indicators. DNSP and CNDHE supplied external supervision and accountability signals. Analyses remained source-specific.

Results: Among 10,280 chronic person-condition episodes, 53.9% (95% CI 52.9–55.0) were centre-provided, 20.8% (19.9–21.7) self/family-financed and 23.1% (22.1–24.0) unattended. Medical examination on arrival, periodic medical review and vaccination were reported by 73.4%, 41.8% and 77.9%, respectively. Untreated prevalence exceeded standardised ENSANUT 2021 estimates for diabetes by 11.55 percentage points (95% CI 7.46–15.65) and hypertension by 13.60 points (9.30–17.90). In the overall primary analysis (6,601 people; 32 states), occupancy was associated with higher odds of unattended care (aOR per state SD 1.29, 95% CI 1.10–1.52; LRT p=0.004); in a joint model, staffing was inversely associated (OR 0.797, 95% CI 0.703–0.904), while general-system capacity was inconclusive. DNSP explicitly reported health-service deficiencies in 155/233 supervised state centres; the state deficiency proportion correlated with lower centre provision (Spearman rho=-0.47; bootstrap 95% CI -0.71 to -0.14). None of six CNSIPEE service-availability contrasts retained evidence after Holm adjustment. Across 3,872 state-months and 5,877 administrative deaths, lagged occupancy was associated with a higher death rate (IRR per 10 points 1.087, 1.009–1.171), but a future-occupancy diagnostic was similar.

Conclusions: Reported chronic-care and periodic-review gaps coincided with state-level associations of higher occupancy and lower staffing with unattended care; DNSP deficiencies correlated with lower centre provision. Service-availability results were inconclusive, and the mortality association lacked temporal specificity, supporting monitoring rather than causal interpretation.

Keywords: prison health, health-system performance, health-care access, care processes, accountability, overcrowding, administrative data, Mexico

1 Background

People deprived of liberty have high burdens of physical and mental illness, while imprisonment places care within custodial institutions and limits independent provider choice [1–3]. The United Nations Standard Minimum Rules for the Treatment of Prisoners assign prison health care to the state and require access without discrimination by legal status [1]; the right-to-health framework requires services to be available, accessible, acceptable and of adequate quality [2]. These obligations are also explicit in regional and national law. Article 18 of the Mexican Constitution requires a penitentiary system based on respect for human rights, and Principle X of the Inter-American Commission on Human Rights recognises the right to health in custody and requires coordination with the public health system [4]. Mexico's Supreme Court has held that failure to provide timely medical care, when it gravely compromises dignity and integrity, may be comparable to constitutionally prohibited torment [5], consistent with Inter-American Court precedents (Tibi v. Ecuador, 2004; Vélez Loor v. Panama, 2010) [6]. Accordingly, prison-provided treatment, care financed by a person or family and unattended need are distinct operational outcomes [1, 2]. Performance assessment must distinguish need, receipt and provider while locating each within the resources and accountability structures of the custodial system.

Mexican evidence has largely described health need: Mexico City studies reported disease burden and non-communicable risk factors [7, 8], and ENPOL characterised geriatric health nationally [9]. A two-prison study examined diabetes and hypertension care [10], while a national ENPOL–ENSANUT preprint compared health risks, conditions and selected treatment indicators [11]. To our knowledge, no national multisource assessment in Mexico has distinguished prison-centre provision, personal or family financing and unattended chronic-care need while examining these pathways alongside prison-specific resources and independent supervision. International evidence

indicates that access is shaped by institutional organisation. Swiss prison and individual characteristics were associated with service use [12]; a Zambian study linked resource shortages and institutional relations to access [13]; and English primary-care data identified between-prison variation [14]. Together, these studies support assessing provision, financing and institutional capacity but do not address the Mexican gap.

The WHO Prison Health Framework separates system inputs, service-delivery outputs and health outcomes, with equity and equivalence as cross-cutting principles [15]. Published indicator research indicates that prison-health performance measures remain unevenly developed, often emphasise processes and depend on comparable data systems [16]. Because administrative records cannot establish individual care receipt and surveys alone cannot assess system capacity or change over time, these sources require complementary, source-specific analysis without implying individual linkage.

Using eight national public data systems spanning 2015 through May 2026, this study aimed to characterise chronic-care access, financing, care processes and equity; benchmark reported absence of diabetes and hypertension treatment against the general adult population; assess prison-specific structural indicators alongside general medical capacity and external supervision; and evaluate repeated service, accountability and longitudinal mortality indicators. Sources were combined only when units and periods were compatible; parallel components remained source-specific and associational and were not treated as a single cohort or causal chain. This design prioritised domain-specific inference over a synthetic ranking because sources differed in populations, units and periods.

2 Methods

2.1 Study design, sources and performance domains

We conducted a national multi-source secondary analysis of public observational data comprising de-identified survey microdata and aggregate administrative records.

Source-specific cleaning and harmonisation produced parallel cross-sectional, cross-survey benchmark and retrospective ecological components rather than a linked cohort. ENPOL 2021 was the individual-level prison source. This probability survey was stratified by state and centre of interest; within state strata, people were randomly sampled from prison-population lists. ENPOL obtained 61,449 completed interviews among 67,584 selected people (90.9%) [17]. Public centre identifiers covered only a subset, so contextual exposures were assigned at state level and centre-restricted analyses were treated as sensitivity analyses.

The 2021 structural component linked ENPOL by state code to CNSIPEE, 12 monthly penitentiary reports (PRS), DNSP and the 2020 marginalisation index [18–21]. Independent ENSANUT Continua 2021 and 2024 adult samples provided general-population benchmarks [22, 23]; DGIS resources and CONAPO projections supplied general-system medical capacity [24, 25]. Retrospective components used CNSIPEE 2021–2024, 2025 descriptive tabulations, 137 monthly PRS reports from January 2015 through May 2026, and 2024–2025 CNDHE open tables [18, 19, 26]. Federal prisons were excluded from state-system denominators. Full source-by-variable definitions—including source fields, variable nature, analytical construct, meaning and coding—are in Additional file 1: Table S1; source periods, analytical roles and linkage constraints are in Table S2.

The WHO Prison Health Framework [15] organised measures into environment and resources; access and financial protection; care processes and prevention; equity; accountability and external supervision; and longitudinal mortality indicators. The latter were repeated ecological death counts over calendar time, not individual follow-up or prospective data collection. Mental-health need and safety were descriptive, and no composite score or ranking was created. Figure 1 maps sources, periods and analytical units. Additional file 1 contains Methods S1–S8, 26 supplementary tables and Figures S1–S2. The ENPOL person-level occupancy model was the overall primary

analysis; component-specific focal, secondary, post hoc and exploratory analyses are identified below. Protocols were locked locally before focal estimation but not externally preregistered. Except where parent–child rules defined structural zeros, models used complete cases; all tests were two-sided.

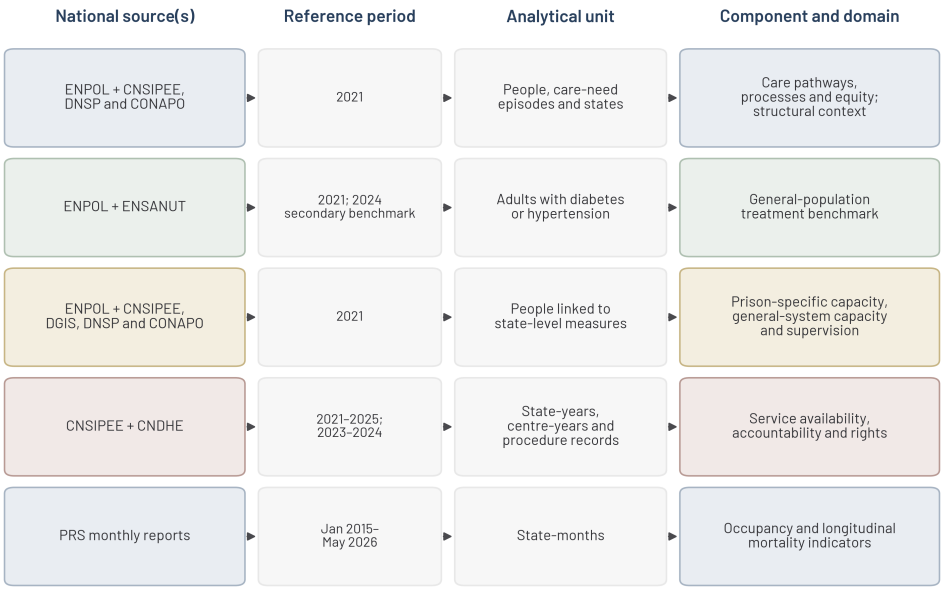


Fig. 1 Study architecture across national data sources and analytical components. The diagram maps each source group to its reference period, analytical unit and contribution to the multidomain assessment. Parallel components contribute complementary evidence; arrows do not denote one linked cohort or a causal chain.

2.2 Study population and measures

The chronic-care analysis included physician-diagnosed diabetes, hypertension, cancer, tuberculosis, hepatitis or HIV. Acute respiratory conditions were excluded because absence of current treatment may not indicate ongoing unmet need. Each person-condition pair formed an episode. The care-need denominator included episodes with ongoing treatment or absence of treatment for a barrier, another reason or an indeterminate reason; completed treatment and stated absence of need were excluded.

Treatment pathways were classified as prison-centre provision, self/family financing, another provider or unattended care. These categories represent reported receipt and provider, not quality, appropriateness, continuity or legal compliance. Descriptive analyses included state and federal prisons; structural models included only state prisons because exposures represented state systems. Among people with diabetes, hypertension or cancer, the primary person-level outcome was at least one unattended condition. A secondary two-part analysis modelled unattended care versus treatment and, among treated episodes, prison-centre versus outside provision.

Care-process indicators were medical examination on arrival, periodic review and vaccination during imprisonment. Secondary measures included centre-provided cervical and breast screening, prenatal review and maternal-care satisfaction. Screening denominators were questionnaire-defined, and maternal satisfaction did not represent general acceptability. Suicidal thoughts and attempts measured contextual need and safety, not service response. Care-process analyses followed a dated post hoc amendment frozen before final modelling. National and jurisdiction-specific percentages used the ENPOL design; Holm adjustment covered the three federal-versus-state care-process contrasts.

The principal structural exposure was state prison occupancy divided by installed capacity in 2021 and standardised across the 32 states before linkage. Prison medical personnel per 1,000 people deprived of liberty was the focal supply measure. Covariates were age, sex, Indigenous identification, state marginalisation, prison-system size and, where conceptually appropriate, the DNSP score. Indeterminate Indigenous-identification responses were treated as missing. Monthly PRS occupancy and alternative transformations were sensitivities.

2.3 Comparative, equity and structural analyses

ENPOL percentages and confidence intervals incorporated the survey design and clustered repeated episodes within people. The overall primary analysis was an unweighted logistic mixed model with a state random intercept, relating occupancy per state standard deviation to at least one unattended non-communicable condition, adjusted for age, sex, Indigenous identification, DNSP, marginalisation and prison-system size. Occupancy was assessed with a likelihood-ratio test, and adjusted odds ratios were reported with Wald intervals. Marginal risks were standardised over observed covariates and contrasted at the first and third occupancy quartiles. Secondary two-part models used condition-adjusted logistic regression with state-clustered variance and t inference. Primary sensitivities varied outcome and exposure definitions, scale, survey weighting, association scale, incarceration duration, state influence, model structure and bootstrap uncertainty. Weighted multilevel, prevalence-ratio and heterogeneity summaries followed established methods [27–30]; Additional file 1: Methods S1–S2 and Tables S3–S10 provide details.

Diabetes and hypertension were the only ENPOL conditions with comparable physician-diagnosis and disease-specific current-treatment items in both ENSANUT rounds. Cancer, tuberculosis, hepatitis and HIV lacked a comparable cross-survey treatment-status construct and remained ENPOL-only; eligibility was fixed by measurement compatibility before estimation. Separate benchmarks included diagnosed adults aged at least 20 years and excluded gestational-only ENSANUT diagnoses. The endpoint was reported absence of current treatment. Each survey retained its own sampling design; ENSANUT was standardised to the disease-specific ENPOL age-by-sex distribution (20–39, 40–59 and at least 60 years). Standardised prevalences, ENPOL-minus-ENSANUT risk differences and prevalence ratios used 95% confidence intervals combining independent survey variances. ENSANUT 2021 was

the component-specific focal contemporaneous benchmark; ENSANUT 2024 was a secondary repeated comparison, not follow-up.

Secondary equity analyses estimated marginal standardised risks of unattended care, prison-centre provision and self/family financing by sex, age and Indigenous identification, adjusting for disease and other demographic variables. We reported adjusted risk differences and prevalence ratios. Holm adjustment covered nine contrasts; inference was suppressed for groups with fewer than 30 episodes or effective sample size below 20.

DGIS medical professionals were aggregated by state after excluding custodial establishments and divided by CONAPO population. The component-specific focal joint 2021 model included prison staffing, occupancy and general medical capacity; reduced state-clustered logistic models paired occupancy with each capacity measure. Models adjusted for demographics, marginalisation and prison-system size; staffing models omitted DNSP because it overlaps health services. A 2,000-replicate state bootstrap assessed uncertainty, and prespecified collinearity criteria governed residualisation. An exploratory seven-indicator CNSIPEE resource screen used Benjamini–Hochberg correction. Additional file 1: Methods S3–S4 and Tables S11–S15 provide harmonisation and diagnostics.

2.4 Retrospective administrative components

The CNSIPEE 2021–2024 state-year panel measured proportions of reporting centres offering any medical service, medication supply and chronic-disease treatment. Official nonresponse and structural absence remained missing; outcomes required determinate reporting from at least 80% of observed centres. Occupancy and staffing were modelled separately with state and year fixed effects, state-clustered variance and small-cluster t inference. The six component-specific focal contrasts were Holm-adjusted; first differences were secondary, and complete-reporting and leave-one-state-out fits were

sensitivities. The 2025 tabulations were descriptive because comparable outcomes were unavailable (Additional file 1: Method S5 and Tables S16–S18).

The PRS state-month panel analysed separately the broad administrative-death category reported through June 2025 and the natural- or disease-death category introduced in July 2025; three reports without statistical tables were not imputed. The component-specific focal historical model was Poisson with state and calendar-month fixed effects, prison population as an offset and one-month-lagged occupancy; the recent series was secondary. Inference used state-clustered variance with 31 degrees of freedom and a 2,000-replicate state bootstrap. Prespecified sensitivities addressed COVID-19, state trends, lags, distribution and influential states; functional-form and future-occupancy checks were post hoc. These measures were interpreted as surveillance signals because individual linkage and clinical cause-of-death adjudication were unavailable (Additional file 1: Method S6 and Tables S19–S21).

The remaining descriptive supplementary displays report the jurisdiction-specific provider and financing distribution, the domain-to-indicator mapping and care-process indicators (Additional file 1: Tables S22–S24).

CNSIPEE accountability analyses followed the dated post hoc amendment. Measures counted medical/psychological complaints and health-related requests to public human-rights bodies; parent–child rules distinguished true zeros from nonresponse. Exploratory fixed-effects count models required at least 80% determinate centre reporting, used prison population as an offset and assessed dispersion and influence with alternative models and leave-one-state-out fits; Holm adjustment covered four exposure–signal models. Counts were not monotonic quality measures because they also reflect reporting access. Exploratory CNDHE descriptions required both a health-related violation type and the state penitentiary system and represent procedure–violation-type–institution records, not unique cases or people. DNSP findings were classified as explicit deficiency, appropriate attention or no disclosed health

finding; non-disclosure was not adequacy. Exploratory state-level DNSP correlations with ENPOL estimates used Spearman coefficients and 10,000 state-bootstrap replicates (Additional file 1: Method S7 and Tables S25–S26).

2.5 Software and reporting

Analyses used R 4.5.3 and Python 3.12.13. Exact package versions, executable commands and validation checks are listed in Additional file 1: Method S8. Completed STROBE checklists for the cross-sectional and retrospective ecological components are also included.

3 Results

Of 61,449 completed ENPOL interviews, the state-prison care-need dataset included 7,571 people and 9,159 chronic person-condition episodes. The primary base comprised 6,674 people with at least one non-communicable condition; complete-case structural models retained 6,601 after excluding one person with missing age and 72 with missing Indigenous identification (Additional file 1: Table S9). Survey-weighted mean age was 46.4 years (95% CI 46.2–46.7), 9.21% were women and 23.7% self-identified as Indigenous; 20.0% had at least two included conditions. Women comprised 27.9% of the unweighted sample, reflecting the ENPOL design, and 78 Indigenous-identification responses were missing. Weighted prevalence was 64.7% for hypertension, 37.7% for diabetes, 9.6% for hepatitis, 4.3% for HIV, 2.3% for tuberculosis and 2.2% for cancer. Median state occupancy/capacity was 1.05 (IQR 0.84–1.21; range 0.35–2.44) (Table 1).

Table 1. Characteristics of respondents with ongoing chronic-care need in state prisons, ENPOL 2021

Characteristic	Unweighted n/N	Survey-weighted estimate (95% CI)	Missing n
People	7,571	—	0
Chronic person-condition episodes	9,159	—	—
Age, years	7,570	46.4 (46.2–46.7)	1
Women	2,116/7,571	9.21% (9.18–9.24)	0
Indigenous self-identification	1,751/7,493	23.7% (22.7–24.6)	78
At least two included chronic conditions	1,529/7,571	20.0% (19.0–20.9)	0
Hypertension	5,055/7,571	64.7% (63.6–65.9)	0
Diabetes	2,838/7,571	37.7% (36.5–38.8)	0
Hepatitis	564/7,571	9.6% (8.9–10.2)	0
HIV	334/7,571	4.3% (3.8–4.7)	0
Cancer	217/7,571	2.2% (1.9–2.5)	0
Tuberculosis	151/7,571	2.3% (1.9–2.6)	0
State occupancy/capacity, median (IQR; range)	32 states	1.05 (0.84–1.21; 0.35–2.44)	0

Notes: Estimates for individual characteristics incorporate the ENPOL design stratum, person weight and finite-population correction. The Indigenous-identification estimate excludes 78 do not know/no-response values. Disease categories are not mutually exclusive. Occupancy/capacity is an administrative state-level summary, not a survey-weighted estimate. CI, confidence interval; IQR, interquartile range.

Across 10,280 national care-need episodes, 53.9% (95% CI 52.9–55.0) were centre-provided, 20.8% (19.9–21.7) self/family-financed, 23.1% (22.1–24.0) unattended and 2.2% (1.9–2.5) supplied by another provider. Centre provision was higher in federal than state prisons (74.6%, 70.7–78.5, versus 51.9%, 50.8–53.0), while self/family financing was lower (5.0%, 3.4–6.5, versus 22.4%, 21.4–23.3); unattended care was 18.4% (15.1–21.6) and 23.5% (22.6–24.5), respectively (Figure 2A; Additional file 1: Table S22). Across state systems, centre provision ranged from approximately 20% to 94%, with wide confidence intervals for some states (Figure 2B).

Among 8,110 non-communicable care-need episodes in state prisons, 18.3% (95% CI 17.3–19.2) were unattended; the strict definition retained 7,789 episodes and estimated documented barriers in 14.9% (14.0–15.8). Among 1,353 unweighted episodes without current treatment, centre non-provision was the predominant reason (717 episodes; weighted 56.9%, 95% CI 54.0–59.8), followed by another reason (19.9%, 17.6–22.1) and lack of money (13.3%, 11.4–15.2) (Additional file 1: Table S8). Among 6,757 treated episodes, 67.4% (66.2–68.6) were centre-provided, 30.8% (29.6–32.0) self/family-financed and 1.8% (1.4–2.2) involved another provider. Complete-covariate

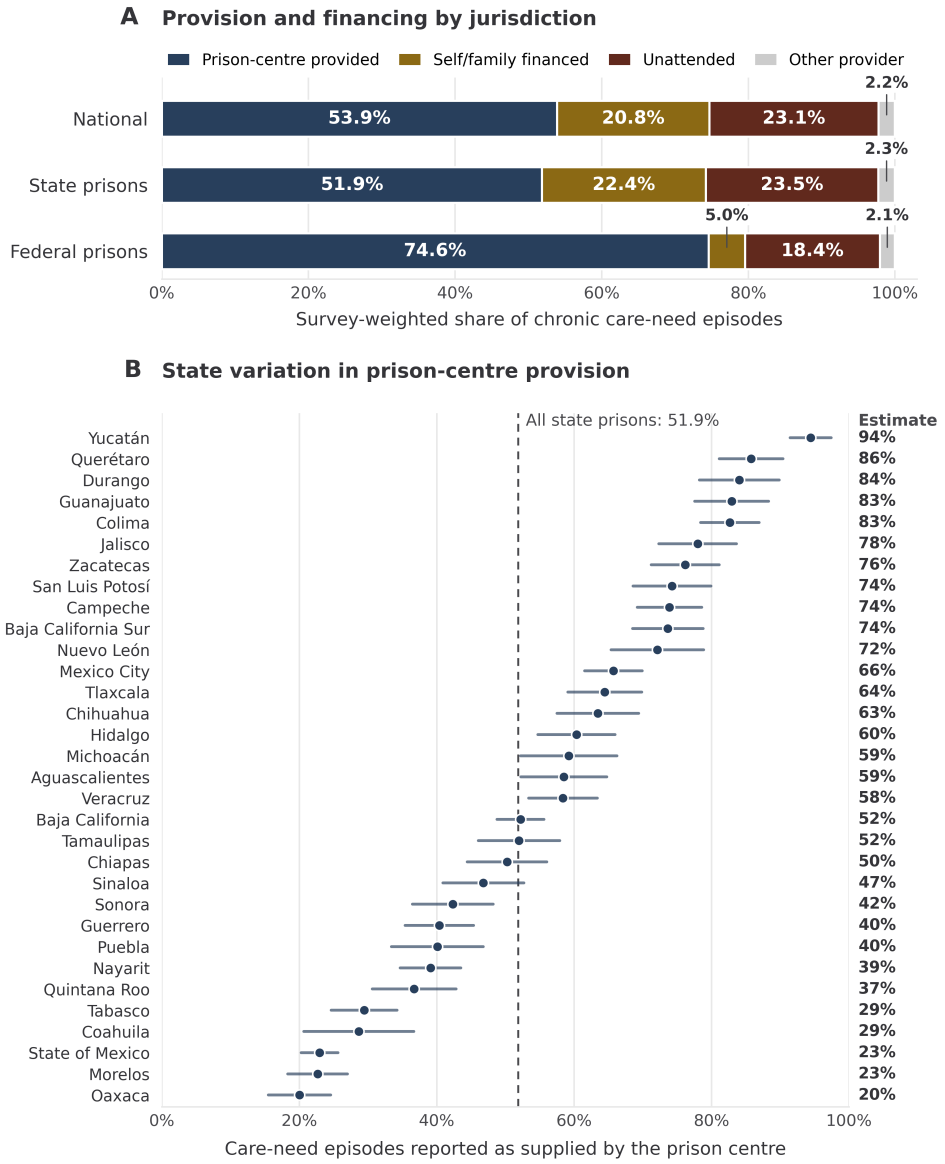


Fig. 2 Reported chronic-care provision nationally, by jurisdiction and across state prison systems. (A) Survey-weighted distribution of 10,280 chronic person-condition episodes with ongoing care need, nationally and in state and federal prisons. Categories are mutually exclusive; direct labels and a fixed segment order support interpretation without relying solely on colour. "Other provider" includes civil-society and other reported providers. (B) Survey-weighted percentage of chronic care-need episodes reported as supplied by the prison centre in each of the 32 state prison systems. Points are state estimates, horizontal lines are design-based 95% confidence intervals and the dashed line is the pooled estimate across state prisons. Estimates incorporate ENPOL design strata, person weights, finite-population corrections and clustering of episodes within people. State estimates describe reported provision and should not be interpreted as rankings of clinical quality.

models retained 8,021 episodes from 6,601 people in Part 1 and 6,680 episodes from 5,463 people in Part 2 across 32 states (Additional file 1: Table S7).

Per state-level standard deviation, occupancy was associated with higher odds of unattended care (aOR 1.27, 95% CI 1.13–1.43; p<0.001) and, among treated episodes, lower odds of centre provision rather than outside provision (aOR 0.63, 95% CI 0.48–0.83; p=0.0015). Adjusted centre provision was 76.3% at the first occupancy quartile and 68.5% at the third (difference -7.8 percentage points, 95% CI -11.4 to -3.5). Greater staffing was associated with lower unattended care (aOR 0.79, 95% CI 0.71–0.88; p<0.001), whereas its association with centre provision among treated episodes was inconclusive (aOR 1.12, 95% CI 0.84–1.49; p=0.430) (Additional file 1: Table S7 and Figure S1).

The primary model included 6,601 people in 32 state systems. A one-standard-deviation increase in occupancy/capacity was associated with 29% higher odds of at least one unattended non-communicable condition (aOR 1.29, 95% CI 1.10–1.52; LRT p=0.004) (Table 2). The fitted model was nonsingular. At the observed covariate distribution, marginal predicted risk was 14.7% at occupancy 0.84 and 17.7% at 1.21, a 3.0-point difference (Figure 3).

Table 2. Associations of state penitentiary resources with unattended non-communicable chronic care

Model and term	Adjusted OR (95% CI)	P value	Analytic sample
Primary occupancy model			
Occupancy/capacity, per state SD	**1.29 (1.10–1.52)**	**0.004†**	6,601 people; 32 states
DNSP score, per state SD	0.90 (0.77–1.05)	0.185	6,601; 32
State marginalisation, per state SD	0.98 (0.84–1.14)	0.794	6,601; 32
Log prison-system size, per state SD	1.16 (0.99–1.37)	0.075	6,601; 32
Age, per 10 years	0.62 (0.59–0.66)	<0.001	6,601; 32
Woman vs man	0.57 (0.49–0.66)	<0.001	6,601; 32
Indigenous self-identification	1.13 (0.97–1.32)	0.129	6,601; 32
Secondary staffing model			
Medical staff per 1,000 people in prison, per state SD	**0.77 (0.67–0.88)**	**<0.001†**	6,601; 32

Notes: The analytic sample column reports people and states, respectively. Mixed-effects logistic regression with a state random intercept. The primary occupancy model includes all terms displayed. The staffing model adjusts for occupancy/capacity, state marginalisation, log system size, age, sex and Indigenous identification; DNSP is omitted because it contains a health-services component and is added in sensitivity analysis. †Likelihood-ratio test for the named state-level exposure; other P values are Wald tests. CI, confidence interval; DNSP, National Penitentiary Supervision Assessment; OR, odds ratio; SD, standard deviation.

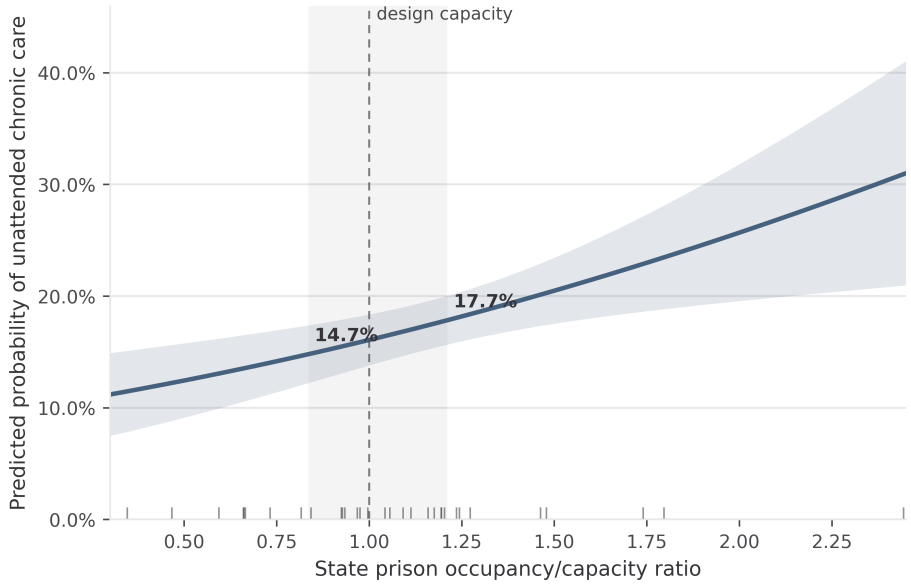


Fig. 3 State prison occupancy and predicted unattended chronic care. Marginal probabilities from the primary mixed-effects logistic model (6,601 people; 32 states), averaged over the observed covariate distribution and adjusted for age, sex, Indigenous identification, DNSP score, state marginalisation and prison-system size. The blue line is the predicted probability, the blue band is its 95% confidence interval, the grey region is the observed state interquartile range (0.84–1.21), the dashed line marks occupancy equal to installed capacity and the rug shows the 32 state exposure values. Predicted risk increased from 14.7% at the first quartile to 17.7% at the third; uncertainty widens at sparsely observed extremes.

Per 10 additional years, the aOR was 0.62 (95% CI 0.59–0.66), and for women versus men it was 0.57 (0.49–0.66). Indigenous identification was inconclusive after adjustment (aOR 1.13, 0.97–1.32). These conditional associations were not primary estimands. The state random-intercept variance decreased from 0.217 to 0.111; the intraclass correlation decreased from 0.062 to 0.033 and the median odds ratio from 1.56 to 1.37.

In disease-specific samples, absence of current treatment was more prevalent in ENPOL 2021 than in age-sex-standardised ENSANUT 2021. For diabetes, prevalence was 19.91% versus 8.36%, a difference of 11.55 percentage points (95% CI 7.46–15.65) and prevalence ratio of 2.38 (95% CI 1.50–3.79; n=3,406 and 1,590). For hypertension, prevalence was 31.73% versus 18.13%, a difference of 13.60 points (9.30–17.90) and prevalence ratio of 1.75 (1.39–2.20; n=6,575 and 2,388) (Table 3;

Additional file 1: Tables S11–S12). These independent cross-sectional samples and harmonised self-reports do not measure clinical control, treatment quality or an effect of incarceration.

Table 3. Cross-survey benchmark of reported absence of current chronic-disease treatment

Disease/year	ENPOL, %	Standardised ENSANUT, %	Difference, points (95% CI)	Prevalence ratio (95% CI)	n: ENPOL; ENSANUT
Diabetes, 2021 primary	19.91	8.36	**11.55 (7.46–15.65)**	**2.38 (1.50–3.79)**	3,406; 1,590
Hypertension, 2021 primary	31.73	18.13	**13.60 (9.30–17.90)**	**1.75 (1.39–2.20)**	6,575; 2,388
Diabetes, 2024 secondary	19.91	8.00	**11.91 (7.77–16.06)**	**2.49 (1.52–4.07)**	3,406; 1,613
Hypertension, 2024 secondary	31.73	25.86	5.87 (-1.17 to 12.90)	1.23 (0.94–1.61)	6,575; 2,513

Notes: Each survey was analysed with its own complex-sample design. ENSANUT estimates were directly standardised to the sex and age-group distribution of the corresponding ENPOL disease sample; that estimated standard was treated as fixed. Variances from the independent surveys were combined without pooling records or weights. Treatment questions are harmonised only at the level of reported current treatment; comparisons do not establish equivalent medication, clinical management, control or quality. CI, confidence interval.

Against ENSANUT 2024, the diabetes difference was 11.91 percentage points (95% CI 7.77–16.06; prevalence ratio 2.49, 1.52–4.07), whereas the hypertension difference was smaller and inconclusive (5.87 points, -1.17 to 12.90; prevalence ratio 1.23, 0.94–1.61). This repeated cross-survey comparison was not follow-up of ENPOL respondents.

Among nine equity contrasts, Indigenous identification was associated with 4.25 percentage points more unattended care (95% CI 1.83–6.67; prevalence ratio 1.25, 1.11–1.40) and 5.23 points less centre provision (-8.19 to -2.27; prevalence ratio 0.91, 0.86–0.96); both remained supported after Holm adjustment. Self/family financing was inconclusive. Women and people aged at least 60 years had lower unattended care and greater centre provision than reference groups, but disease mix, selection, survival, segregation or custodial conditions may explain these descriptive differences; they were not automatically interpreted as equity advantages (Additional file 1: Table S15).

The joint state-clustered model retained 6,601 people in all 32 states. Staffing was associated with lower unattended care (OR per state SD 0.797, cluster-HC1 95% CI 0.703–0.904; bootstrap 0.671–0.919), and occupancy with higher unattended care

(OR 1.276, 1.160–1.404; bootstrap 1.061–1.523). General-system medical capacity was inconclusive (OR 1.039, 0.969–1.115; bootstrap 0.743–1.125) (Table 4; Additional file 1: Tables S13–S14). Correlation was -0.15 and variance-inflation factors were below 1.3. These ecological associations indicate that prison-specific measures contained information not substituted by this general-capacity measure; they do not identify causal effects.

Table 4. Structural models of unattended care with general-system capacity

Model and focal term	OR per state SD (cluster-HC1 95% CI)	State-block bootstrap 95% CI	People/states
Prison-specific model: prison medical staff	**0.786 (0.701–0.881)**	0.669–0.900	6,601/32
Prison-specific model: occupancy	**1.254 (1.145–1.373)**	1.071–1.499	6,601/32
General-capacity model: general medical capacity	**1.082 (1.018–1.150)**	0.796–1.173	6,601/32
General-capacity model: occupancy	**1.308 (1.190–1.437)**	1.111–1.673	6,601/32
Joint model: prison medical staff	**0.797 (0.703–0.904)**	0.671–0.919	6,601/32
Joint model: general medical capacity	1.039 (0.969–1.115)	0.743–1.125	6,601/32
Joint model: occupancy	**1.276 (1.160–1.404)**	1.061–1.523	6,601/32

Notes: Person-level logistic models used state-clustered HC1 variance with t(31) reference and 2,000 state-block bootstrap replicates. All models adjusted for age, sex, Indigenous identification, state marginalisation and prison-system size; staffing models also included occupancy. General medical capacity was DGIS medical professionals per 1,000 general-population residents. Correlation between prison and general medical capacity was -0.146; variance-inflation factors were 1.26 and 1.16, below protocol thresholds. CI, confidence interval; DGIS, General Directorate of Health Information; OR, odds ratio; SD, standard deviation.

Among valid ENPOL responses, 73.36% (95% CI 73.02–73.71; n=60,867) reported an examination on arrival, 41.77% (41.39–42.16; n=61,395) reported periodic medical review and 77.86% (77.55–78.17; n=61,419) reported vaccination. Federal-minus-state differences were +5.88 percentage points for examination (95% CI 4.57–7.18), +9.06 for periodic review (7.51–10.62) and -3.30 for vaccination (-4.72 to -1.88); all remained supported after Holm adjustment (Table 5).

Table 5. ENPOL-reported care processes by prison jurisdiction

Indicator	National, % (95% CI)	Federal, %	State, %	Federal minus state, points (95% CI)	Holm P value
Arrival medical examination	73.36 (73.02–73.71)	78.81	72.93	**5.88 (4.57–7.18)**	<0.001
Periodic medical review	41.77 (41.39–42.16)	50.16	41.10	**9.06 (7.51–10.62)**	<0.001
Vaccination	77.86 (77.55–78.17)	74.81	78.11	**-3.30 (-4.72 to -1.88)**	<0.001

Notes: Estimates incorporate ENPOL strata, person weights and finite-population corrections. Valid yes/no responses were analysed; do not know and no response were missing. Unweighted national denominators were 60,867, 61,395 and 61,419, respectively. Holm adjustment covered the three federal-versus-state contrasts. The questions do not establish content, timing, clinical appropriateness or vaccine type. CI, confidence interval.

In questionnaire-defined flows, centre-provided cervical and breast screening were reported by 41.01% and 30.68% of women; these were not guideline-eligible coverage estimates. Periodic prenatal review was reported by 82.40% of 1,214 respondents, and 72.76% of 1,001 were satisfied or very satisfied with maternal care. Suicidal thoughts since entry were reported by 11.78% of 61,407 respondents; among 7,663 respondents with ideation, 34.34% reported an attempt. These measures describe need and safety, not service response (Additional file 1: Table S24).

The occupancy association remained present with the strict documented-barrier outcome (aOR 1.33, 95% CI 1.11–1.60; LRT p=0.0061; 6,340 people); coding indeterminate Indigenous responses as non-Indigenous produced a similar estimate (aOR 1.29, 1.10–1.51; p=0.0035; 6,673 people). Alternative exposure definitions based on the mean, median, logarithm or prior mixed-year source yielded aORs of 1.28–1.36. Episode-level modelling, adjustment for condition count, state-scaled weights and alternative outcome forms were concordant (Additional file 1: Tables S3 and S10). Adjustment for incarceration duration among 6,580 people produced aOR 1.28 (1.09–1.50; p=0.0056). Across leave-one-state-out models, aORs ranged from 1.25 to 1.38 and no interval included one. The parametric-bootstrap interval was 1.11–1.52; a 2,000-replicate state cluster bootstrap yielded 1.04–1.69, and a state-clustered person-level model yielded aOR 1.26 (1.11–1.42). In the subset with identifiable centres of interest (3,920 people, 44 centres, 25 states), the estimate was attenuated and inconclusive

with a state intercept (aOR 1.19, 0.99–1.43) but remained present with a centre intercept (aOR 1.21, 1.05–1.39); the nested fit was singular because state variance collapsed to zero. The adjusted prevalence ratio was 1.18 per state SD (1.07–1.30), and the third-versus-first-quartile marginal prevalence ratio was 1.21.

The prespecified staffing model included the same 6,601 people and adjusted for occupancy, marginalisation, system size, age, sex and Indigenous identification. Each state-standard-deviation increase in medical staff per 1,000 PDL was associated with lower unattended-care odds (aOR 0.77, 95% CI 0.67–0.88; LRT p=0.00028). Estimates were similar after adding DNSP (aOR 0.77, 0.68–0.88; p=0.00039) or log-transforming staffing (aOR 0.78, 0.69–0.88; p=0.00028) (Additional file 1: Table S5 and Figure S2).

In the exploratory screen of seven CNSIPEE resources, budget per PDL was nominally associated with unattended care in 23 states (aOR 0.82, 95% CI 0.68–0.98; p=0.0349) but not after Benjamini-Hochberg correction (q=0.122) (Additional file 1: Table S4).

The exploratory occupancy-by-communicability interaction was detectable with all conditions (OR 0.79, 95% CI 0.70–0.89; p<0.001) but inconclusive after excluding hepatitis (OR 0.86, 0.68–1.08; p=0.186). Imprecise condition-specific analyses were hypothesis-generating, not evidence of a mechanism.

The CNSIPEE panel included up to 124 state-year observations from 32 states in 2021–2024. None of six within-state occupancy or staffing contrasts with the reported proportions of centres offering any medical service, medication supply or chronic-care services retained evidence after Holm adjustment (all adjusted p=1.000; Table 6; Additional file 1: Tables S16–S17). Estimates were imprecise, and chronic-care availability covered only three years; results were inconclusive rather than evidence of no association. The 2025 bridge reported 211,025 people, 176,970 spaces (aggregate occupancy ratio 1.192) and 1,281 medical personnel across 31 reporting states; Mexico

City staffing was unavailable. Comparable service outcomes were absent, precluding extension of the models (Additional file 1: Table S18).

Table 6. Longitudinal administrative indicators of prison-health-system performance

Component and outcome	Exposure	Observations	Estimate (95% CI)	Multiplicity or robustness result
Panel A. CNSIPEE service-availability indicators				
CNSIPEE: any medical service	Occupancy per 10 points	124 state-years	-0.05 points (-0.23 to 0.13)	Holm p=1.000
CNSIPEE: medication supply	Occupancy per 10 points	124 state-years	-1.61 points (-4.06 to 0.83)	Holm p=1.000
CNSIPEE: chronic care	Occupancy per 10 points	92 state-years	0.03 points (-3.71 to 3.77)	Holm p=1.000
CNSIPEE: any medical service	Medical staff per 1,000 PDL	122 state-years	0.00 points (-0.07 to 0.07)	Holm p=1.000
CNSIPEE: medication supply	Medical staff per 1,000 PDL	122 state-years	0.18 points (-0.91 to 1.26)	Holm p=1.000
CNSIPEE: chronic care	Medical staff per 1,000 PDL	90 state-years	0.51 points (-2.21 to 3.23)	Holm p=1.000
Panel B. PRS administrative mortality indicators				
PRS: historical deaths	Lagged occupancy per 10 points	3,872 state-months	**IRR 1.087 (1.009–1.171)**	Bootstrap 1.014–1.177
PRS: historical, COVID excluded	Lagged occupancy per 10 points	3,168 state-months	IRR 1.076 (0.997–1.161)	Sensitivity
PRS: future-exposure diagnostic	Future occupancy per 10 points	3,840 state-months	IRR 1.083 (1.007–1.165)	Post hoc
PRS: explicit disease-death label	Lagged occupancy per 10 points	352 state-months	IRR 1.068 (0.977–1.167)	Secondary, 11 months

Notes: CNSIPEE linear models included state and year fixed effects; estimates are within-state changes in the reported proportion of centres. PRS Poisson models included state and calendar-month fixed effects and log end-of-month prison population as offset. All intervals used state-clustered HC1 variance and a small-cluster t reference. The historical PRS label does not establish cause of death. CI, confidence interval; CNSIPEE, National Census of State Penitentiary Systems; IRR, incidence rate ratio; PDL, people deprived of liberty; PRS, Prevention and Social Reintegration.

The historical PRS panel included 3,872 state-months, 121 months and 5,877 broad-category administrative deaths. A 10-point increase in lagged occupancy was associated with a rate ratio of 1.087 (95% CI 1.009–1.171; bootstrap 1.014–1.177) and a modelled difference of +0.039 deaths per 1,000 people-month between 100% and 120% occupancy (0.003–0.074) (Table 6; Additional file 1: Tables S19–S20; Figure 4). The COVID-exclusion estimate was 1.076 (0.997–1.161), and future rather than lagged occupancy produced a similar estimate (1.083, 1.007–1.165), weakening directional interpretation. The separate 11-month natural- or disease-death estimate was inconclusive (1.068, 0.977–1.167). These results are an ecological surveillance signal,

not causal or prospective evidence or a threshold at 100% occupancy (Additional file 1: Table S21).

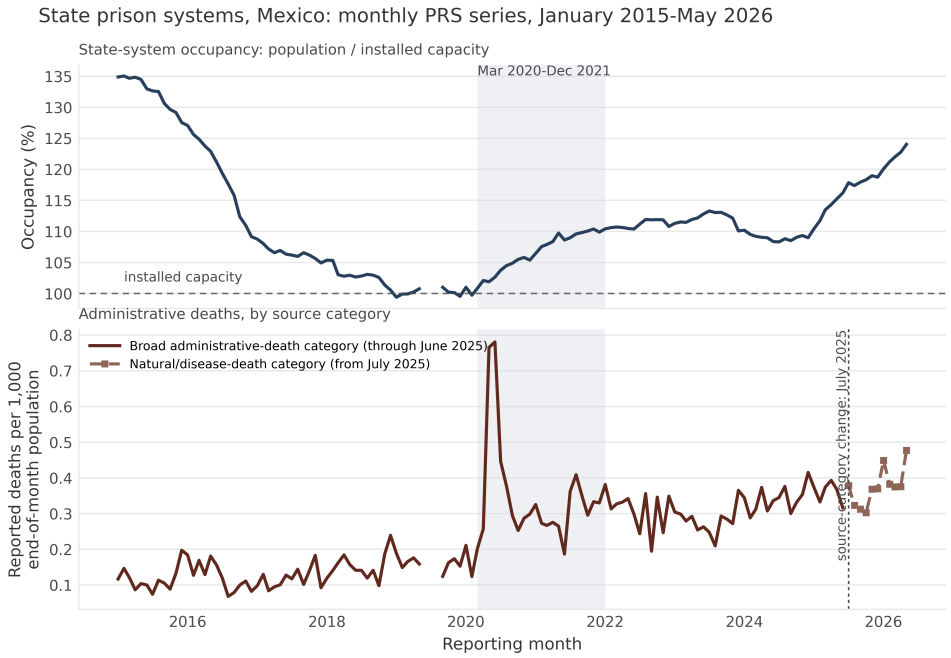


Fig. 4 National monthly prison occupancy and reported administrative mortality rates, 2015–2026. Monthly national aggregates across the 32 state prison systems. The upper panel shows reported population divided by installed spaces. The lower panel shows reported deaths per 1,000 end-of-month population, calculated monthly as 1,000 times the national total of state-system deaths divided by the corresponding state-system population; end-of-month population approximates monthly person-time. The historical broad administrative-death category contained 5,927 reported events in 123 extractable months, whereas the lagged-occupancy model retained 5,877 events in 121 months because its first month and the month after the 2019 data gap lacked a valid one-month lag. From July 2025, the distinct natural- or disease-death category contained 980 events over 11 months and is plotted separately; the two categories are not treated as equivalent. Shading marks March 2020–December 2021, the protocol-defined COVID sensitivity-exclusion period. The figure is descriptive and displays no fitted association or clinically adjudicated cause of death.

After applying parent–child rules, determinate-centre coverage for CNSIPEE accountability measures was 92.5%–100% in 2021–2024. Medical/psychological complaint records numbered 859, 7,142, 4,084 and 6,822, equivalent to 25.3, 35.3, 18.4 and 22.8 per 100 complaints or petitions in determinate centres; health-related requests numbered 1,113, 1,202, 2,451 and 2,241, or 34.3–42.1 per 100 requests. The 2025 report

recorded 9,576 federal and 15,861 state medical/psychological complaint motives; health was the alleged right in 78.6% and 48.9% of requests, respectively.

In exploratory fixed-effects models, a 10-point within-state occupancy increase was associated with more medical/psychological complaint recording (Poisson QMLE IRR 1.65, 95% CI 1.20–2.28; negative-binomial 1.46, 1.08–1.97). The inverse staffing estimate did not persist under negative-binomial modelling (IRR 0.95, 0.81–1.11), and health-rights request models were inconclusive. Overdispersion and dependence on both underlying problems and reporting access preclude treating counts as monotonic quality scores (Additional file 1: Table S25).

CNDHE tables contained 25 accepted-conciliation and two accepted-recommendation health-related records for state penitentiary systems in 2023, versus 16 and zero in 2024. These sums across violation types are not necessarily unique procedures and cannot indicate a decline because State of Mexico contributed 16 records in 2023 but had a nonnumeric missing value in 2024 (Additional file 1: Table S25).

DNSP 2021 explicitly reported health-service deficiencies in 155 of 233 supervised state centres (66.5%), appropriate attention in nine (3.9%) and neither classification in 69 (29.6%). State deficiency proportions correlated with lower ENPOL centre provision (Spearman rho=-0.47; bootstrap 95% CI -0.71 to -0.14), whereas correlation with unattended care was inconclusive (rho=0.16; -0.15 to 0.46). This concurrent ecological triangulation does not establish clinical quality or causality (Additional file 1: Table S26; Figure 5).

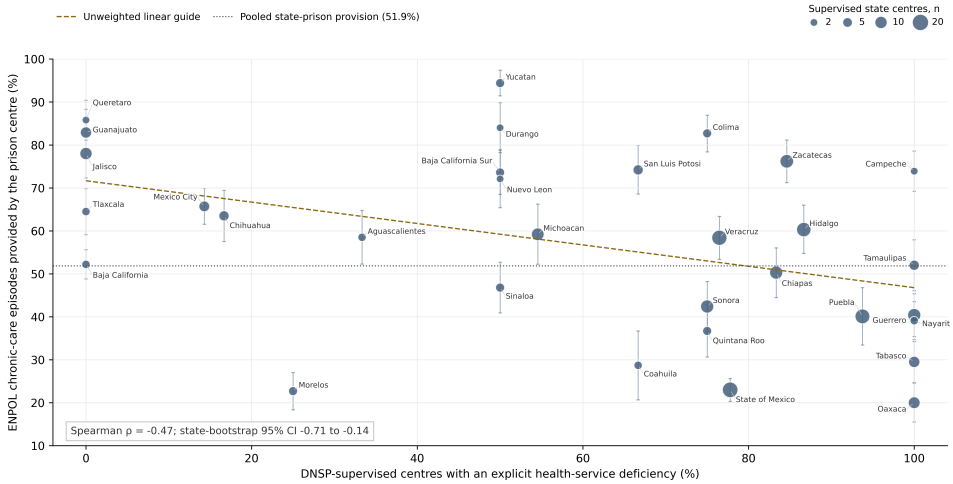


Fig. 5 DNSP health-service deficiencies and ENPOL prison-centre provision. Each point represents one state. The horizontal axis is the proportion of state centres supervised by DNSP 2021 with an explicitly reported health-service deficiency; the vertical axis is the ENPOL design-based estimate of chronic-care episodes supplied by the prison centre. Bubble area reflects the number of supervised state centres; reference circles correspond to 2, 5, 10 and 20 centres. The horizontal reference is the pooled state-prison estimate (51.9%), vertical bars are ENPOL 95% confidence intervals and the fitted line is descriptive. Spearman rho=-0.467 (two-sided P=0.007; 10,000-replicate state-bootstrap 95% CI -0.710 to -0.141). The bootstrap resampled states but did not propagate ENPOL sampling uncertainty. DNSP non-disclosure was not treated as adequacy, and this concurrent ecological comparison does not establish clinical quality, causality or direction.

4 Discussion

Together, the sources indicated gaps in reported access and prison-specific structural signals, while repeated service, accountability and mortality evidence was mixed. In 2021, prison centres reportedly provided 53.9% of chronic-care episodes with ongoing need; respondents or their families financed one fifth, and nearly one quarter were unattended. Centre non-provision was the leading stated reason for absent treatment. These categories extend performance assessment beyond morbidity by distinguishing institutional provision, external financial dependence and unattended need.

Care-process and external-supervision measures provided a complementary perspective. Approximately three quarters reported an examination on arrival and more than three quarters reported vaccination, but only 41.8% reported periodic review. These items represent distinct care processes and cannot be inferred from the reported existence of medical services. DNSP documented health-service deficiencies in two thirds of supervised state centres, and larger state deficiency proportions correlated with lower ENPOL-reported centre provision. ENPOL individual reports and DNSP findings in supervised centres are not interchangeable, but their concurrent ecological pattern was consistent with a systems interpretation; neither measured clinical quality, timeliness or disease control.

The independent benchmark was also consistent with an access gap. Age-sex-standardised absence of diabetes and hypertension treatment was higher in ENPOL than in ENSANUT 2021. This comparison does not estimate an effect of imprisonment because the populations differ in selection, social conditions, disease history, need and questionnaire wording. ENSANUT 2024 was a repeated population benchmark, not follow-up; the diabetes difference persisted, while the hypertension difference was inconclusive.

The 2021 structural results were concordant across related outcomes: higher occupancy was associated with unattended care and lower centre provision among treated

episodes, while greater prison medical staffing was associated with lower unattended care. Both prison-specific measures remained informative after including general state medical capacity, whose coefficient was inconclusive. These contemporaneous ecological associations support measuring custodial-system resources rather than substituting a general state-capacity indicator, but they do not identify effects of overcrowding or staffing. The temporal components did not resolve this inferential limitation. CNSIPEE service-availability contrasts were inconclusive after multiplicity adjustment and spanned few years with ceiling-prone outcomes. Complaint findings were model-dependent, and changing CNDHE coverage precluded trend estimation. Complaint counts may increase because conditions worsen, reporting becomes more accessible or both; they are accountability signals, not monotonic quality scores. Lagged occupancy was associated with administrative deaths, but the COVID-exclusion interval included the null and a similar future-occupancy estimate weakened directional interpretation. This temporal diagnostic is compatible with shared trends, exposure persistence or residual time-varying confounding. The PRS result is therefore a surveillance signal requiring prospective centre-level validation, not evidence of a causal mortality pathway.

This study extends Mexican prison-health research from morbidity to reported provision. Prior studies documented disease burdens and risk factors in Mexico City prisons [7, 8] and geriatric health nationally [9]; reviews describe broader illness and aftercare gaps [3, 31] and deficiencies in non-communicable disease detection and management [32]. International evidence links resource shortages and institutional relations to access [13], indicates that prison context and gatekeeping shape service use [12], and identifies organisational variation in continuity and prison primary care [14, 33]. Overcrowding literature provides context for structural pressure without establishing a causal mechanism [34]. The present contribution integrates these concerns by

classifying ongoing care need according to institutional provision, personal or family financing, or non-receipt. Convergence across source-specific components supports this systems interpretation; divergence identifies uncertainty and measurement gaps rather than a common individual trajectory.

The financial finding is consistent with evidence that direct charges can obstruct prison care [35]. US prison copayments were associated with failure to receive needed visits [35], but Mexico's arrangements differ and ENPOL does not measure a formal copayment policy [17, 35]. Self/family financing should therefore not be labelled a fee. Instead, it indicates reliance on resources outside the prison system and demonstrates why combining prison provision with privately financed treatment would obscure financial protection.

The findings have five implications for monitoring and research. First, monitoring should distinguish institutional provision from family-financed treatment; classifying both as "treated" would obscure financial dependence and may overstate the prison system's contribution. Second, arrival assessment, periodic review, prevention and disease-specific follow-up should be measured separately because service availability does not establish receipt. Third, occupancy and prison staffing should be assessed alongside person-reported care, external supervision and population benchmarks [14–16, 36]; these sources are complementary rather than interchangeable. Fourth, repeated administrative indicators require stable definitions, centre identifiers, missingness codes and comparable denominators. Complaint and rights-procedure counts must also be interpreted in relation to reporting accessibility. Finally, the higher unattended care and lower centre provision reported by Indigenous people warrant a focused equity audit, while sex and age differences require centre- and condition-level investigation before being classified as inequities.

Performance assessment should remain domain-specific rather than combine provision, financing, resources, service availability and mortality into a ranking. Structural,

process and outcome measures are complementary [15, 16, 36], and their discordance and differing uncertainty are informative. A composite would conceal those differences and imply unestablished construct validity. These operational measures also have normative relevance: Mandela Rule 24 assigns state responsibility and equivalence of care, while the right-to-health framework includes financial and practical accessibility [1, 2]. The study supports statements about reported provision and structural association, not every element of individual entitlement. Its measures should complement, not replace, facility inspection, clinical audit or legal analysis.

To our knowledge, this is the first national multi-source assessment in Mexico to distinguish prison-centre provision, personal or family financing and unattended chronic-care need and to examine these pathways alongside prison-specific resources and independent supervision. The design further incorporated accountability indicators and 121 months of administrative mortality data while preserving source-specific inference rather than constructing a pseudo-linked cohort or composite ranking. Additional strengths include design-based survey analyses, a 32-state panel, clustered and bootstrap inference, protocol-locked focal contrasts, explicit analytical hierarchy, automated validation and sensitivity analyses of outcome definition, exposure measurement, influence, scale and centre identification.

Several limitations constrain interpretation. The cross-sectional individual and 2021 structural components cannot establish temporal order or causality and remain vulnerable to residual state-level confounding and limited ecological degrees of freedom. Partial centre identifiers and incomplete ENPOL–CNSIPEE matching may have misclassified individual conditions and obscured within-state heterogeneity. ENPOL outcomes were self-reported and did not measure diagnosis validity, severity, treatment adequacy, adherence, continuity, stock-outs, disease control or clinical quality. Care-process, screening, maternal-care and suicidality items had questionnaire-defined or restricted denominators and did not establish clinical appropriateness or service

response. The provider model was conditional on treatment, the broad unattended definition included ambiguous reasons, the primary mixed model did not incorporate survey design, and complete-case analysis excluded 73 people. ENPOL and ENSANUT were independent cross-sectional surveys with different populations and treatment constructs; standardisation could not address selection into imprisonment or socioeconomic, diagnostic and severity differences, and ENSANUT 2024 was not follow-up. DGIS staffing was ecological and did not identify specificity or mechanism. CNSIPEE offered few comparable years, ceiling-prone outcomes, changing layouts and incomplete reporting; the 2025 release lacked comparable service outcomes. Complaint models were overdispersed and sensitive to reporting access, while CNDHE records were non-unique and had changing coverage. DNSP captured only disclosed findings in supervised centres, treated non-disclosure as unknown and did not propagate ENPOL sampling uncertainty. PRS death definitions changed, were not clinically adjudicated, used end-of-month population as approximate person-time, omitted three files without statistical tables and yielded a similar future-exposure association; the recent series covered only 11 months. The administrative components therefore support surveillance rather than directional, prospective or causal inference. Finally, the assessment is not an overall performance score and does not comprehensively measure clinical quality, disease control, continuity, efficiency, acceptability, emergency response, mental-health care, maternal care or adjudicated outcomes.

Future research should establish prospective centre-level surveillance with stable identifiers, consistent denominators and missingness codes, and linkage to clinical records and public health services. Repeated data collection should assess care receipt, continuity, disease control, clinical quality, emergency and mental-health care, adjudicated outcomes and equity, while externally validating whether person-reported, administrative and supervision indicators predict subsequent outcomes. Structured

chronic-care instruments such as ACIC-P could complement this surveillance platform [37].

5 Conclusions

Across national sources, prison centres reportedly provided 53.9% of ongoing chronic-care episodes, 20.8% relied on personal or family financing and 23.1% were unattended; periodic medical review was reported by 41.8%, and DNSP documented health-service deficiencies in 66.5% of supervised state centres. Higher occupancy and lower prison medical staffing were associated with poorer reported access, while general-system capacity and repeated service, accountability and mortality indicators produced mixed evidence. Future prospective centre-level studies should use stable identifiers, clinically meaningful outcomes and linkage across prison and public health services to test these signals and guide equitable system improvement.

6 List of abbreviations

ACIC-P: Assessment of Chronic Illness Care–Prison; **aOR:** adjusted odds ratio; **CI:** confidence interval; **CNDHE:** National Census of State Public Human Rights Bodies; **CNSIPEE:** National Census of State Penitentiary Systems; **CONAPO:** National Population Council; **DGIS:** General Directorate of Health Information; **DNSP:** National Penitentiary Supervision Assessment; **ENPOL:** National Survey of the Population Deprived of Liberty; **ENSANUT:** National Health and Nutrition Survey; **HIV:** human immunodeficiency virus; **IQR:** interquartile range; **IRR:** incidence rate ratio; **LRT:** likelihood-ratio test; **OR:** odds ratio; **PDL:** people deprived of liberty; **PRS:** Prevention and Social Reintegration; **QMLE:** quasi-maximum-likelihood estimation; **SD:** standard deviation; **STROBE:** Strengthening the Reporting of Observational Studies in Epidemiology.

7 Declarations

7.1 Ethics approval and consent to participate

The Comité de Ética en Ciencias de la Salud del Centro Universitario de Tlajomulco issued a favourable ethics determination for this secondary public-data study (reference CUTLAJO/DS/CEICS/016/26; 2 July 2026). The Committee waived the requirement for individual informed consent because the study used only publicly available, de-identified databases, involved no participant contact and included no attempt at re-identification. The determination covers the ENPOL, ENSANUT, DGIS, CNSIPEE, CNDHE, DNSP, PRS and CONAPO components analysed here because each uses only public de-identified microdata or public aggregate administrative information under the same no-contact, no-re-identification design. The review and consent waiver were consistent with Articles 16 and 17(I) of Mexico's *Reglamento de la Ley General de Salud en Materia de Investigación para la Salud* and section 11.3 of NOM-012-SSA3-2012. The study was also conducted in accordance with paragraph 32 of the 2024 World Medical Association Declaration of Helsinki and Guideline 10 of the 2016 CIOMS *International Ethical Guidelines for Health-related Research Involving Humans*.

7.2 Consent for publication

Not applicable.

7.3 Availability of data and materials

The public source data analysed in this study are available from INEGI (ENPOL, CNSIPEE and CNDHE), the Instituto Nacional de Salud Pública and Secretaría de Salud (ENSANUT Continua), DGIS (health resources), PRS (monthly national penitentiary reports), CNDH (DNSP) and CONAPO (marginalisation and population projections). Version 1.1.0 of the reproducibility archive for the

original 2021 component is available at https://doi.org/10.5281/zenodo.21443940. Software-only version 2.0.2 for the complete integrated analysis is available at https://doi.org/10.5281/zenodo.21477930 and contains the analysis code, methodological protocols, dependency provenance and configuration dictionaries for all components.

7.4 Competing interests

The authors declare that they have no competing interests.

7.5 Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

7.6 Authors' contributions

KAPP: Conceptualization; Investigation; Methodology; Project administration; Writing - original draft.

SGP: Conceptualization; Investigation; Methodology; Writing - original draft.

JCADJ: Conceptualization; Investigation; Methodology; Writing - original draft.

PNVB: Conceptualization; Investigation; Validation; Writing - original draft.

TEHC: Conceptualization; Methodology; Validation; Writing - original draft.

NENR: Investigation; Methodology; Validation; Writing - original draft.

RMDN: Investigation; Methodology; Validation; Writing - review & editing.

OFD: Investigation; Validation; Visualization; Writing - review & editing.

MARG: Conceptualization; Investigation; Validation; Writing - review & editing.

EBG: Investigation; Validation; Visualization; Writing - review & editing.

JBR: Formal analysis; Software; Project administration; Supervision; Writing - review & editing.

All authors read and approved the final manuscript.

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Use of generative AI and author oversight. OpenAI LLM was used to assist with grammar and language editing. It was not used to make autonomous scientific or authorship decisions. All analytical decisions, source interpretations, numerical results and manuscript claims were reviewed by the named authors, who retain full responsibility for the work.

8 Additional file

File name: Additional file 1.

File format: PDF.

Title: Supplementary methods, tables and figures.

Contents: Additional file 1 contains Methods S1–S8, Tables S1–S26, Figures S1–S2, and separate completed STROBE checklists for the cross-sectional and retrospective ecological components. These materials document operational definitions, source and performance-domain mapping, sample and linkage audits, care-process and sensitivity analyses, cross-survey harmonisation, structural and longitudinal models, accountability indicators, and external-supervision triangulation.

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