



# Therapeutic Outcomes and Associated Factors among Tuberculosis Patients Initiated on Treatment in the Parakou-N'dali Health Zone (Benin): A Retrospective Study 2020-2024

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## Abstract

**Introduction:** Tuberculosis remains a major public health challenge in sub-Saharan Africa. Despite national program efforts, unfavorable treatment outcomes persist in specific regions. This study evaluated tuberculosis treatment outcomes and associated risk factors among patients followed in the Parakou-N'dali health zone from 2020 to 2024. **Methods:** We conducted an analytical retrospective cohort study in TB diagnosis and treatment centers in Parakou, Boko, and N'dali. All patients initiated on anti-tuberculosis treatment between 2020 and 2024 were included. Data extracted from registry records were analyzed using SPSS software. Multinomial logistic regression identified factors associated with unfavorable outcomes. **Results:** A total of 917 patients were included, with a male predominance (73.4%) and a mean age of 37.5 years. Pulmonary cases accounted for 78.3% of the cohort, with 95.8% being new cases. HIV seroprevalence was 12.8%. The overall treatment success rate was 89.2% (7.2% deaths, 2.62% loss to follow-up, and 0.98% failure). Factors significantly associated with death included comorbidities, especially diabetes ( $p = 0.031$ ), relapses ( $p = 0.007$ ), and anemia ( $p < 0.05$ ). **Conclusion:** Although the treatment success rate is relatively high, it remains below national performance standards. Reducing mortality requires comorbidity management, early screening, and enhanced patient follow-up.

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## Subject Areas

Infectious Diseases

## Keywords

Tuberculosis, Therapeutic Outcomes, Treatment Success Rate, Mortality

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## 1. Introduction

Tuberculosis (TB) remains a critical infectious disease in global public health, caused by *Mycobacterium tuberculosis* and responsible for substantial morbidity and mortality, particularly in resource-limited settings [1]. Despite effective therapeutic regimens, the COVID-19 pandemic severely disrupted health systems and TB control services, reducing case notifications and interrupting continuity of care [1].

In Benin, TB control is managed by the National Tuberculosis Program (NTP), integrated into national policy for communicable diseases. Anti-TB drugs are provided free of charge at all Diagnosis and Treatment Centers (CDT) per international guidelines [2]. Recent data show a 91% therapeutic success rate for new cases in Benin in 2023, reflecting efforts to meet international targets [3].

Between 2020 and 2022, 28,944 presumptive TB cases were screened, indicating high diagnostic activity [4]. However, unfavorable outcomes—including deaths, treatment failures, and loss to follow-up—remain significant obstacles, particularly in peripheral health zones plagued by socio-economic and logistical challenges [2] [4].

In the Parakou-N'dali health zone, a previous analysis of 2011-2015 data [5] revealed success rates below national targets, highlighting the need for longitudinal, context-specific monitoring. However, the impact of health system adjustments during the post-COVID-19 period (2020-2024) remains uninvestigated.

Therefore, this study aims to evaluate local therapeutic outcomes and their determinants in the Parakou-N'dali health zone, aiming to identify factors associated with favorable and unfavorable outcomes to inform improved NTP performance at the local level.

## 2. Study Methodology

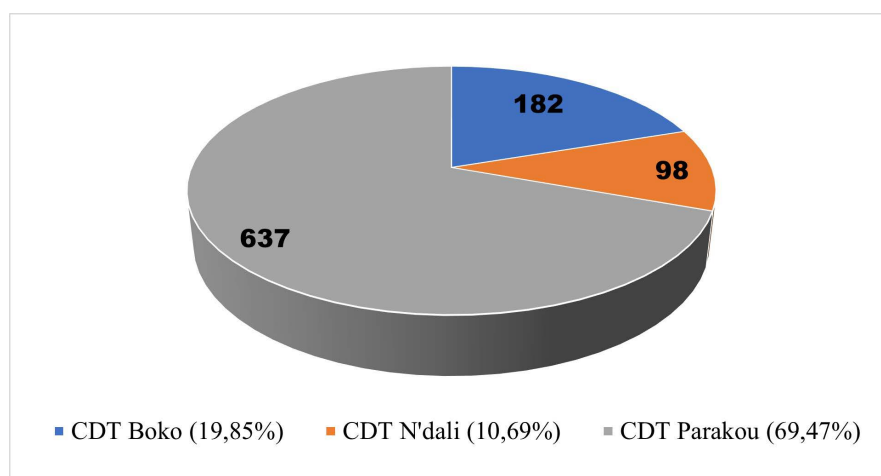
This is a retrospective cohort study of tuberculosis patients followed between 2020 and 2024 within three TB diagnostic and treatment centers (CDTs) in the Parakou-N'dali health zone (Boko, Parakou, and N'dali). The study population consisted of all patients diagnosed with pulmonary or extra-pulmonary tuberculosis at these centers during the specified period. All patients screened and initiated on anti-TB treatment within the health zone with a complete medical record were included. For incomplete records, efforts were made to contact patients to gather missing information. Conversely, patients who left the study area before complet-

ing treatment without the possibility of follow-up, or those whose records could not be completed despite follow-up, were excluded.

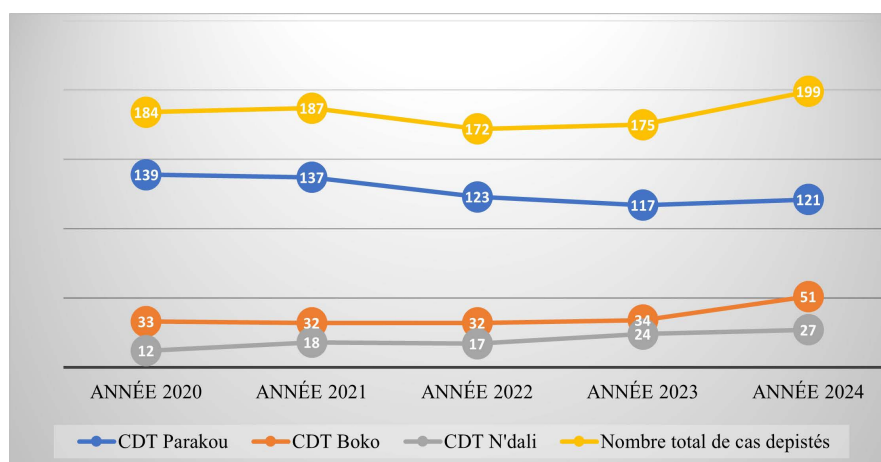
Data were collected using KoboCollect software, in collaboration with CDT nurses trained on the methodology. Sources included patient records, TB registers, treatment cards, home visit logs, and investigation registers. Data were analyzed using SPSS (version 31) and Microsoft Excel. The dependent variables studied were unfavorable therapeutic outcomes, represented by death (yes/no), treatment failure (yes/no), and loss to follow-up (yes/no).

### 3. Results

This study enrolled 917 patients initiating tuberculosis (TB) treatment within the Parakou-N'Dali health zone. Participants were screened and recruited across three Diagnostic and Treatment Centers (CDTs), with distribution across centers shown in **Figure 1**.



**Figure 1.** Graphical representation of screening proportions by CDT in the Parakou-N'Dali health district.



**Figure 2.** Evolution of TB case detection at diagnostic and treatment centers (CDT) in the N'Dali health district, 2020-2024.

Tuberculosis (TB) screening within the Parakou-N'Dali health zone remained stable between 2020 and 2024, with annual case notifications exhibiting minimal fluctuation between 172 and 199. Temporal trends in screening data are illustrated in **Figure 2**.

As illustrated in **Figure 2**, there was a marginal screening activity at the Parakou Diagnostic and Treatment Centre (CDT); nevertheless, this site remains the primary facility in the health zone, contributing 69.47% of total screenings. Conversely, the Boko and N'Dali DTCs exhibited an upward trend in screening volume over the study period.

Regarding sociodemographic characteristics, the mean age of tuberculosis patients was 37.51 years, with a median of 35 years and a range of 2 to 94 years. Males predominated significantly (73.4%) compared to females (26.6%). The studied population was predominantly urban (82.6%) and hailed from an economically vulnerable background. Regarding educational level, 30.4% of participants had no formal education, 33.6% had a primary level, 25.6% secondary, and only 10.4% higher education. The majority were married (66.0%), followed by single individuals (31.9%), while divorced (0.7%) and widowed (1.4%) individuals represented marginal proportions.

Based on a professional analysis, the breakdown indicates that 28.2% of participants were unemployed, while 26.4% were self-employed. Farmers accounted for 18.8%, employees 11.7%, and 14.9% belonged to other occupational categories. Regarding monthly income, 42.1% of subjects reported earning less than 50,000 FCFA, 37.8% reported earnings between 50,000 and 100,000 FCFA, 17.7% fell within the 100,000 to 150,000 FCFA range, and only 2.4% exceeded 150,000 FCFA. The majority of participants lived in concrete dwellings (83.8%), with 15.4% in mud-walled housing, and only 0.8% in apartments.

From a clinical standpoint, 97.1% of participants reported no family history of tuberculosis. HIV serology was negative in 86.2% of subjects, positive in 12.8%, and not performed in 1.0%. The majority (83.6%) reported no comorbidities, whereas 7.6% suffered from cardiovascular diseases, 2.9% from co-infection, 2.8% from malaria, 2.4% from a surgical condition, and 0.7% from sickle cell disease. Concerning lifestyle habits, 91.2% of participants were non-smokers and 88.8% did not consume alcohol. Furthermore, only 0.5% were deprived of liberty, confirming that the study population originated mostly from the general community.

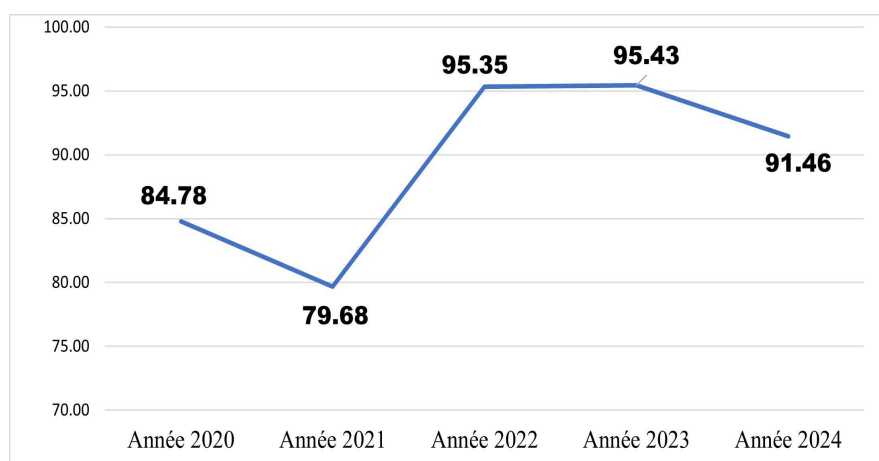
Clinically, the majority of tuberculosis cases were newly diagnosed (95.8%), whereas relapses (2.9%) and treatment failures (1.47%) were rare. The most frequently diagnosed type was smear-positive pulmonary tuberculosis (PTB+) (78.3%), smear-negative pulmonary tuberculosis (EPTB) (17.1%), and smear-negative pulmonary tuberculosis (PTB-) (4.6%). Among EPTB cases, the most prevalent sites were pleural (71.6%), followed by abdominal (2.7%), osseous (2.5%), and cutaneous (1.8%) forms.

Treatment adherence was high, with 98.3% of patients strictly complying with

their anti-tuberculosis regimen. Therapeutic complications were rare (0.8%). Access to care was reported as easy by 81.1% of patients, moderate by 12.7%, and difficult by 6.2%. Almost all patients received family support (97.3%) and presented with a preserved general condition (98.1%).

Tuberculosis primarily affected the general population (86.4%), followed by people living with HIV (12.5%), while diabetics (0.9%) and institutionalized individuals (0.2%) represented marginal proportions. Regarding Directly Observed Treatment (DOT), 63.2% of patients received DOT at the Tuberculosis Diagnostic and Treatment Centers (CDTs), 20.6% at a partner center, and 16.2% did not receive DOT. Finally, the availability of pre-therapeutic assessments remained insufficient, being performed in only 42.3% of patients. The mean hemoglobin level was 10.65 g/dL, ranging from 4.8 to 15.5 g/dL. Blood transfusion was required in 1.7% of cases, even though 17.1% presented with severe anemia (hemoglobin level < 7 g/dL).

A therapeutic success rate of 89.2% (818 out of 917) was observed, comprising cases of cure, with 7.20% (66/917) deaths, 2.62% (24/917) lost to follow-up, and 0.98% (9/917) treatment failures. **Figure 3** presents the trend in favorable treatment outcomes (cure or treatment completed) on a year-by-year basis from 2020 to 2024.



**Figure 3.** Trends in successful tuberculosis treatment outcomes (cure and treatment completion) among patients in the Parakou-N'Dali health zone, 2020-2024.

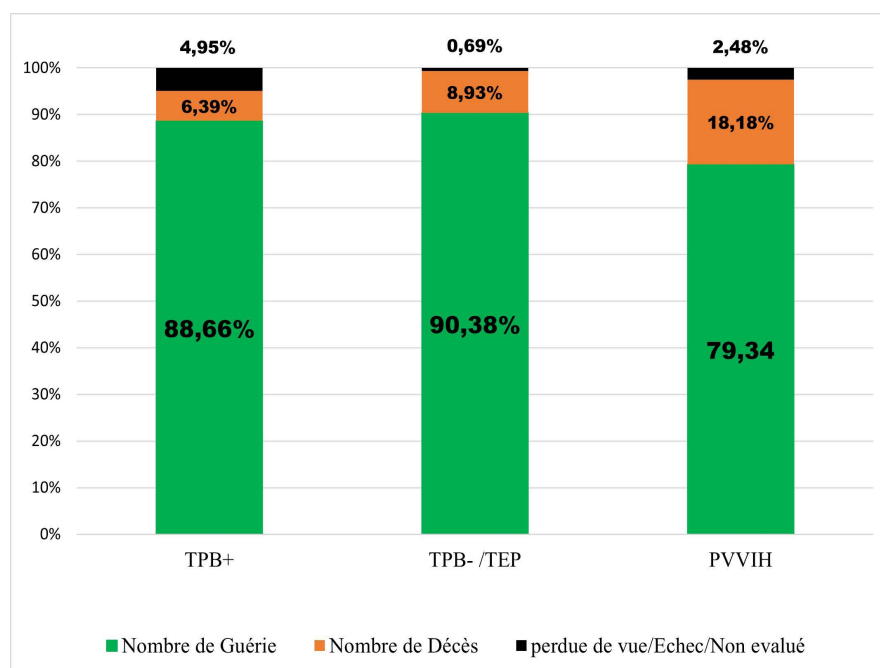
The number of successful outcomes (cures) remained consistently high throughout the study period, with an annual incidence between 149 and 182 cases and an upward trajectory observed since 2022. The treatment success rate demonstrated an enhancement, ascending from 79.68% in 2021 to 91.46% in 2024, indicative of a progressive optimization in patient management protocols. Concurrently, the number of recorded deaths significantly declined, from 22 cases in 2020 to 5 cases in 2023, before experiencing a marginal increase to 11 cases in 2024. Consequently, the mortality rate declined from 11.96% in 2020 to 2.86% in 2023, subsequently rising slightly to 5.53% in 2024. Treatment failures remained low and gen-

erally stable (ranging between 0 and 4 cases annually), with no distant trend. A very limited number of patients were lost to follow-up (24 cases total), with more than 50% of these cases occurring in 2021 (13 cases). The table below summarizes the evolution of treatment outcomes for tuberculosis patients from 2020 to 2024 in the Parakou-N'Dali health zone.

**Table 1.** Trends in therapeutic outcomes among tuberculosis patients, 2020-2024: The Parakou-N'Dali health zone.

|                     | Year 2020<br>N (%) | Year 2020<br>N (%) | Year 2022<br>N (%) | Year 2023<br>N (%) | Year 2024<br>N (%) | Total<br>N (%)    |
|---------------------|--------------------|--------------------|--------------------|--------------------|--------------------|-------------------|
| Deaths              | 22 (11.96)         | 21 (11.23)         | 7 (4.07)           | 5 (2.86)           | 11 (5.53)          | <b>66 (7.20)</b>  |
| Failures            | 3 (1.6)            | 4 (2.14)           | 1 (0.58)           | 1 (0.57)           | 0                  | <b>9 (0.98)</b>   |
| Cures               | 156 (84.78)        | 149 (79.68)        | 164 (95.35)        | 167 (95.43)        | 182 (91.46)        | <b>818 (89.2)</b> |
| Losses to follow-up | 3 (2.1)            | 13 (6.95)          | 0                  | 2 (1.14)           | 6 (3.01)           | <b>24 (2.62)</b>  |
| Total               | 184 (100)          | 187 (100)          | 172 (100)          | 175 (100)          | 199 (100)          | <b>917 (100)</b>  |

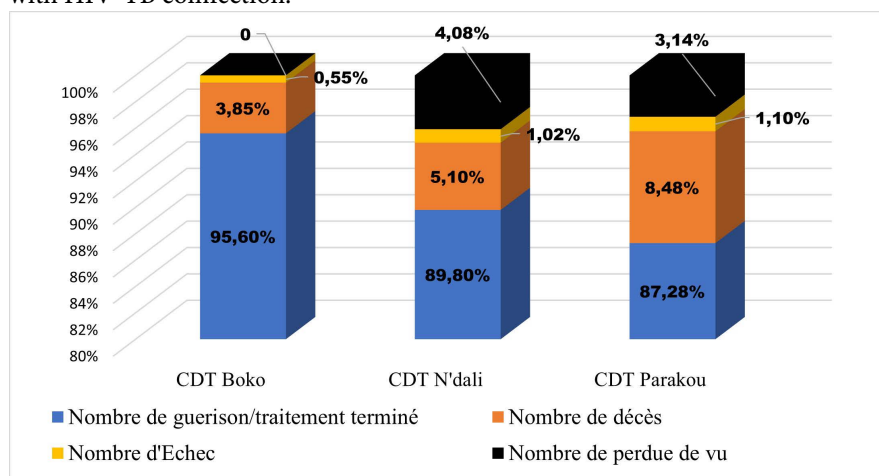
Treatment outcomes, stratified by tuberculosis classification, HIV serostatus, and diagnostic/treatment facility, are presented in **Figure 4** and **Figure 5**.



**Figure 4.** Tuberculosis treatment outcomes by clinical type and HIV status in the Parakou-N'Dali health zone, 2020-2024.

As illustrated in **Figure 4**, the therapeutic success rate among individuals with bacteriologically confirmed pulmonary tuberculosis within the health zone was

88.66% during the study period, in contrast to a 79.34% rate observed in patients with HIV-TB coinfection.



**Figure 5.** Treatment outcomes of tuberculosis patients managed at Diagnostic and Treatment Centres (CDT) in the Parakou-N'Dali health zone, 2020-2024.

Analysis of therapeutic outcomes by Diagnostic and Treatment Centers (CDT) reveals that the Boko CDT recorded a very high cure rate, with a low death rate estimated at approximately 3.85%. The N'Dali CDT also demonstrated good therapeutic performance, marked by a high cure rate (89.8%), although one treatment failure (approx. 1.02%) and four patients lost to follow-up (4.08%) were observed. Parakou managed the highest number of patients, accounting for the majority of cures (556); however, this center also recorded the highest number of deaths (54 cases), representing 8.48%.

Following the chi-square test, variables achieving a p-value less than 0.20 were included in the multinomial logistic regression analysis. This analysis revealed several significant associations.

Regarding the “death” outcome, patients without diabetes exhibited a lower risk of mortality, consistent with the established association between chronic comorbidities and increased fatality rates ( $B = -2.006$ ;  $p = 0.031$ ;  $OR = 0.135$ ). Similarly, new tuberculosis cases had a significantly lower risk of death compared to relapse cases ( $B = -2.229$ ;  $p = 0.007$ ;  $OR = 0.108$ ). Patients with moderate to severe anemia demonstrated a significant increase in the risk of death ( $B = -1.937 - -1.981$ ;  $p = 0.010$  to  $0.004$ ;  $OR \approx 0.14$ ), indicating that anemic patients were less likely to achieve a cure. Conversely, HIV status was not significantly associated with mortality in this study, although a trend suggests that PLHIV (People Living with HIV) experience higher rates of unfavorable outcomes ( $B = -0.780$ ;  $p = 0.176$ ;  $OR = 0.46$ ).

Regarding treatment failures compared to cure, patients presenting with a comorbidity, particularly diabetes, had an increased risk of treatment failure ( $p = 0.003$ ;  $OR = 1.34$ ). Paradoxically, yet significantly, patients reporting difficult access to care had a lower probability of failure ( $p = 0.034$ ;  $OR = 0.64$ ). Patients who received a blood transfusion had a significantly lower probability of treatment fail-

ure, likely linked to enhanced medical surveillance ( $B = -1.260$ ;  $p = 0.005$ ;  $OR = 0.28$ ). Furthermore, HIV-negative patients had a slightly higher probability of failure compared to PLHIV ( $p = 0.047$ ;  $OR = 1.57$ ).

Finally, regarding loss to follow-up, patients without comorbidities were less likely to be lost to follow-up, suggesting lower treatment adherence among those with chronic illnesses ( $B = -2.842$ ;  $p = 0.024$ ;  $OR = 0.058$ ). Follow-up by a partner center also reduced the probability of loss to follow-up ( $B = -1.349$ ;  $OR = 0.26$ ), although this association was not statistically significant ( $p = 0.25$ ).

#### 4. Discussion

Between 2020 and 2024, the tuberculosis (TB) therapeutic success rate in the Parakou-N'Dali health zone reached 89.2%, falling marginally below the 91% national average reported by the Benin National Tuberculosis Program (NTP) in 2023 [4]. Nevertheless, this performance is satisfactory, exceeding the World Health Organization (WHO) target of >85% for drug-susceptible TB [1]. This outcome highlights the effectiveness of care provided within the zone's three Diagnostic and Treatment Centers (CDTs), despite existing structural constraints. Ade *et al.* reported an overall treatment success rate of approximately 86% among patients with extrapulmonary tuberculosis in Benin. Although their study population differed from ours, this finding provides a useful national reference for interpreting the 89.2% treatment success rate observed in our study [6].

A longitudinal analysis indicates a positive trend, with the success rate rising from 79.7% in 2021 to 91.5% in 2024. This increase likely results from intensified supervision, strengthened community-based follow-up, and targeted interventions by Borgou regional following the district's low ranking by the NTP in 2022. Conversely, a decline in screening at the Parakou CDT—which handles 69.5% of the zone's caseload—threatens to undermine these gains by hindering early detection. In contrast, the upward screening trend observed in Boko and N'Dali CDTs suggests a positive local dynamic.

Regarding unfavorable outcomes, the 7.2% mortality rate exceeds the 5.5% national average [3], yet aligns with regional findings in Parakou (6.8%) [7] and Cotonou (7.5%) [8]. Multivariate analysis confirms that mortality is significantly associated with comorbidities—especially diabetes ( $B = -2.006$ ;  $p = 0.031$ ;  $OR = 0.135$ ), anemia ( $B = -1.937 - -1.981$ ;  $p = 0.010 - 0.004$ ;  $OR \approx 0.14$ ), and relapse cases ( $B = -2.229$ ;  $p = 0.007$ ;  $OR = 0.108$ ). These findings are consistent with established risk factors in West Africa [9]. Notably, the lack of a significant association with HIV status suggests effective integration of HIV-TB care and adequate antiretroviral access.

The treatment failure rate observed (0.98%) is lower than the national average (3%) [4], reflecting good therapeutic adherence (98.3%). Failure is significantly associated with the presence of comorbidities ( $p = 0.003$ ;  $OR = 1.34$ ), while patients who received blood transfusions show a reduced risk of failure ( $B = -1.260$ ;  $p = 0.005$ ;  $OR = 0.28$ ), likely linked to better medical monitoring. Paradoxically,

limited access to care was associated with fewer failures ( $p = 0.034$ ;  $OR = 0.64$ ), potentially indicating that patients in remote areas benefit more from more intensive, systematic home-based follow-up.

Loss to follow-up, while low (2.6%), merits attention, with a peak in 2021 primarily driven by a 4.08% loss rate at the N'Dali CDT, coinciding with the loss of key personnel and temporary service disruption. This vulnerability underscores the need for strengthening human resources and expanding community-based Direct Observed Treatment, Short-course (DOTS). Finally, the high death rate at the Parakou CDT (8.5%) indicates that case volume may exceed optimal staff capacity. Further decentralization of care to peripheral centers is recommended to reduce this workload and sustain recent improvements.

## Conflicts of Interest

The authors declare no conflicts of interest.

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