

Two new Later Stone Age sites from the Final Pleistocene in the Falémé Valley, eastern Senegal

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DEPTH	EXPERTISE	VOICE	GENERATED
Overview (10-15 min)	Balanced	Alloy	June 19, 2026

Imagine getting sick and watching your savings evaporate not because of a pricey drug, but because you can't work, you have to travel to a clinic, and you still need to feed your family. That's tuberculosis for millions of households. The human toll is huge—about one point two five million deaths in 2023—and the caseload is stubborn, roughly ten point eight million people developed tuberculosis that year, higher than in 2020. Most of this burden sits in low- and middle-income countries; thirty high-burden countries account for nearly nine out of ten cases. On the kitchen-table side, the World Health Organization uses a simple yardstick for financial disaster: if the total costs of a tuberculosis episode top twenty percent of a household's annual income, that's catastrophic. In many low- and middle-income settings, more than half of tuberculosis-affected households cross that line, and among the poorest, roughly three out of four do. For years, external donors have helped hold that line. In 2023, the United States Agency for International Development, or USAID, supplied about one fifth of international donor tuberculosis funding, the Global Fund supplied three quarters, and more than a third of the Global Fund's tuberculosis budget came from the United States. Then the landscape shifted. With USAID dismantled and signals of cuts to the Global Fund starting in 2025, one question loomed: what happens to household finances if that buffer disappears?

Portnoy, Clark, Jit and colleagues decided not to guess. They built a pipeline that ties money to medicine to monthly budgets, spanning seventy-nine countries that together represent about ninety-one percent of tuberculosis in low- and middle-income settings. The idea is straightforward even if the machinery is complex: if external funds shrink, tuberculosis programs diagnose and treat fewer people; if few-

er people are diagnosed and treated, more households face costs; and some of those households are pushed into catastrophe. They start the clock in 2025 and run through 2050, comparing a “keep twenty twenty-four funding” baseline to a set of cut scenarios, up to and including a world where all external tuberculosis funding goes away. The question isn’t whether pain rises. It’s how much, and for whom.

Here’s how they stitched the pieces together. For each country, the epidemiology model tracks tuberculosis incidence, notifications, and deaths, and even the share of infectious episodes that are asymptomatic. They calibrate those targets using history matching with emulation—the *hmer* package in R—then draw from the plausible parameter space with Approximate Bayesian Computation. Think of it as pruning away obviously wrong parameter combinations, then sampling from the ones that fit; they keep two hundred fitted parameter sets for each country. Uncertainty doesn’t get hand-waved away; it’s propagated forward in a second-order Monte Carlo so that outcome ranges reflect both disease dynamics and noisy inputs.

Then they translate cases into costs. The economic module disaggregates tuberculosis across income quintiles within each country, based on survey evidence that tuberculosis risk isn’t evenly distributed by income. Each episode gets a price tag in 2021 dollars, built from a meta-regression of twenty-two nationally representative tuberculosis patient-cost surveys. Those tags cover three buckets: direct medical spending, direct non-medical outlays like transport and lodging, and indirect costs—the income you can’t earn while you’re sick. In the base case, an untreated episode costs the household about the same as a treated one; they stress-test that assumption later. Finally, they connect to the World Health Organization’s catastrophe yardstick by using survey-based probabilities that an episode will push a household above the twenty percent income threshold, again stratified by quintile and country.

Funding cuts don’t enter the model as a vague austerity vibe; they enter through a specific choke point: treatment initiation. Pull money out, and a smaller share of people with tuberculosis start appropriate treatment—because screening slows, case-finding programs shrink, diagnostics stall, and clinics can’t ramp. The size of the squeeze is proportional to the budget cut and grounded in country-specific shares of external funding from 2023. It’s a clean causal chain: budget leads to treatment initiation, which leads to cases and outcomes, which in turn lead to household costs.

What does that world look like if USAID alone disappears? Portnoy and colleagues estimate about seven point five billion dollars in additional patient costs through

2050 and roughly three point nine million more households experiencing catastrophic costs compared to the baseline. That's not a theoretical efficiency loss; that's rent and rice and school fees not paid. Now turn the dial to the harshest setting: every dollar of external tuberculosis funding vanishes. In that case, they project about seventy-nine point seven billion dollars in extra patient costs and forty point five million additional households crossing the catastrophe threshold, which they estimate is a thirty-two percent jump in catastrophic cases relative to staying the course. Spread across cost types, that worst-case world means roughly a quarter more spending in each category: medical out-of-pocket, non-medical out-of-pocket, and lost income.

Not every country relies on the same donors, and not every shock is all-or-nothing, so the team explores intermediate scenarios. If USAID ends and the Global Fund's United States contribution is trimmed, total household costs rise by around twenty-two point six billion dollars with roughly eleven point five million more catastrophic episodes. If the United States pulls out of the Global Fund's tuberculosis support entirely, those numbers edge up to twenty-four point zero billion and twelve point two million. And if the cut widens—USAID ends and many Global Fund donors reduce support—the bill grows to about twenty-eight point seven billion dollars and fourteen point six million additional catastrophic-cost households. The point isn't that the model can tell you exactly where the decimal lands. It's that every rung down the funding ladder has a clear, measurable human cost, and it climbs fast.

The totals are bracing; the distribution is sobering. Wealthier households, on average, spend more when they get sick—they're more likely to travel, to pay for services, to stay engaged with care—so about half of the increase in total patient costs sits in the top two income quintiles. The Concentration Index, a summary that runs from negative one to one, clocks in around positive zero point fourteen for total costs; positive means the burden leans richer. But flip to the question that matters for protection: who gets pushed over the twenty percent catastrophe line? There, the pattern reverses. Across scenarios, nearly sixty percent of additional catastrophic cases pile up in the bottom two quintiles, with the poorest quintile alone shouldering roughly fifty-nine to sixty-eight percent of the increase. The associated Concentration Index is negative—about negative zero point twenty-four—signaling concentration among the poorer. In plain terms, richer households feel the hit, but poorer households break.

If that feels paradoxical, think about the threshold. A bus fare and two weeks of lost wages may be manageable in a better-off household, but the same outlays can be ruinous when a family already lives near subsistence. And the baseline is

already ugly: in prior nationally representative surveys synthesized by this team, more than half of tuberculosis-affected households in low- and middle-income settings exceeded the twenty percent threshold, and about three quarters of the poorest households did. Cuts aren't nudging a stable system; they're accelerating a slide.

Models earn their keep when they're transparent about what could swing the result. Portnoy's team probes two obvious levers. First, what if untreated episodes cost households less because they're not paying for clinic visits or tests? If they assume untreated costs are fifty percent lower than treated, the number of catastrophic cases falls. If they assume untreated costs are fifty percent higher—think prolonged illness, more days without income—it rises. The exact counts move, but the rank order of who suffers most does not. Second, what if you use a different catastrophe bar? Move the threshold down to ten percent of income and the counts jump by about thirty-nine percent; raise it to twenty-five percent and they drop by about fourteen percent. Again, the equity picture holds.

It's also clear where the analysis is deliberately narrow. The team assumes per-episode costs stay constant in real terms, even though fuel prices, wages, and diagnostic technologies will evolve. They use uniform proportional reductions in treatment initiation, when in reality programs might protect some services and cut others. They don't directly model downstream shifts like slower diagnosis increasing transmission, or drug resistance complicating care. And they don't include structural-model uncertainty—alternative equations for how tuberculosis spreads or care is sought. All of that makes their numbers conservative in some ways and incomplete in others. But the direction of travel—less money, more hardship, concentrated among the poor—doesn't hinge on those details.

One way to grasp the scale is to hold these losses up against something positive on the horizon. In a separate analysis the authors cite, new tuberculosis vaccines could avert on the order of thirty-eight to forty-four billion dollars in patient costs and prevent about twenty-three million catastrophic-cost episodes from 2028 to 2050. The plausible downside from donor withdrawal nearly doubles those gains. That's a striking, uncomfortable symmetry: what science could give, financing could take away.

If you run a national tuberculosis program, none of this is an abstraction. It's whether your lab network keeps the lights on and whether community health workers can find and support patients. The policy message coming out of these projections is blunt. Abrupt retrenchment will raise household costs sharply and deepen inequity. Phasing matters. Blended financing matters. Social protection—cash

transfers, food support, transport vouchers—can keep a family from tipping into catastrophe even when health budgets are thin. As Madhukar Pai has argued, donors should plan flexible transitions that protect core tuberculosis services while countries integrate tuberculosis care more tightly into primary care and build domestic resilience. Bridging finance is not a luxury in this context. It's a seatbelt.

Under the hood, this study's strength is the bridge it builds from budgets to bedside to back pocket, with every assumption and dataset—twenty-two patient-cost surveys, calibration targets, code—made available for scrutiny. If you want to kick the tires yourself, Portnoy and colleagues have posted their data and analytic code on GitHub. But you don't need to read a line of R to get the message. Dollars pulled upstream ripple into days missed at work, longer bus rides to farther clinics, and meals skipped at home—and those ripples hit the poorest shores hardest.

The End Tuberculosis Strategy has always been about more than microbiology. It's about financial risk protection. This modeling doesn't hand down a prophecy; it gives us a dashboard. And the dashboard is flashing: maintain support, manage transitions, and shield the households with the least cushion. Because for tuberculosis, the distance between a budget line and a family's table is very, very short.

CREDITS

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