Indian Ocean 'leak' into the southern Atlantic from the Agulhas Current system[2,9] (which runs southwards along the eastern edge of southern Africa). Increases in the salinity of northward-bound waters in the Atlantic are associated with a stronger AMOC[4], and accordingly, Agulhas leakage has been proposed as an key driver of AMOC change during deglaciations and rapid climate events[2,5,7]. The salinity of the subtropical Indian Ocean is itself influenced by the influx of less salty waters advected from the tropical Pacific Ocean by the Indonesian throughflow (ITF) current — which is therefore a further factor that can modulate the thermohaline composition of southern Atlantic waters[6].

Nuber *et al*. investigated patterns of salinity change in the Indian Ocean and the ocean waters next to southeastern Africa over the past 1.2 million years using a series of marine sedimentary records, including a newly developed one for offshore Madagascar. The authors carried out geochemical measurements of the calcium carbonate shells of microscopic plankton, called foraminifera, found in these sediments. This allowed them to determine changes in the composition of the stable oxygen isotopes in seawater that had occurred over time at each site, using established protocols to correct for the confounding influence of other factors. The oxygen-isotope composition of seawater is commonly used as a proxy for ocean salinity, because both quantities are controlled by evaporation, precipitation and advection[4,5].

Intriguingly, Nuber *et al*. found that pronounced trends of warming and salinification occurred in the Indian Ocean about 20,000 years, on average, before the onset of global deglaciations. The authors contend that the resulting build-up and subsequent further transfer of saline Indian Ocean waters into the South Atlantic region eventually boosted the AMOC, and with it, the northward transport of heat required for each global deglaciation.

Nuber and colleagues support their assertions with palaeoclimate simulations of glacial climates that have a suppressed AMOC. Using a state-of-the-art climate model, the authors artificially increased the salinity of southern Atlantic Ocean waters to simulate the intrusion of salty water masses from the Indian Ocean. The simulations suggest that this saline influx can speed up the recovery of the AMOC from a subdued state in just a few centuries, even when fresh water is persistently introduced into the North Atlantic Ocean (to resemble the addition of meltwater from disintegrating ice sheets during deglaciation).

So, what causes salinity in the Indian Ocean to rise 20,000 years before deglaciation? Nuber *et al*. discount atmospheric drivers, surmising that the ITF current has a key role in modulating basin-wide salinity anomalies in the Indian Ocean over these timescales.

The ITF brings fresher waters to the Indian Ocean from the Pacific Ocean through marine passages in the Indonesian archipelago. The authors use a model of sea-level topography to show that the maximum change in sea–land surface distribution across the Indonesian archipelago occurs when global sea levels are about 40–60 metres lower than today — values that, on average, resemble global sea-level around 20,000 years before deglaciations. Accordingly, Nuber *et al*. propose that changes in sea level, and the associated exposure of continental shelves in the Indo-Pacific region, led to constricted ITF flows and the eventual build-up of salinity in the Indian Ocean (Fig. 1).

This study presents a tantalizing working hypothesis for how the climate system transitions from glacial to interglacial states. However, questions remain about the proposed mechanism of advected salinity, regarding the importance of evaporative fluxes, winds and the role of the Southern Ocean. Furthermore, it is not straightforward to tie ITF strength to the exposure of continental shelves[10,11], and evidence suggests that portions of the Indonesian shelves were permanently exposed before about 400,000 years ago[12] — which complicates interpretations of the effects of ITF change over the past million years. Nevertheless, Nuber and colleagues' findings and proposed mechanism represent an advance in our understanding of ice-age climates, and highlight the multifaceted nature and enigma of glacial–interglacial climate change.

Kaustubh Thirumalai is in the Department of Geosciences, University of Arizona, Tucson, Arizona 85721, USA.
e-mail: kaustubh@arizona.edu

1. Broecker, W. S. & van Donk, J. *Rev. Geophys.* **8**, 169–198 (1970).
2. Beal, L. M., De Ruijter, W. P. M., Biastoch, A., Zahn, R. & SCOR/WCRP/IAPSO Working Group 136. *Nature* **472**, 429–436 (2011).
3. Nuber, S. *et al. Nature* **617**, 306–311 (2023).
4. Thirumalai, K. & Richey, J. N. *US CLIVAR Var.* **14**(3), 8–12 (2016).
5. Marino, G. *et al. Paleoceanogr. Paleoclimatol.* **28**, 599–606 (2013).
6. Weijer, W. *et al. J. Geophys. Res. Oceans* **124**, 5336–5375 (2019).
7. Caley, T., Giraudeau, J., Malaizé, B., Rossignol, L. & Pierre, C. *Proc. Natl Acad. Sci. USA* **109**, 6835–6839 (2012).
8. Gordon, A. L. *J. Geophys. Res. Oceans* **91**, 5037–5046 (1986).
9. Durgadoo, J. V., Rühs, S., Biastoch, A. & Böning, C. W. B. *J. Geophys. Res. Oceans* **122**, 3481–3499 (2017).
10. Di Nezio, P. N. *et al. Paleoceanogr. Paleoclimatol.* **31**, 866–894 (2016).
11. Sarr, A.-C., Sepulchre, P. & Husson, L. *J. Geophys. Res. Atmos.* **124**, 2574–2588 (2019).
12. Sarr, A.-C. *et al. Geology* **47**, 119–122 (2019).

The author declares no competing interests.

Politics

US prison population data reveal racial disparities

Jessica M. Eaglin

A public data set on the size and racial composition of US prison populations has been generated. Its analysis indicates how biases in sentencing lengths shape prisons' racial make-up in the United States. **See p.344**

Fifty years ago, the United States initiated an unprecedented increase in its prison population that disproportionately affected its racial minorities (see go.nature.com/3knvxcf). From 2009, numbers of incarcerated people began to stabilize and modestly decline[1]. Klein *et al*.[2] report on page 344 that conditions created by the COVID-19 pandemic led to a dramatic reduction in prison populations in every state. The authors find that Black people remained in prison disproportionately during this period, and provide evidence that this might be because they receive notably longer sentences than do white people. The findings highlight the enduring importance of racially disparate sentencing in the US criminal system.

From 2009 to 2019, the US prison population declined by 11% nationwide, probably as a result of legal reforms adopted by some states — drug courts, algorithmic risk assessments and criminal-code revisions that shortened sentence lengths for specific offences, for instance[3,4]. But delineating the impact of various reforms on incarceration or racial disparities has been challenging, owing to a lack of coherent data-reporting methods across prisons and states.

To overcome this challenge, Klein *et al*. built a remarkable public data set. They collected and analysed monthly — and in some cases weekly — observations on the size and racial composition of the prison populations in all 50 US states, as well as in Washington DC

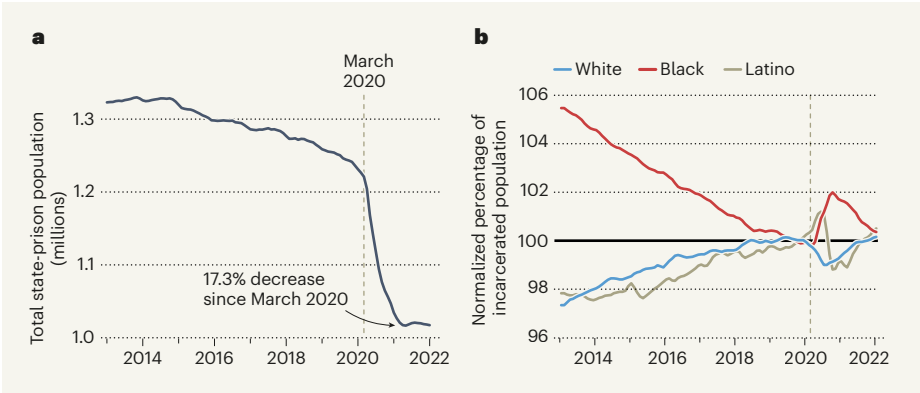

Figure 1 | Changes in US prison populations between 2013 and 2022. Klein *et al.*[2] have analysed changes in the size and racial composition of prison populations in the United States over time. **a**, There was a gradual decrease in the number of people in prison over many years, followed by a drastic decrease between March 2020 and July 2021, owing to the COVID-19 pandemic. **b**, Racial disparities increased significantly during this pandemic period — particularly for Black people, who disproportionally remained in prison. Here, 100% represents the mean prison population for each group between March 2019 and February 2020, with other numbers indicating percentage changes from that mean. (Figure adapted from Figs 1a and 3c of ref. 2.)

and the federal system over the past 20 years (these separate jurisdictions together produce the total US prison population). The authors treat the pandemic-related period of prison-population reduction as a 'stress test' on the US criminal system, and use their data set to determine whether and how this period of intense decarceration exacerbated racial disparities.

The authors demonstrate that, before the pandemic, trends in prison numbers varied widely between states — with some populations increasing, some decreasing and some remaining stable. By contrast, the incarcerated population decreased in every state between March 2020 and July 2021, amounting to a reduction of at least 17% nationwide (Fig. 1a). After July 2021, the varying approach to prisoner reductions resumed.

Klein and colleagues find that the COVID-19 pandemic accelerated, and changed, trends in decarceration. Before the pandemic, declines in prison populations were associated with a modest decrease in racial disparities. Black people make up 13.6% of the US population (see go.nature.com/3mgi11q). Nationwide, the proportion of the prison population that was Black decreased from 41.6% in March 2013 to 38.9% in March 2020, according to Klein and colleagues' data. By contrast, the national and state-by-state percentage of Black and Latino prisoners increased almost uniformly during the pandemic period. Nationwide, the Black prison population increased by 0.9 percentage points between March and November 2020 alone (Fig. 1b).

The authors investigate three possible explanations for this trend — prison admissions, prison releases and sentence lengths. Previous empirical research has pointed to the interplay between admissions and releases as the cause of mass incarceration, and thus the key to reducing it[5]. But Klein and colleagues' data set, which includes state-level information on police encounters and court proceedings, reveals a more nuanced decarceration dynamic. Here, longer sentences, distributed along racial lines, were the key factor in the sharp rise during the pandemic in Black (and, in many states, Latino) prisoners.

Between March and November 2020, fewer Black people entered prisons than was the case, on average, between January 2019 and February 2020 in many states. By contrast, the number of Black people being released was similar during both time periods. Nevertheless, racial disparities in state prison populations often increased. Klein *et al.* infer from this trend that Black people disproportionately remained in prisons serving longer sentences than those of white people. Drawing on their in-depth data set, the authors rule out, through case study, the possibility that this rise was due to a relative increase in the severity of crimes committed by Black or Latino people during the pandemic. These findings highlight how sentencing demographics have a crucial role — albeit one less visible than admissions and releases — in shaping a prison population's enduring racial composition.

Two observations about US prison populations before the pandemic bolster this conclusion. First, the racial disparity in prison admissions between Black and white people is much less extreme than the racial disparities in the composition of the prison population[6]. Klein and colleagues' data set demonstrates that an interruption in admissions, as occurred during the pandemic, increases the disparity of the prison population's racial composition under such conditions. Exactly how the racial composition changes will depend on jurisdiction-specific sentencing demographics. Second, the authors observed that the few states for which the study's overall trends did not apply incarcerated fewer people for shorter-term (less than two-year) sentences before the pandemic than did other states. This feature made these states immune to the sharp rise in racial disparities during the pandemic.

Although there are limits to the authors' findings, this study speaks to the continuing debates about decarceration policies in the United States. It demonstrates that existing policies that aim to reduce the country's prison populations tend to benefit those who already get shorter sentences — in this case, white people. It casts doubt on eligibility criteria and other mechanisms that prioritize these individuals for programmes that avoid incarceration as punishment or permit early release from prison as long-term responses to the phenomenon of mass incarceration.

Klein *et al.* do not analyse the impact of specific decarceration methods, such as algorithms or shortened sentence lengths for specific offences. But their data set can — and should — be used to determine whether and how specific legal reforms affect prison populations and the racial composition of prisons. As decarceration-policy debates continue, this data set will be essential in delineating which kinds of reform are most effective and why.

But weighing in on which criminal legal reforms are preferred is not the point of this study. Rather, Klein and colleagues demonstrate that different methods to reduce the incarcerated population will alter the racial composition of prisons over time. In doing so, they have shown empirically what criminal-law and criminal-policy scholars have long theorized[7,8]. Ultimately, then, the study challenges scholars and policymakers to place structural and racial inequalities in the criminal system at the centre when imagining how to decarcerate going forward. Without addressing persistent disparities in sentence length, even successful efforts to contain the US prison population will contribute to enduring racial disparities in prisons over time.

Jessica M. Eaglin is in the Maurer School of Law, Indiana University, Bloomington, Indiana 47405, USA.
e-mail: jeaglin@indiana.edu

1. Carson, E. A. *Prisoners in 2019* (US Bureau of Justice Statistics, 2020).
2. Klein, B. *et al. Nature* **617**, 344–350 (2023).
3. Eaglin, J. M. *Minn. Law Rev.* **104**, 2715–2740 (2020).
4. Zimring, F. E. *The Insidious Momentum of Mass Incarceration* (Oxford Univ. Press, 2020).
5. Pfaff, J. F. *Locked In: The True Causes of Mass Incarceration — And How to Achieve Real Reform* (Basic Books, 2017).
6. Garland, B. E., Spohn, C. & Wodahl, E. J. *Justice Policy J.* **5**, https://www.cjcj.org/media/import/documents/racial_disproportionality.pdf (2008).
7. Harcourt, B. E. *Fed. Sentencing Rep.* **27**, 237–243 (2015).
8. Eaglin, J. M. *SMU Law Rev.* **66**, 189–226 (2013).

The author declares no competing interests.
This article was published online on 19 April 2023.