

## Commentary

# *Critical metabolism: Towards a metabolic justice?*

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*Drawing on meetings and workshops involving an international and inter-disciplinary team, this commentary focuses on the relationship between metabolism and critical public health. We relate global indicators of metabolic ill-health to changes in the ways in which metabolisms are being conceptualized and lived. As metabolism is increasingly framed in social-ecological rather than individual-somatic terms, we highlight works that identify forms of metabolic injustice. While we welcome these altered frames, we also note that the multifaceted nature of metabolism poses a challenge for conventional forms of justice. The purpose of our commentary is to open debate on what just metabolisms might entail.*

## Introduction: A Global Metabolic Crisis?

Metabolism seemingly lies at the heart of contemporary health challenges. Type 2 diabetes mellitus (T2DM), a condition related to metabolic processing, is ‘pervasive, exponentially growing in prevalence, and outpacing most diseases globally’ (Agarwal et al. 2023). Similar trajectories are reported for cardiovascular disease (CVD) and metabolic syndrome (Roth et al. 2020). Mainstream epidemiology utilises somatic measures including high blood pressure, Body Mass Index (BMI) and high Fasting Plasma Glucose (FPG) as key indicators of poor metabolic health (Foreman et al. 2018). Despite contestation over the ways in which bodies are measured and normalised (Gutin 2018, Hatch 2016, Solomon 2016, Vaughan 2019) these metrics are linked to inherited traits, life course stage and lifestyles, and utilized irrespective of social, cultural or economic conditions (Glasgow & Schrecker 2015, Shim 2014, Yates-Doerr 2015). They have been transferred wholesale to lower and middle-income countries (LMICs), where metabolic risks are frequently framed as outcomes of lifestyle changes (Vaughan 2019).

As Vaughan notes, explanations for this metabolic crisis frequently refer to epidemiological transitions whereby non-communicable diseases (NCDs) surpass communicable disease in morbidity and mortality records, with an assumed causal relation involving improved infection prevention and control, and changes to population age structures and lifestyles (Herrick 2023, Omran 1971). So defined, the

problem space shapes its own solution – improved public awareness surrounding risk factors is linked to assumptions of individual responsibility for diet, healthy living and exercise, with some level of commercial and state engagement with sales taxes, dietary and public space infrastructure.

This framing is partial and problematic, for at least four reasons. First, knowledge of the full extent of the metabolic disease burden is hindered by poorly calibrated proxy metrics and approximations, many of which are based on questionable norms (Adams 2016, Vaughan 2019). Fat studies scholars have, for example, questioned forms of measurement and a pathologisation of diversity (Colls & Evans 2014, Land 2018). Second, transition narratives are often underpinned by questionable causality. For example, metabolic related health problems, like T2DM and CVD, can be secondary effects of infectious disease. Human immunodeficiency virus (HIV) and tuberculosis (TB) can produce long-term inflammation-associated conditions and diabetes (Vaughan 2019). The multimorbidity that results is more accurately labelled as a function of impoverishment rather than transition (Farmer 1999). Third, and following this, metabolisms may be changing as a result of chemical and physical alterations to environments and bodies. Poor air quality, heat exposure and climate related stresses all contribute to shifts in metabolic related disease incidence (Mandal et al. 2023). Shifting food types, and changes to the inputs that feed the animals and plants, kill the pests and boost agricultural productivity, have altered metabolic substrates (Landecker 2023). As bodies adjust to environmental changes, tissues and microbiomes can shift in ways that alter metabolic processes (Speakman et al. 2023). Finally, metabolic diseases and syndromes are more prevalent within disadvantaged socio-economic classes (Hemmingsson et al. 2023), and in minoritized, gendered and racialised groups (Colen et al. 2021, Hatch 2016). Incidence maps onto congested living conditions, impoverishment, discrimination, erratic income-earning opportunities, workplace pressures, and shifts in physical activity and sleep patterns. This prompts some to talk of structural violence in relation to metabolic damage (Campbell et al. 2024).

Across the humanities and social sciences, researchers have demonstrated how historical, political economic and planetary changes combine to materially alter metabolic living (the suite of processes that ‘people endure to survive the porosity that all life entails’ (Solomon 2016, p. 9)). Work in Central America has linked diabetes prevalence to colonial histories of plantation agriculture, and the resulting soil degradation and dietary impoverishment (Moran-Thomas 2019). In Jamaica, structural adjustment and conditional overseas development assistance framed the ability of the government to lower child malnutrition levels, contributing to a rise in childhood obesity (Altink 2020). In West Papua, food sovereignty and environmental relations of Indigenous populations were threatened by industrialized plantations and global food systems (Chao 2023). Studies of several states in sub-Saharan Africa provide further evidence of composite shifts and relational changes (Tousignant et al. 2023) and demonstrate the importance of legacy harms, historical and global processes (Vaughan 2019). Bodies, it turns out, are porous, absorbing (rather than simply consuming) the world around them (Solomon 2016). As that world changes, so too do the ways in which organisms regulate their interactions.

In sum, news of metabolic disease may have been exaggerated (a result of poorly calibrated measurements), but causes have been misinterpreted, and solutions have been misaligned to the issues at hand.

## Metabolic Justice?

Widespread, unevenly experienced challenges to metabolic living imply systemic inequities in access to metabolic quality of life (the bundle of material and social conditions that contribute to robust metabolic function and flourishing) and uneven exposures to metabolic threats (the multiple challenges to successful metabolic living). This invites a social and environmental justice approach to the question of metabolic health outcomes.

The rationale is appealing. There is, for example, in Moran-Thomas' (2019) account of metabolic deterioration in Belize, a causal pathway from colonial expropriation of resources to the impoverishment of soils and diets, and a decline in public health. The injustices are compounded by poorly resourced public health approaches which encourage individual health monitoring and responsibility for lifestyle changes. In Brazil, the radical nutritionist and geographer José de Castro highlighted the metabolic injustices of sugar cane plantations as long ago as the 1940s, wherein ‘whole organisms became saturated with sugar’ (Davies 2019, p. 843). Indeed, land use changes are used by several commentators within the social sciences to highlight metabolic rifts and politics (Barua 2024). Some of this work focuses on the shifts in global

provisioning systems as corporate food empires commandeer landscapes, soils, vegetative and animal life to divert energy and matter towards shareholder, private equity, and wealthier consumer markets. As environments and people are impoverished and exploited, there are clear injustices of various kinds (health, economic and multispecies) being enacted in the name of unequal global supply chains.

Given the landscape and environmental aspects of metabolic living, one approach is to suture well-established environmental justice arguments to metabolic processes. The interactions of genes, cells, adipose tissue, bodies, atmospheres, food systems, landscapes and planetary changes emphasise the relational nature of subcuticular processes and environments. Studies from this perspective share analytical breadth with epigenetics, exposome and syndemic approaches that link environmental changes to shifts in biomolecular and bodily processes (Landecker 2011, Mansfield & Guthman 2015). For Chao (2023, np), this involves attention to bodies of various kinds: the eaters, their organs, cells and tissues, as well as the eaten, ‘the plants, animals, and ecosystems whose own metabolic activity makes food for humans possible’. As we have already implied, this extends beyond the processes of eating and energy throughput: bodies are ‘historically constituted, socially shaped, symbolically charged, and affectively mediated’ (Chao 2023, np). The resulting metabolic politics involve a wide range of social and material relations that can include reemerging and chronic infections, stresses, chemical atmospheres, and much else besides. Key questions for researchers and those interested in justice include: where do we draw the boundaries around metabolism, and are current formulations of justice sufficient for dealing with metabolic relations? We will take each question in turn.

### *Changing Metabolisms*

Metabolism is not quite what it was. As Landecker (2011, 2013, 2019, 2024) has chronicled, metabolism is unravelling epistemologically (as ideas change) and ontologically (as the internal and external matters of metabolism alter). Metabolism is operating within a new milieu, altered by changes in trace elements, endocrine disruptors, the advent of new materials (including microplastics), shifts in microbiomes, ambient and bodily temperatures, and disrupted daily rhythms. This new set of chemical and social conditions for metabolism has spurred a move away from the concept of metabolism as largely passive, with routine maintenance organised by a sovereign and genetically determined body and its associated chemical cycles. Instead, metabolism is understood as curiously agentic (Solomon 2016), with metabolic outputs involved in orchestrating bodies, regulating processes, and ‘resisting’ chemical and other treatments (Landecker 2024). Bodies, tissues and cells are actively responding to alterations in habitats and environments, a process that links the global and the planetary to the cellular and the molecular. In short, this unravelling of metabolism does two things. First, in terms of critical public health, it takes metabolism beyond the body. Metabolic health is no longer a matter for individuals and their bodies alone. Second, it emphasizes how environments get under the skin, changing the ways in which metabolism and metabolic bodies are organized.

### *Changing Justice*

Justice most often refers to a suite of intersecting concerns that rest on a fair distribution of the conditions, both procedural and substantive, necessary to flourish. This includes retrospective considerations such as possible reparations for previous wrongs; current concerns over the distribution of wealth, power, respect or basic needs; and/or ongoing access to processes and procedures for decision-making or rules (Barnett 2011, Sen 2009). These can form clear principles for a just outcome including the right to redress if an injury results from negligence, violence, or other process; access to nutritious food, potable water, and basic income; the ability to be heard, to raise concerns and to receive a fair hearing (Fricker 2007).

There are undoubtedly instances where historical as well as contemporary metabolic injustices can be identified, when somatic norms, human rights or environmental conditions are clearly violated and forms of expression are silenced. But it is also often the case that the normative aspects of justice claims, and their legal execution through jurisprudence, are difficult to apply to aspects of metabolic living that are frequently mundane, long-term, invisible, cumulative, and attritional. In a similar vein to recent toxicological and pollution studies (Liboiron et al. 2018), exposures can be well within legal limits, or below the assumed thresholds of critical acute damage, but still contribute to changes in metabolic outcomes. As Landecker (2023, p. 59) has noted, the ubiquity of changes to metabolic chemistries raises ‘new questions about the

systemic rather than the overtly toxic impacts of these hidden practices'. In these circumstances, state and legal protections of persons must be supplemented by a system adapted to the socially and materially complex matters implied by the emerging metabolic sciences. This needs to recognize not only the slow violence (Nixon 2013) involved in metabolic change, but also the requirement to elevate these slow and often imperceptible changes to matters of public controversy (Berlant 2007). It involves making attritional lethality or metabolic weathering into a different kind of public, or slow, emergency (Anderson et al. 2020).

While the food, air and daily stressors may be insufficiently 'toxic' to be labelled as critically dangerous, the accumulation of metabolic stressors produces a condition wherein the previously safe contributes to progressive decline. In some cases, relatively minor alterations to metabolic living may trigger significant changes. When bodies (human as well as nonhuman) are already at the margin of metabolic wellbeing, minor shifts in sleep, temperature, air quality and so on can produce sizeable health effects. A non-exhaustive list of challenges for any resulting account of metabolic justice include:

- There are multiple contributors to metabolic change. Many of these will be mundane, non-acute, cumulative, and sub-lethal or sub-toxic.
- Time frames can be long and may be inter-generational, with significant latency between changes and their effects.
- Metabolic processes can be affected by distant actors and processes. Accountability may be diffuse and spatially composite.
- Changes to nonhuman and commensal species (for example microbiomes) may affect human health indirectly, requiring forms of justice thinking that relate to more-than-human entities.
- Sorting through different forms of evidence, proof standards and knowledge claims presents epistemological as well as legal challenges.
- Identifying appropriate political subjects, institutional and other levers for change requires careful consideration.
- Assessing solutions, including pharmaceutical, promissory, and other fixes to metabolic problems, will involve consideration of beneficiaries, power relations, and unintended consequences.
- Generating alliances across social and transnational groups, and between people and nonhuman actors, involves generating equivalences and solidarities.

Metabolism isn't unique in this respect, but we would argue that it presents significant challenges to narrowly conceived justice-based approaches. The question then becomes: how might a critical health approach address the challenge of metabolic living?

## Just Metabolisms

Given the mundane and systemic nature of metabolic challenges, it is difficult to mobilise justice arguments founded upon a single ideal or good. As with many other controversies, metabolic changes will involve working with multiple 'goods' or norms (including contestations over norms, like, for example, body fat). In relation to food and diet this would include making food accessible, nutritious, tasty, good value and so on (Mol 2021). In the UK, there have been several instances of attempts to address metabolic health through in-school meal provision, seeking to establish trust, authority, taste, cost effectiveness as well as celebrity backing to establish change (Pike & Kelly 2014). In relation to sleep deprivation and disruption to circadian rhythms, which can affect metabolic compartmentalisation, positive change would involve addressing labour practices, equity, service delivery, efficiency, cost effectiveness and much else besides (White 2022). In cases like these, various forms of justification (market, industrial, civic, domestic, and so on) are used to advance, and block, change. How various 'goods' are ordered becomes a key means to assess processes and outcomes.

Here, we take inspiration from Boltanski and Thévenot's (2006) pragmatic sociology of criticism. Reasoning that actors of all kinds apply critical reasoning to the issues and situations they face, the authors suggest studying how groups and organisations utilize various forms of justification to sanction action. In studies of this process, they suggest that core principles commonly inform but do not determine the ways in which issues play out. In empirical cases, they emphasise the importance of measuring devices and materials in testing and then furnishing justifications. In its first iteration, modes of justification included

market, industrial, civic, domestic, inspired and fame orders, each of which was associated with specific values, types of evidence, roles and practices, materials, objects and so on. Market orders of worth typically emphasized monetary forms of justification; civic orders collective welfare, while fame related to renown, popularity and so on. How these orderings played out would relate to the specific ways in which matters were staged, curated and negotiated.

Taking this seriously involves observing the practices of raising issues, testing claims, mobilizing devices, balancing goods, resolving, or diminishing contests and conflicts. It can also, we would suggest, facilitate a form of active engagement, where researchers work with groups to build and test evidence. For example, speculating on metabolic approaches in informal settlements in Dhaka, Bangladesh (Rashid 2024), competency groups would be assembled to discuss key challenges. Once groups have prioritized issues, they can call on other experts and materials to develop their case. Depending upon their discussion they might be assisted to gather air quality measurements, to generate evidence on food access and adulteration, gender inequalities, ambient temperatures in dwellings and workplaces, stress, sleep patterns and security of tenure. Groups could consider ways to mobilise evidence or possible levers for change. This could involve making things public (Latour & Weibel 2005) through social media, exhibitions, theatre or culturally valuable forms. Once material and social conditions have been mapped out, and links to metabolic processes developed, the trial (or test of strength of proposed justifications) would need to establish barriers to change, and how any arising controversy is managed or undermined by established approaches to public health.

Similar approaches can be outlined elsewhere. In Brazil, large public health data sets, linked to welfare programmes, can be analysed by citizen groups to assess evidence for metabolic changes. Again, the generative nature of exhibiting speculative forms of evidence and data-linkage can be formative in making metabolism public. In the UK and other higher income settings, similar models can be developed. Here and elsewhere, engaging with patients' groups or those directly targeted by pharmaceutical marketing to manage metabolic risks may be an opportunity to explore recent commercial and pharmaceutical changes to metabolic politics. Assessing quick fixes in terms of civic as well as other forms of justification would provide timely data on the public legitimacy of current developments.

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While the metabolic issues in these and other cases are deeply rooted and widely branched, a first step in developing just metabolisms will be to disrupt familiar narratives and responsibilities, while seeking to identify agencies and institutions that can affect meaningful change. Metabolism, as a concept with which to work, has the potential to stitch together transnational and trans-corporeal relations, to link the molecular, the bodily and the planetary. We recognize that justice can be a rallying call, drawing attention to inequities of many kinds. But we would also counsel that established versions of universal justice and resulting legal norms can only be part of a solution in relation to complex systemic issues like metabolic change. While there is a clear need for metabolism to be considered through wider lenses, the conceptual and practical tools for doing so require articulating and ordering the multiple goods or normativities that are involved in metabolic living.

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## Conflicts of interest

We report no conflicts of interest

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## References

- Adams, V. (Ed.). (2016) *Metrics: What counts in global health*. Duke University Press.
- Agarwal, S., Wade, A. N., Mbanya, J. C., Yajnik, C., Thomas, N., Egede, ... & Graham, S. (2023) The role of structural racism and geographical inequity in diabetes outcomes. *The Lancet*, 402(10397), 235-249. [https://doi.org/https://doi.org/10.1016/S0140-6736\(23\)00909-1](https://doi.org/https://doi.org/10.1016/S0140-6736(23)00909-1)
- Altink, H (2020). Tackling child malnutrition in Jamaica, 1962–2020. *Humanities and Social Sciences Communications*, 7(1), 50. <https://doi.org/10.1057/s41599-020-00536-5>
- Anderson, B., Grove, K., Rickards, L., & Kearnes, M. (2020) Slow emergencies: Temporality and the racialized biopolitics of emergency governance. *Progress in Human Geography*, 44(4), 621-639. <https://doi.org/10.1177/0309132519849263>
- Barnett, C. (2011) Geography and ethics: Justice unbound. *Progress in Human Geography*, 35(2), 246-255. <https://doi.org/10.1177/0309132510370672>
- Barua, M. (2024) Metabolic politics: A comparative synthesis. *Transactions of the Institute of British Geographers*, e12712. <https://doi.org/https://doi.org/10.1111/tran.12712>
- Berlant, L. (2007) Slow death (sovereignty, obesity, lateral agency). *Critical Inquiry*, 33(4), 754-780. <https://doi.org/10.1086/521568>
- Boltanski, L., & Thévenot, L. (2006) *On justification: Economies of worth*. Princeton University Press.
- Campbell, J., Andrade, F., & Chiu, C.-Y. (2024) Syndemic theory application: Obesity, type 2 diabetes and structural violence. *Archives of Physical Medicine and Rehabilitation*, 105(4), e6-e7. <https://doi.org/https://doi.org/10.1016/j.apmr.2024.02.016>
- Chao, S. (2023, 4<sup>th</sup> May) *Metabolic (in)justice*. Society for Social Studies of Science. [https://4sonline.org/news\\_manager.php?page=30028](https://4sonline.org/news_manager.php?page=30028).
- Colen, C. G., Pinchak, N. P., & Barnett, K. S. (2021) Racial disparities in health among college-educated African Americans: Can attendance at historically Black colleges or universities reduce the risk of metabolic syndrome in midlife? *American Journal of Epidemiology*, 190(4), 553-561. <https://doi.org/10.1093/aje/kwaa245>

- Colls, R., & Evans, B. (2014) Making space for fat bodies? A critical account of 'the obesogenic environment'. *Progress in Human Geography*, 38(6), 733-753. <https://doi.org/10.1177/0309132513500373>
- Davies, A. (2019) Unwrapping the OXO cube: Josué de Castro and the intellectual history of metabolism. *Annals of the American Association of Geographers*, 109(3), 837-856. <https://doi.org/10.1080/24694452.2018.1530585>
- Farmer, P. (1999) *Infections and inequalities: The modern plagues*. University of California Press.
- Foreman, K. J., Marquez, N., Dolgert, A., Fukutaki, K., Fullman, N., McGaughey, . . . & Murray, C. J. L. (2018) Forecasting life expectancy, years of life lost, and all-cause and cause-specific mortality for 250 causes of death: reference and alternative scenarios for 2016-40 for 195 countries and territories. *Lancet*, 392(10159), 2052-2090. [https://doi.org/10.1016/s0140-6736\(18\)31694-5](https://doi.org/10.1016/s0140-6736(18)31694-5)
- Fricker, M. (2007) *Epistemic injustice: Power and the ethics of knowing*. Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780198237907.001.0001>
- Glasgow, S., & Schrecker, T. (2015) The double burden of neoliberalism? Noncommunicable disease policies and the global political economy of risk. *Health & Place*, 34, 279-286. <https://doi.org/https://doi.org/10.1016/j.healthplace.2015.06.005>
- Gutin, I. (2018) In BMI we trust: reframing the body mass index as a measure of health. *Social Theory & Health*, 16(3), 256-271. <https://doi.org/10.1057/s41285-017-0055-0>
- Hatch, A. R. (2016) *Blood sugar: Racial pharmacology and food justice in Black America*. University of Minnesota Press.
- Hemmingsson, E., Nowicka, P., Ulijaszek, S., & Sørensen, T. I. A. (2023) The social origins of obesity within and across generations. *Obesity Reviews*, 24(1), e13514. <https://doi.org/https://doi.org/10.1111/obr.13514>
- Herrick, C. (2023) Geographic mythology and global health. *Annals of the American Association of Geographers*, 113(6), 1516-1533. <https://doi.org/10.1080/24694452.2023.2187755>
- Land, N. (2018) Fat knowledges and matters of fat: Towards re-encountering fat(s). *Social Theory & Health*, 16(1), 77-93. <https://doi.org/10.1057/s41285-017-0044-3>
- Landecker, H. (2011) Food as exposure: Nutritional epigenetics and the new metabolism. *BioSocieties*, 6(2), 167-194. <https://doi.org/10.1057/biosoc.2011.1>
- Landecker, H. (2013) Postindustrial metabolism: Fat knowledge. *Public Culture*, 25(3), 495-522. <https://doi.org/10.1215/08992363-2144625>
- Landecker, H. (2019) A metabolic history of manufacturing waste: Food commodities and their outsides. *Food, Culture & Society*, 22(5), 530-547. <https://doi.org/10.1080/15528014.2019.1638110>
- Landecker, H. (2023) The food of our food: Medicated feed and the industrialization of metabolism. In H. Landecker, *Eating beside ourselves* (pp. 56-85). <https://doi.org/10.1215/9781478024064-003>
- Landecker, H. (2024) Life as aftermath: Social theory for an age of anthropogenic biology. *Science, Technology, & Human Values*, 50(4), 679-712. <https://doi.org/10.1177/01622439241233946>
- Latour, B., & Weibel, P. (Eds.) (2005) *Making things public. Atmospheres of democracy*. MIT Press.

- Liboiron, M., Tironi, M., & Calvillo, N. (2018) Toxic politics: Acting in a permanently polluted world. *Social Studies of Science*, 48(3), 331-349. <https://doi.org/10.1177/0306312718783087>
- Mandal, S., Jaganathan, S., Kondal, D., Schwartz, J. D., Tandon, N., Mohan, V., Prabhakaran, D., & Narayan, K. M. V. (2023) PM<sub>2.5</sub> exposure, glycemic markers and incidence of type 2 diabetes in two large Indian cities. *BMJ Open Diabetes Research & Care*, 11(5). <https://doi.org/10.1136/bmjdr-2023-003333>
- Mansfield, B., & Guthman, J. (2015) Epigenetic life: biological plasticity, abnormality, and new configurations of race and reproduction. *cultural geographies*, 22(1), 3-20. <https://doi.org/10.1177/1474474014555659>
- Mol, A. (2021) *Eating in theory*. Duke University Press.
- Moran-Thomas, A. (2019) *Traveling with sugar: Chronicles of a global epidemic*. University of California Press.
- Nixon, R. (2013) *Slow violence and the environmentalism of the poor*. Harvard University Press.
- Omran, A. R. (1971) The epidemiological transition: A theory of the epidemiology of population change. *The Milbank Memorial Fund Quarterly*, 49(4), 509-538.
- Pike, J., & Kelly, P. (2014) Jamie's school dinners: celebrity culture, food and the problem of healthy eating. In J. Pike & P. Kelly, *The moral geographies of children, young people and food: Beyond Jamie's school dinners* (pp. 23-43). Palgrave Macmillan UK. [https://doi.org/10.1057/9781137312310\\_2](https://doi.org/10.1057/9781137312310_2)
- Rashid, S. F. (2024) *Poverty, gender and health in the slums of Bangladesh: Children of crows*. Routledge.
- Roth, G. A., Mensah, G. A., Johnson, C. O., Addolorato, G., Ammirati, E., Baddour, L. M., Barengo, N. C., & . . . Fuster, V. (2020) Global burden of cardiovascular diseases and risk factors, 1990-2019: Update from the GBD 2019 study. *Journal of the American College of Cardiology*, 76(25), 2982-3021. <https://doi.org/10.1016/j.jacc.2020.11.010>
- Sen, A. (2009) *The idea of justice*. Allen Lane.
- Shim, J. (2014) *Heart sick: The politics of risk, inequality and heart disease*. NYU Press.
- Solomon, H. (2016) *Metabolic living: Food, fat, and the absorption of illness in India*. Duke University Press. <https://doi.org/10.2307/j.ctv125jprm>
- Speakman, J. R., Sørensen, T. I. A., Hall, K. D., & Allison, D. B. (2023) Unanswered questions about the causes of obesity. *Science*, 381(6661), 944-946. <https://doi.org/doi:10.1126/science.adg2718>
- Tousignant, N., Ehrenstein, V., Calkins, S., Cousins, T., Poleykett, B., & Waltz, M. (2023) *Introduction: Metabolic thinking and the predicaments of growth in Africa*. Somatosphere. <https://somatosphere.net/introduction-metabolic-thinking-and-the-predicaments-of-growth-in-africa/>.
- Vaughan, M. (2019) Conceptualising metabolic disorder in Southern Africa: Biology, history and global health. *BioSocieties*, 14(1), 123-142. <https://doi.org/10.1057/s41292-018-0122-3>
- White, J. (2022) Circadian justice. *Journal of Political Philosophy*, 30(4), 487-511. <https://doi.org/10.1111/jopp.12271>
- Yates-Doerr, E. (2015) *The weight of obesity: Hunger and global health in postwar Guatemala*. University of California Press.