A Pluralistic (Mosaic) Approach to Causality in Health Complexity

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A PLURALISTIC (MOSAIC) APPROACH TO CAUSALITY IN HEALTH COMPLEXITY

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Key messages:

- Population health benefits from a complexity approach that allows us to study phenomena using a plurality of methods.
- In the field of health complexity, causal questions remain key, requiring a pluralistic approach to causality.
- Complexity approaches, at least in the field of population health, go counter to reductionist approaches and instead advocate for a plurality of types of causes.
- A complexity approach to health can generate different types of evidence for public health interventions and foster a proactive way to address health inequalities.

Key readings:

- Galea, S., M. Riddle, and G. A Kaplan. 2010. "Causal Thinking and Complex System Approaches in Epidemiology." *International Journal of Epidemiology* 39 (1): 97–106. https://doi.org/10.1093/ije/dyp296.
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17.1 The causal mosaic approach in the health sciences

Causality is a central question in philosophy and the practice of the sciences. The model of providing a single definition of 'cause' or 'causality' that fits different scientific contexts as well as its everyday use has not proved successful. As a reaction, a number of philosophers

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have proposed various *pluralistic* approaches to causality. For a reconstruction of failed attempts to give a monistic account of causality, see Russo and Williamson (2007) and Illari and Russo (2014); an overview of varieties of pluralism is given in Illari and Russo, this volume, Maziarz in this volume, and Illari and Russo (2014, chap. 23). In this chapter, we endorse a pluralistic approach to causality and specifically call for applying a *causal mosaic* approach, as developed by Illari and Russo (2014, chap. 24) in the field of health complexity. We believe that thinking about causal concepts as mosaics, in the sense explained below, helps not only to understand causation from a philosophical perspective but also to think about the design and results of empirical studies – in this chapter, we focus on population health. Our claim is not that all health problems are complex in nature (an ontological claim), but that a pluralistic approach is required to engage with the complexity of health (a claim that we locate more at the level of methodology and epistemology). While our chapter motivates the need for causal pluralism from a methodological perspective, the chapter of Greenhalgh et al. (this volume) well exemplifies the complexity of health *in practice*.

We will briefly highlight the main characteristics of this pluralistic approach to causality, and then focus on aspects of it that are salient to our field of study, namely, health complexity. We will not, however, discuss the foundations of causal pluralism in general or of the foundations of the causal mosaic approach in particular, as these are presented in detail elsewhere (see e.g., Illari and Russo 2024; Russo 2022, 2023).

The pluralistic causal mosaic approach acknowledges a variety of existing concepts of cause/causation at work in the practice of the sciences and developed in the philosophical literature. Illari and Russo (2014) have systematized large parts of the current debates on causality, identifying no fewer than 20 notions or concepts, including the counterfactual concept of cause, causal mechanisms, and those cashing out causality as 'agency'.

Different causal concepts and notions have varying roles depending on the specific question or problem they are intended to address. A causal mosaics approach distinguishes philosophical questions of causality and scientific problems of causality. Tables 17.1 and 17.2

Table 17.1 Philosophical questions of causality

Metaphysics
What is causality? What kind of things are causes and effects?
E.g., what is disease causation? What kind of entities are the causes of health and disease?
Semantics
What does it mean that A causes B?
E.g., what does it mean to cause or to prevent disease? Or to promote health?
Epistemology
What notions guide causal reasoning?
E.g., what notions guide studying disease causation, for instance, in experimental or observational settings?
Methodology
How to establish whether A causes B? Or how much of A causes B?
E.g., what are appropriate methods to study disease causation? Are there thresholds to establish disease causation?
Use
What to do once we know that A causes B?
E.g., what evidence licenses action, for instance, at the level of public health?

Table 17.2 Scientific problems of causality

Inference
Does A cause B? To what extent?
E.g., does this exposure (e.g., sugar in soft drinks) cause this outcome (e.g., high diabetes incidence)?
Explanation
How does A cause or prevent B?
E.g., how does sugar in soft drinks cause increased incidence of diabetes?
Prediction
What to expect if A does (not) cause B?
E.g., what are the projections for diabetes, given the current evidence?
Explanation
How does A cause or prevent B?
E.g., what are the biological and socio-economic mechanisms explaining the development of diabetes in different populations?
Control and Intervention
What factors should be held fixed to study the relation between A and B?
E.g., what methodological tools can be used to study exposure to sugar-sweetened beverages if we cannot control this factor in an experimental setting?
Reasoning and Teaching
Which arguments are considered legitimate in establishing whether / how / to what extent A causes B?
How should causal reasoning be taught to students, given that causation and inference are philosophical topics?
E.g., under what conditions are correlational studies sufficient? Is experimental evidence needed, and if so in which cases? To what extent can the results of one study be generalized?

re-elaborate the philosophical questions and scientific problems as they were originally formulated by Illari and Russo (2014), with specific reference to questions related to health and disease.

For any available causal concept in specific fields, we need to understand whether, for instance, said notion attempts to account for metaphysical or epistemological aspects or tries to help with problems of inference or explanation. For instance, randomized controlled trials (RCTs) work with a notion of 'cause' that is largely experimental in character, based on the assumption that one can manipulate a single cause at a time, and, by equalizing treatment assignment, estimate its effects. RCTs enable the estimation of causal effects (provided that the RCT is appropriately designed), but are not as useful for identification of causes, since they only enable us to investigate one factor at a time. They are also not very useful for *explanation* – primarily because RCTs remain largely silent about *how and why* causes operate in their environment. Other chapters, for instance Andersen (this volume), explore in more detail the specific ontological assumptions underpinning different causal models, and why it matters to disentangle them.

In contrast to committing ourselves to any single concept of causality, thinking of causal concepts as a mosaic offers a *library of concepts* from philosophy and the sciences. But a causal mosaic is not just a large shelf with concepts standing one next to the other. As the term suggests, we need to form an image, a *mosaic*, using these concepts, by placing them in the correct position, depending on which role they have. For instance, it is important to

understand how individuals express and exercise their agency (or lack of it) in managing their health (via qualitative methods that largely work with agency-based notions of cause), but this requires a different methodological approach from establishing the efficacy of a medical treatment (via quantitative methods that may adopt a counterfactual, statistical, or experimental notion of cause). In empirical research and clinical settings, both aspects are relevant and important for understanding health, and this is precisely why we need to combine studies of different types. Moreover, different methodological approaches are carriers of different *perspectives* of the researchers, a topic that is thoroughly discussed in the chapters of MacLeod and of Sözüdoğru (this volume). While we confine our discussion to causality here, it is worth noting that our position is supported by a pluralistic approach to methodology (in the health sciences and elsewhere), a beneficial approach not only for understanding phenomena but also for shaping (more just and inclusive) policy responses (see also later Section 17.3). To repeat, this does not exclude the possibility that simplification and reduction are sometimes possible or useful, but it indicates that this is not a beneficial goal from a scientific or policy perspective.

In this chapter, we first introduce the main features of a complexity approach to health and then provide more details on how this pluralistic 'mosaic' view of causality can shed light, methodologically, on how complexity approaches can be used to study health.

17.2 A complexity approach to the health sciences

Health is complex in a similar sense to other complex phenomena, such as the global economy, the climate, ecosystems, or the urban environment. 'Complex' here goes beyond its lay term and instead refers to a specific meaning rooted in complex systems theory (Byrne 1998; Cilliers 2002; Ladyman and Wiesner 2020; Urry 2005). Health complexity has previously been conceptualized as 'poor health and health inequalities as outcomes of a multitude of interdependent elements within a connected whole' (Rutter et al. 2017). Health complexity refers to the fact that there is not one cause of a certain health problem. Instead, for most problems, many interacting factors play a role. These factors influence each other, implying that a certain factor might be a cause of another, and vice versa. In addition, these causes depend on context, in the sense that factors might only function as a cause of a disease if they co-occur with other factors. The web of factors that collectively 'produce' certain health problems is frequently referred to as a complex system.

In the health sciences, Rutter et al. (2017) list the following features of complex systems: emergence, feedback, adaptation, non-linearity, multifinality, equifinality, barriers to change, and stochasticity. Focusing on the first three features, Rutter et al. (2017) explain that '*emergence*' refers to properties that cannot be directly predicted from the 'elements' in the system itself: the system is 'more than the sum of its parts' (Anderson 1972). For instance, in understanding obesity from a complex systems perspective, we see that the distribution of obesity across the population 'emerges' from the interactions between variations in food consumption and physical activity across groups, conditions related to employment, transport infrastructure, economic and social factors, and others (Luna Pinzon et al. 2022). *Feedback* refers to the ways in which causal relations do not just flow from cause to effect but also back to the cause. Feedback may be positive, amplifying an effect, or negative, counteracting it. For instance, from the perspective of social dynamics, a smoking ban in public places makes smoking less visible and appealing, leading to fewer people starting smoking, which in turn reduces its visibility even further. On the other hand, reducing the

price of a sugar-sweetened drink leads to an increase in sales, which generates economies of scale for the manufacturer, supporting further reductions in price, while increasing brand visibility which leads to even greater popularity of the drink, greater market dominance, and further increased sales. Finally, *adaptation* describes how systems and behaviours change in response to interventions. For instance, lowering the tar content of cigarettes may lead smokers to take more and deeper drags (see e.g., (Broadbent 2013, 111; Parascandola 2011)). Or, to continue on the previous example, sugar-sweetened beverage manufacturers reformulate their products and change their pricing structures in response to a fiscal intervention, in order to maintain their profits.

It is important to note that complex systems, including health and disease, do not necessarily show *all* these features at any one time. Yet, recognizing that systems have at least some of these features calls for a methodological response to incorporate the complexity of the health problem at stake.

The need to look at human health and diseases from a complex systems perspective has been argued for in a number of publications (Apostolopoulos, Hassmiller Lich, and Lemke 2020; Castellani et al. 2022; Cohen et al. 2022; Diez Roux 2011; Kenzie et al. 2017; Movsisyan, Rehfuess, and Norris 2020; Plsek and Greenhalgh 2001; Rod et al 2023a,b; Rutter et al. 2017; Sturmberg and Martin 2014; Van Der Wal et al. 2021). In part, the health sciences have attempted to address the challenge of studying health and disease from a complex systems perspective by introducing increasingly sophisticated methods for data analysis, notably computational models (Crielaard et al. 2022; Marshall and Galea 2015; Ness, Koopman, and Roberts 2007). For instance, systems dynamics models have been used to model the dynamics of (parts of) the systems generating health in populations (Darabi and Hosseinichimeh 2020). Researchers have used such models to simulate affordable scenarios to reduce illness and health care costs in local health care systems (Homer et al. 2016), the effects of social norms and health awareness on group-level body mass index in different sociocultural groups (Crielaard et al. 2020), and preventive interventions on modifiable risk factors in Alzheimer's disease (Uleman et al. 2023).

Nevertheless, thinking in terms of complexity goes beyond a set of methods. Instead, complexity can be seen as a *lens* through which we understand and intervene in health problems, and consequently also how we address questions of *causality* (Galea, Riddle, and Kaplan 2010). Using this lens requires integrating insights from multiple methodological approaches, as arising, for example, in epidemiology, the biomedical sciences, computational sciences, and the social sciences and humanities. The reason why we need multiple approaches is that the complexity of health problems requires that these questions are tackled from multiple perspectives, e.g., a mix of qualitative and quantitative approaches, experimental and observational, and likewise situated within their context and the complex systems in which they take place. While we can't go into all the details of what combinations of such methodologies entail, some of these issues are addressed in the chapters of Pagliarin, Schoonenboom, or Zahle (this volume).

Health *complexity*, – be it population, public, or clinical, – does not only require a change in the way we understand health, but it also requires a programme for the multi-disciplinary study of health and disease, in which *different* types of questions are legitimate and needed. Multiple disciplines are required because features of complex systems often do not respect disciplinary boundaries (in the first place, it is far from obvious to establish what a system is or what its boundaries are, see e.g., Beisbart, Kaiser and Krickel, or Kleinhans in this volume). The formulation of multiple questions goes hand in hand with a broader perspective on causality combined with the synergistic use of existing methods.

In the philosophy of science and epidemiology, this position has been called *methodological pluralism*, according to which (i) there is no pre-determined hierarchy of methods, (ii) different methods are suited to different types of problems, and (iii) different methods help us understand problems from different angles (Broadbent, Vandenbroucke, and Pearce 2017; Maziarz 2019; Mitchell 2003; Ruphy 2016; Russo 2022; Vandenbroucke, Broadbent, and Pearce 2016). Yet, in the majority of formulations, methodological pluralism is silent on the nature of causation, and on causal concepts (perhaps with the exception of Russo (2022) which explicitly couples methodological and causal pluralism). This means that methodological pluralism may remain vulnerable to an objection from those whose approach to causality restricts the methodological approaches that may be employed. The mosaic approach to causal concepts that we propose goes hand in hand with methodological pluralism, and neither form of pluralism has previously been explicitly discussed in the context of complex systems, as we do in this chapter.

However, methodological pluralism is not a licence for an 'anything goes' strategy. It aims instead appropriately to motivate the choice of methods *for a given purpose* guided by, in this case, complex systems theory. This pinpoints, for instance, the need to integrate qualitative and ethnographic methods with quantitative methods: important methodological developments in, e.g., the 'causal inference approach' in epidemiology, and the strong causal setup of an RCT, need to be complemented by a variety of methods across disciplines and kinds of evidence.

In what follows, we suggest that understanding health complexity centrally involves questions of causality, formulated in a variety of ways, and that these questions can best be approached from a pluralistic 'mosaic' perspective on causality.

17.3 Causal questions are at the heart of health complexity

In asking questions about health and disease from a complex systems perspective, causality remains central in the reasoning. In fact, the fundamental purpose of studies in health complexity is to support improvements in population health and this, in turn, means that causal reasoning is an inescapable part of the field. 'Cause' is the word we use to indicate the conceptual bundle that includes figuring out what will happen when an action leads to an outcome. However, it is not explicitly addressed in the literature advocating a complexity approach to health (see Section 17.2). Whether we are tackling questions of polypharmacy, diabetes in disadvantaged populations, or the variability of the efficacy of medical therapies, we ask questions of causality, albeit expressed and formulated in different forms, and not always reducible to 'Does cause (C) cause effect (E)?'. This is often taken as *the* one formulation of causal questions, in turn presupposing that 'cause'/'causality' has one meaning or definition.

A complex systems approach builds on a variety of ways in which we can ask causal questions – about cause*s* of effects, interactions, or prevention – addressing the patterns of health problems as they emerge over time and space, the underlying mechanisms, and the dynamics that make them change over time.

The need to systematically address this variety of questions extends the dominant 'causal inference' approach in public health, which gives primacy to methods such as RCTs that are premised on the idea that we can isolate causal factors and study their effects while minimizing interference from other surrounding factors (Hernán and Robins 2020). Returning to our earlier discussion of RCTs, these yield important and often valuable findings about the efficacy of interventions, but a complexity approach calls for an extension of these approaches to embrace a much broader range of causal questions and methods. The causal inference approach

and RCTs are well suited to tackling *a single type of causal question*, but many complex health problems require answering a wider range of such questions (see e.g., Cartwright and Hardie 2012). Thus, for example, we need to complement RCTs with other forms of studies in order to understand how complex systems (as in the case of urban environments, for example) influence health inequalities, as their impact is not the function of an individual or narrow set of factors, but the result of dynamic interactions between multiple elements at multiple scales. The same applies to dynamic interactions of multiple factors and circumstances, which change and adapt over time, or to environmental exposures. The implication of applying a complex systems lens to health is not that RCTs or the causal inference approach are wrong; RCTs provide robust but limited information about complex phenomena, for example, because they often do not consider 'context' as a proper causal factor. The information provided by RCTs and causal inference analyses can be broadened by embracing a wider set of methodological approaches that allow the study of causal relations in a multiplicity of ways.

Health complexity is interested in causal questions, but not just formulated as 'Does some factor *C* cause some effect *E*?'. Health complexity considers causes and effects of health and disease to vary from biochemical to social factors, including socio-economic environment or other characteristics of individuals and groups. From the existing literature, and our experience in the field, we have formulated some examples of questions that can be tackled with a complexity approach:

- How are changes in some factor *C* causally related to changes in the effect *E*?
  - This may mean studying average effects but also variations across individuals and groups and over time, both about the putative cause and about the putative effect.
- How do changes in an outcome, brought about by an exposure or intervention, in turn 'feed back' affect that exposure or intervention?
  - This means studying feedback loops, which are by definition not accommodated in formal approaches that require causal models to be 'acyclic'.
- For which range of values is effect *E* most/least sensitive to causes *C*?
  - This means studying the effect of *C* on *E*, specifically for its non-linearity and dependence on the state of the system.
- Given known effect(s) *E*(s), what are their causes *C*s?
  - This means starting causal inquiry from the existence of some effect *E* (e.g., higher obesity rates), and trying to find its causes (e.g., genetic factors, health-related behaviours, urban environment characteristics). This is a question about the *causes of effects*, rather than the *effects of causes*.
- How do multiple *C*s contribute to some effect(s) *E*(s)?
- Methods deployed in health complexity also ask questions about the effects of causes and specifically ask how *multiple* causes, together and in interaction, lead to some observed effect(s). Under what conditions does some factor C cause health outcome E, and in whom?
  - Health complexity goes beyond establishing (biochemical) effects of causes on health outcomes and also asks *for whom* and *under what conditions* this applies, bringing in specific questions about the contexts and environments of individuals, and their characteristics.

- How do factors at different levels affect each other, interact, and ultimately affect individual health outcomes? Can we explain or predict individual health outcomes E based on factors Cs on other levels?
    - These two questions address issues of multi-level causality, in terms of either explanation or prediction. This is relevant in studies of interaction between, e.g., individual, group, and societal levels. They do so also by bringing in considerations about context, as something to be studied in detail, rather than controlled for.

In sum, causality is a central concern in the study of health and disease, and a complexity approach helps us see that causal questions take different formulations, in turn requiring different methodological approaches.

In the next section, we illustrate how these questions of causality can be systematized and understood in a causal mosaic approach.

17.4 The causal mosaic of health complexity

As mentioned in Section 17.1, we endorse here a causal mosaic approach, according to which there are several problems of causality (see Table 17.2). Health complexity addresses problems of causality, at times focusing on questions about inference, explanation, or control. We focus in this section on how the pluralistic approach to causal methods requires, in turn, thinking in pluralistic 'mosaic' terms about philosophical questions of causality. As explained in Section 17.2, a complexity approach significantly broadens single-faceted perspectives such as RCTs and also any approach attempting to reduce disease causation to matters of bio-chemistry (at the same time, a complexity approach may *also* be used to shed light on the complexity of health and disease at the biochemical level). Pluralistic methodological approaches can be successful insofar as they are accompanied by appropriate conceptual underpinnings. To do so, we begin with substantiating pluralism about methodology. Then we move towards philosophical questions of causality, specifically relating to epistemology, metaphysics, and finally of the use of causal knowledge (as they have been formulated in Table 17.1).

- [Methodology] A plurality of causal *methods*: health complexity employs methods from epidemiology, computational science, social science (including ethnographic methods), biomedical science, and others. It does not establish a hierarchy among such methods and instead recognizes that different methods help with studying different aspects of causal relations: the most appropriate set of methods in any particular circumstance is the one that is best suited to answering the specific question at hand. Pluralism about causal methods requires deep and thorough reflection on data collection and data analysis: which data are best suited to a given causal question? What can we learn from, e.g., qualitative or quantitative data, or from observational or experimental methods? It is through a pluralistic approach to methods that health complexity can address questions of causality formulated in different ways (see Section 17.3).
- [Epistemology] A plurality of causal *concepts*: the various methods employed in health complexity use different concepts of 'cause'. Ethnographic methods work with notions of agency and power, some causal inference approaches work with an experimental notion of cause, and computational methods often work with an information-theoretic notion of cause (e.g., 'information flow'). There may be tensions between different epistemological

approaches to causality, for instance, between a positivist or post-structuralist one, but any such tension can be explained and handled in a pluralistic approach, by specifying the scope of the application of such an approach, and as long as no approach pretends to establish itself as the dominant one. What needs to be established in any single study is how different concepts and methods contribute to answering the question at stake, thus offering *complementary* entry points into such questions. Using different approaches may also lead to conflicting results, showing how any mosaic is not meant to provide a full and immutable picture, but instead fosters continuous dialogue and progress in methods and conceptualizations of causality. Also, causal mosaic is not an approach to resolve conflicts but to enhance the quality of methodology.

- [Metaphysics] A plurality of *causal paths*: health complexity moves away from the type of reductionist thinking in which causal relations, however complex, will eventually be reduced to simple, direct, one-cause-one-effect relations. While it does not argue for any particular causal metaphysics, it is a statement about causal metaphysics insofar as it refuses to be persuaded that any particular metaphysical account provides the basis for such a reduction. This rejection is the metaphysical assumption of the health complexity approach and is clearly related to aspects of [Methodology] and of [Epistemology] discussed above. This, our metaphysical commitment is minimal and, as explained at the beginning of the chapter, our objective is not to argue for health complexity on metaphysical, but on epistemological and methodological grounds. This causal metaphysics, in practice, means that the design of public health responses should identify multiple possible types of causes and how they interact across levels and anticipate how actors in the system (population, policy, and practice) may react to these paths. Likewise, medical treatment may also benefit from complexity approaching, studying how health outcomes are also influenced by the close internal and external environment of the individual.
- [Use] In the philosophy of causality, questions of 'use' of causal knowledge have been brought to the stage to reflect on the advantages and limits of evidence-based approaches in medicine and policy (Cartwright 2011; Cartwright and Hardie 2012). The key to designing 'effective' interventions has been defined as having 'the best' evidence, which gives primacy to evidence generated by RCTs and meta-analyses, which are certainly appropriate and feasible in some contexts, but not all. A health complexity approach challenges this recipe for designing effective interventions. The design of public health responses does not only come 'top-down' from evidence generated in 'clean' empirical studies but also from participatory and co-production practices that establish a close dialogue, especially with people living in vulnerable circumstances. For instance, in M.H. Rod 2023, the identification of vulnerability is key, and it is operationalized through a complexity approach. This is not merely a way of stratifying populations according to variables that are proxies for disadvantage. Instead, it calls for a different conceptual and methodological approach to data collection and data analysis. It is *also* a normative point about how to address *inequalities* differently, e.g., by paying attention to the voices of experts. This different take on the 'use' of causal knowledge shows how these dimensions – methodology, epistemology, metaphysics – are deeply interconnected and implicitly act as drivers for the design of public health interventions.

In sum, health complexity retains the centrality of causal questions, and a pluralistic approach to causality supports its pluralistic methodology. We have followed the approach of 'causal mosaic' to show that a complexity approach to health is not a juxtaposition of

methods, and instead requires significantly changing the theoretical approach to problem definition in the study of health and disease, and in the design of policies. Our take on causality clearly benefits from complementary discussions in other chapters of the volume, as we have signalled throughout the chapter.

17.5 Concluding remarks

That the world is complex is a truism. We have argued that population health contains many instances of this complexity and that the design of public health responses must take this into account. A complexity approach to health is primarily and foremost to acknowledge such complexity and to discuss *how*, in practice, to study and intervene in health and disease, and how to consider their complexity. In turn, this creates pressure to evolve the way in which we think of public health responses (and of medical treatment too).

The emerging literature on health complexity focuses on the legitimacy of such an approach, presents empirical studies that adopt the approach, and discusses how intervention could be set up differently by adopting such an approach. However, this literature rarely addresses in an explicit and direct way how one should understand 'causality' within this perspective, although – as we have seen – health complexity is permeated by causal questions.

Our chapter fills this gap, arguing that we do not need a *new* concept of causality, nor should we be tempted to extend any of the previous efforts to capture all causal concepts in one sweeping analysis. We build on the existing literature to establish the need for pluralistic approaches (see, for instance, Illari and Russo, Maziarz this volume). The philosophy of causality has already provided us with a library of concepts, which are often associated with corresponding methods: from experiments and RCTs to observational studies and ethnographic approaches, the specific causal notions at work vary greatly. We aim to contribute to the development of pluralistic approaches to causality proposed in the philosophical literature, notably on the causal mosaic approach, pointing out not just that causality remains central in applying a complex systems approach to health but also that we need to embrace a pluralistic approach about causal methods and their epistemological and metaphysical underpinnings. At the same time, our chapter does not exhaust the discussion, and we refer the reader to Moneta and Tieleman (this volume) who discuss causal complexity from the perspective of economics and econometrics, or to the chapters of Canali and Ratti and of Zahle, who discuss in detail questions related to data quality and causality –a very relevant issue for health complexity.

An empirical approach to health complexity will not be successful if it descends into another kind of causal 'euphemism' as Hernán (2018) puts it, or if it tries again the route of reductionist approaches. We need instead to regain the ability to establish synergies across domains and approaches, to provide rich and nuanced accounts (*thick*, in philosophical terms) of the causes of, and effects on, health. While work on the foundations of a complexity approach to health is in progress, we need further empirical studies to demonstrate the appropriateness and value of such approaches. Some empirical studies have been done using this approach (Apostolopoulos et al. 2018; Castellani et al. 2022; Crielaard et al. 2020; Luna Pinzon et al. 2022; Merabet et al. 2022; Russ, Reis, and van Tongeren 2019; Uleman et al. 2023; van Olden et al. 2022), and we hope that this chapter will contribute to further methodological developments, by providing a meaningful approach to understanding questions of causality. This chapter has laid down the theoretical setup, which we hope will support the development of practical guidance about how the chosen pieces of the mosaic stand next to one another.

Note

1 Federica Russo led the conception and writing-up of the chapter. All other authors contributed equally to the chapter.

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