

Health Complexity

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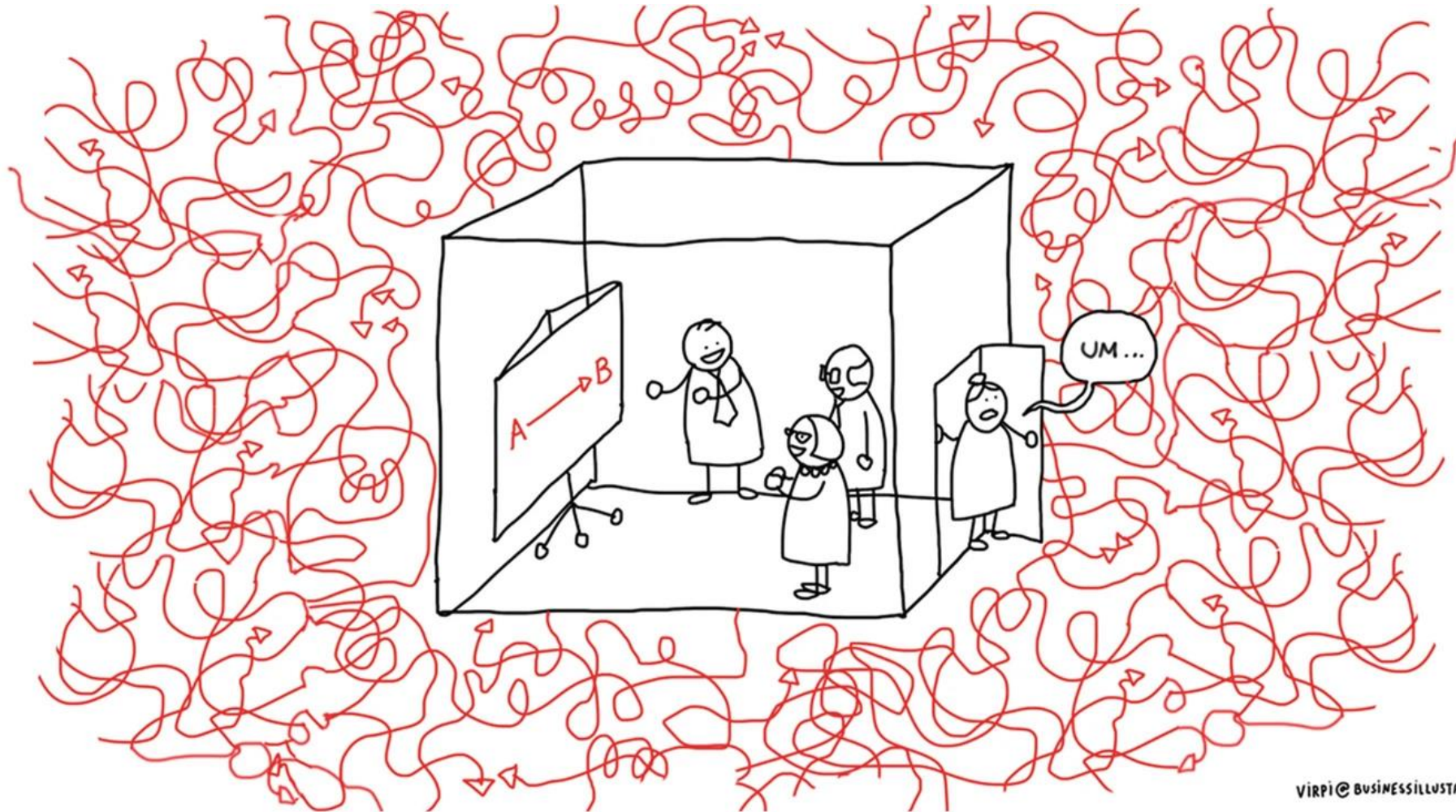


25 leading risk factors for the global burden of disease

Leading risks 2000	Percentage of total DALYs, 2000	Leading risks 2021	95% UI for Ranking	Percentage of total DALYs, 2021	Percentage change in number of DALYs, 2000–2021	Percentage change in age-standardised rate of DALYs, 2000–2021
1 Particulate matter pollution	10.6 (8.5 to 12.3)	1 Particulate matter pollution	(1 to 2)	8.0 (6.7 to 9.4)	-17.2 (-25.9 to -6.2)	-41.9 (-47.2 to -35.6)
2 Child growth failure	9.3 (6.4 to 11.1)	2 High systolic blood pressure	(1 to 2)	7.8 (6.4 to 9.2)	34.3 (26.7 to 42.3)	-24.3 (-28.4 to -20.0)
3 Low birthweight and short gestation	8.9 (8.3 to 9.6)	3 Smoking	(3 to 6)	5.7 (4.7 to 6.8)	10.8 (3.2 to 19.9)	-34.8 (-39.2 to -29.7)
4 High systolic blood pressure	6.3 (5.2 to 7.4)	4 Low birthweight and short gestation	(3 to 6)	5.6 (4.8 to 6.3)	-32.4 (-41.2 to -22.3)	-33.0 (-41.6 to -22.8)
5 Smoking	5.6 (4.7 to 6.5)	5 High fasting plasma glucose	(3 to 6)	5.4 (4.8 to 6.0)	88.2 (80.5 to 96.4)	7.9 (3.3 to 12.9)
6 Unsafe water source	4.0 (2.3 to 5.2)	6 High body-mass index	(3 to 10)	4.5 (1.9 to 6.8)	96.5 (87.1 to 105.8)	15.7 (9.9 to 21.7)
7 Unsafe sanitation	3.3 (2.7 to 3.9)	7 High LDL cholesterol	(7 to 10)	3.0 (1.9 to 4.2)	27.0 (20.8 to 33.6)	-26.1 (-29.6 to -22.4)
8 High fasting plasma glucose	3.1 (2.8 to 3.5)	8 Kidney dysfunction	(6 to 10)	3.0 (2.6 to 3.4)	49.5 (42.7 to 57.0)	-12.4 (-16.5 to -7.9)
9 High LDL cholesterol	2.6 (1.6 to 3.6)	9 Child growth failure	(6 to 14)	2.6 (1.4 to 3.5)	-69.8 (-77.5 to -62.4)	-71.5 (-78.8 to -64.4)
10 Unsafe sex	2.6 (2.1 to 3.2)	10 High alcohol use	(7 to 11)	2.5 (2.1 to 3.1)	12.4 (2.6 to 20.9)	-25.8 (-32.0 to -20.4)
11 High body-mass index	2.5 (1.1 to 3.9)	11 Unsafe sex	(11 to 17)	1.5 (1.4 to 1.7)	-35.0 (-44.6 to -20.1)	-52.4 (-58.9 to -42.3)
12 High alcohol use	2.4 (1.9 to 3.1)	12 Diet low in fruits	(11 to 22)	1.5 (0.6 to 2.3)	22.5 (15.5 to 34.0)	-26.6 (-30.9 to -20.5)
13 No access to handwashing facility	2.3 (-0.5 to 4.9)	13 Unsafe water source	(11 to 24)	1.5 (0.8 to 2.0)	-60.1 (-67.1 to -53.2)	-66.3 (-72.0 to -60.2)
14 Kidney dysfunction	2.2 (1.9 to 2.4)	14 Diet high in sodium	(8 to 36)	1.4 (0.3 to 3.2)	27.6 (1.3 to 41.2)	-26.8 (-40.9 to -19.1)
15 Occupational injuries	1.6 (1.5 to 1.7)	15 Diet low in whole grains	(12 to 23)	1.4 (0.6 to 2.1)	30.1 (24.0 to 36.6)	-23.3 (-26.9 to -19.5)
16 Secondhand smoke	1.6 (0.8 to 2.4)	16 Secondhand smoke	(11 to 26)	1.2 (0.6 to 1.8)	-16.0 (-22.0 to -6.5)	-45.3 (-48.9 to -40.3)
17 Diet low in fruits	1.3 (0.5 to 2.0)	17 Iron deficiency	(12 to 23)	1.2 (0.9 to 1.6)	1.6 (-2.1 to 5.3)	-18.1 (-21.2 to -15.2)
18 Iron deficiency	1.3 (0.9 to 1.7)	18 Lead exposure	(10 to 52)	1.2 (0.0 to 2.4)	28.8 (6.9 to 42.2)	-23.9 (-28.9 to -18.4)
19 Diet high in sodium	1.2 (0.3 to 2.7)	19 Unsafe sanitation	(14 to 23)	1.1 (0.9 to 1.4)	-63.8 (-69.8 to -57.6)	-69.2 (-74.4 to -63.2)
20 Suboptimal breastfeeding	1.2 (0.9 to 1.5)	20 Occupational injuries	(15 to 21)	1.1 (1.0 to 1.2)	-25.2 (-30.7 to -20.3)	-43.6 (-47.5 to -39.8)
21 Diet low in whole grains	1.2 (0.5 to 1.8)	21 Drug use	(17 to 24)	1.0 (0.8 to 1.1)	31.1 (23.6 to 38.3)	-4.6 (-10.1 to 0.8)
22 Lead exposure	1.0 (0.0 to 2.0)	22 Low temperature	(19 to 26)	0.9 (0.8 to 1.0)	9.6 (-1.5 to 21.6)	-39.5 (-44.2 to -34.5)
23 Low temperature	0.9 (0.7 to 1.0)	23 No access to handwashing facility	(11 to 53)	0.8 (-0.2 to 1.8)	-60.5 (-68.9 to -52.3)	-65.7 (-73.4 to -57.8)
24 Drug use	0.8 (0.7 to 0.9)	24 Diet low in vegetables	(20 to 29)	0.7 (0.4 to 1.0)	21.8 (13.3 to 35.7)	-28.5 (-33.4 to -21.3)
25 Diet low in vegetables	0.6 (0.4 to 0.9)	25 Diet low in omega-6 polyunsaturated fatty acids	(11 to 53)	0.6 (-2.0 to 2.3)	32.9 (23.4 to 38.8)	-21.3 (-25.7 to -17.0)
29 Diet low in omega-6 polyunsaturated fatty acids	0.5 (-1.7 to 1.9)	36 Suboptimal breastfeeding	(30 to 40)	0.3 (0.2 to 0.4)	-71.3 (-75.7 to -66.2)	-71.4 (-75.8 to -66.4)

■ Environmental and occupational risks
■ Behavioural risks
■ Metabolic risks

Health is a complex phenomenon



Complex public health problems

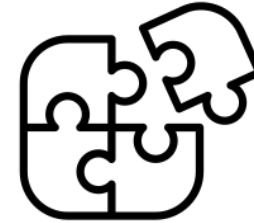
Public health problems are multifaceted and constantly evolving, and they **emerge from a complex and 'messy' world** characterized by interactions, non-linearity, interference, feedback loops, adaptation, and evolution.



Simple
The relationship between
cause and effect is obvious



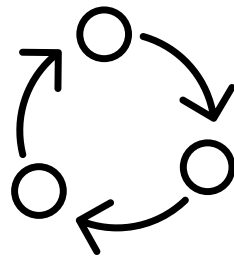
Complicated
The relationship between cause and effect is clear,
but requires expert analysis



Complex
The whole is different than the sum of the parts

Interconnected
mechanisms

Dynamics



Chaos
The relationship between
cause and effect cannot be determined



We need to ask a **new type of questions**



Complex Systems Lens

Look for diversity instead of averages

Study non-linearity and feedback
instead of assuming linearity

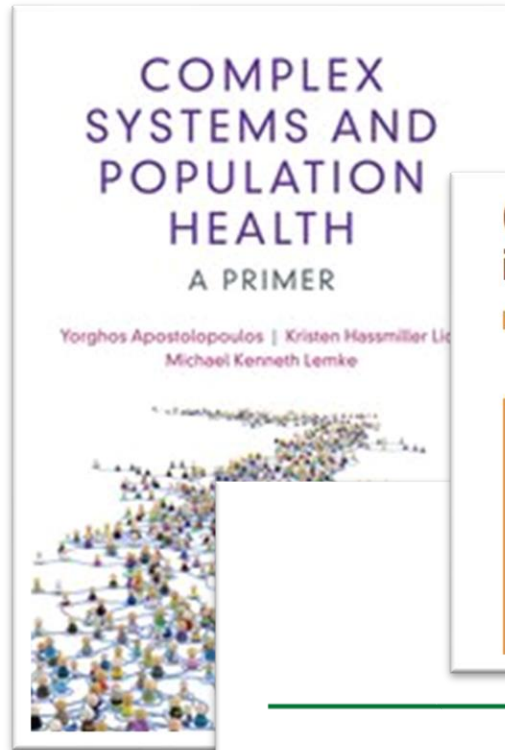
Explore interactions, networks, and group
dynamics instead of assuming independence

Assess the importance of context in time and
space instead of assuming standardized
conditions

Study evolution across generations
instead of ignoring history

Identify emergent features of complex systems
instead of isolating single effects

Complexity thinking in public health



Home > [Handbook of Epidemiology](#) > Living reference work entry

Systems Approaches to Health Research and Prevention

Springer Reference
LIVE 
Handbook of Epidemiology
Springer

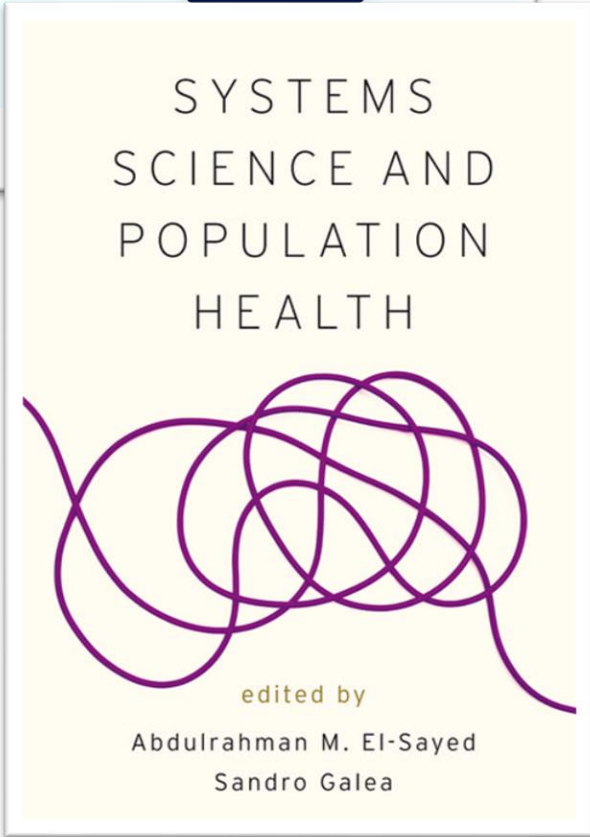
Complex Systems Thinking and Current Impasses in Health Disparities Research

Ana V. Diez Roux, MD, PhD

Complex systems approaches have received increasing attention in public health because reductionist approaches yield limited insights in the context of dynamic systems. Most discussions have been highly abstract. There is a need to consider the application of complex systems approaches to specific research questions. I review the features of population health problems for which complex systems approaches are most likely to yield new insights, and discuss possible applications of complex systems to health disparities research. I provide illustrative examples of how complex systems approaches may help address unanswered and persistent questions regarding genetic factors, life course processes, place effects, and the impact of upstream policies. The concepts and methods of complex systems may help researchers move beyond current impasse points in health disparities research. (*Am J Public Health*. 2011;101:1627–1634. doi:10.2105/AJPH.2011.200546)

WHEN COMPLEX SYSTEMS APPROACHES MAKE THE MOST DIFFERENCE

A key characteristic of the types of population health problems for which complex systems approaches may be useful is the presence of influential positive or negative feedback loops.^{25,26} Examples of feedback mechanisms include feedback between behavioral and environmental features (healthy food availability promoting a healthier diet, which, in




The need for a complex systems model of evidence for public health

Harry Rutter, Natalie Savona, Ketevan Glonti, Jo Bibby, Steven Cummins, Diane T Finegood, Felix Greaves, Laura Harper, Penelope Hawe, Laurence Moore, Mark Petticrew, Eva Rehfuess, Alan Shiell, James Thomas, Martin White

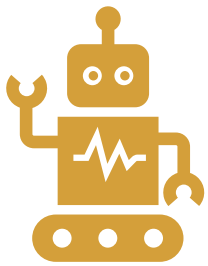
Despite major investment in both research and policy, many pressing contemporary public health challenges remain. To date, the evidence underpinning responses to these challenges has largely been generated by tools and which require high levels of individual agency, have low reach and impact, and tend to widen health inequalities.^{9–11} Shifts within multiple elements across the many systems that influence obesity are required, some of which might

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How do we *understand* complex health phenomena?

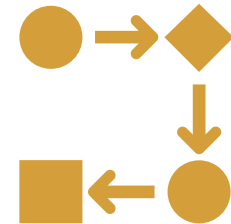
Three core dimensions that directly relate to complex systems



the health ***patterns*** that emerge from complex systems



the ***mechanisms*** that produce them



the ***dynamics*** that make them change over time

Smoking – a public health success?



Navigating in an era of complex health issues

Patterns

Describe the emergence of complex public health issues across spatial-temporal scales



Delineate the problems and set boundaries for targeted intervention in specific subgroups

Mechanisms

Understand how elements of a system interact at multiple levels to create complex public health issues



Identify central leverage points for intervention

Dynamics

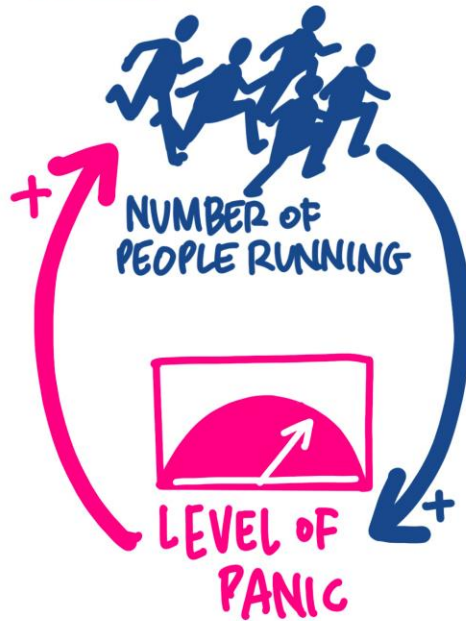
Explore how complex public health issues change over time because of dynamical processes



Intervene on vicious circles across levels, which generate excessive burdens of disease

FEEDBACK LOOPS

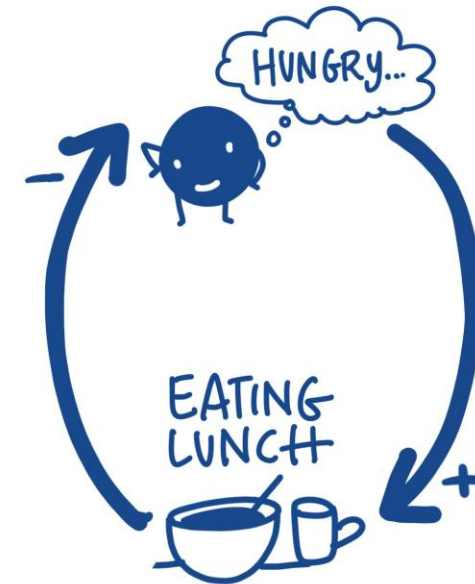
REINFORCING LOOP



- Leads to instability
- Exponential growth



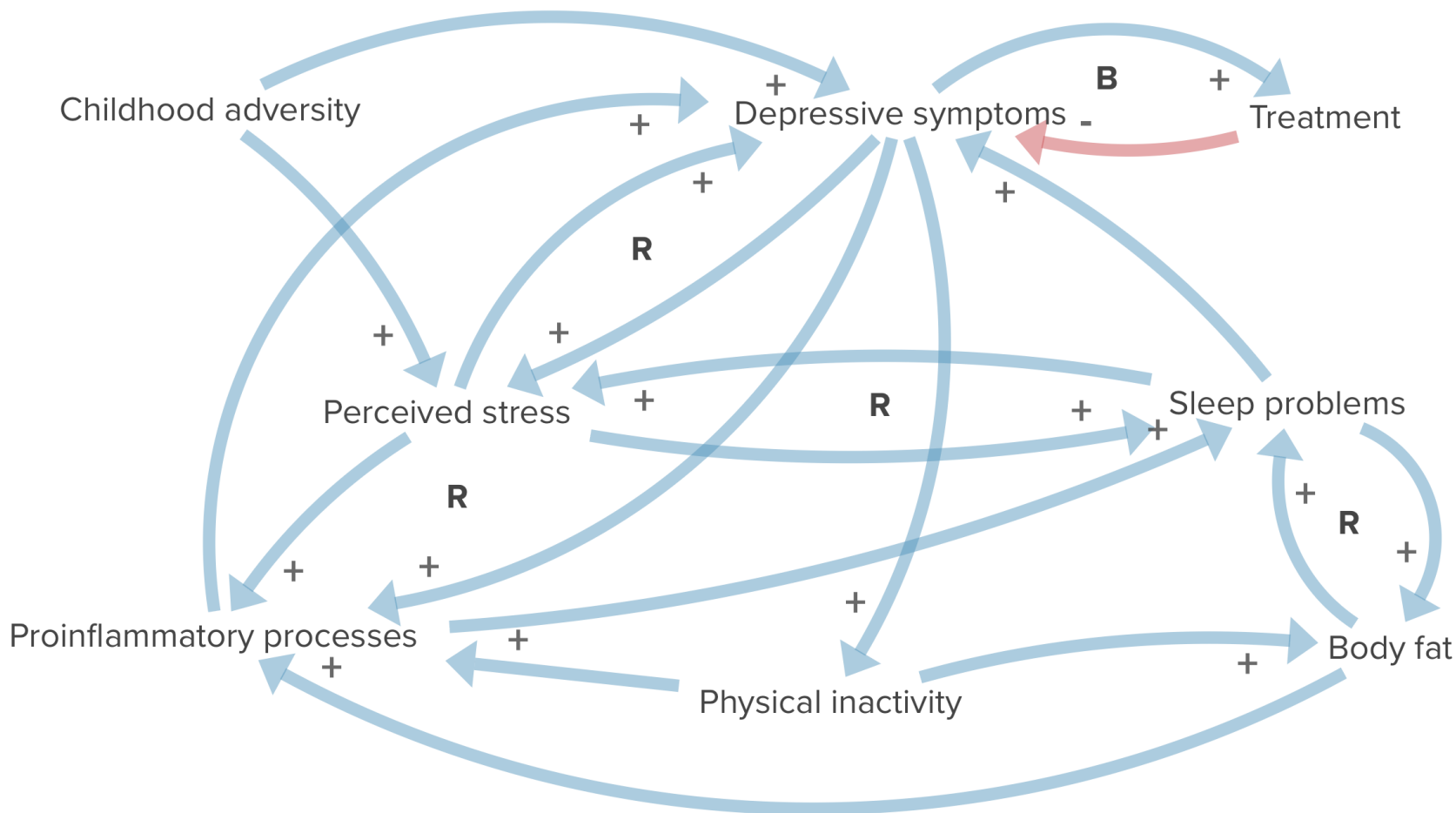
BALANCING LOOP



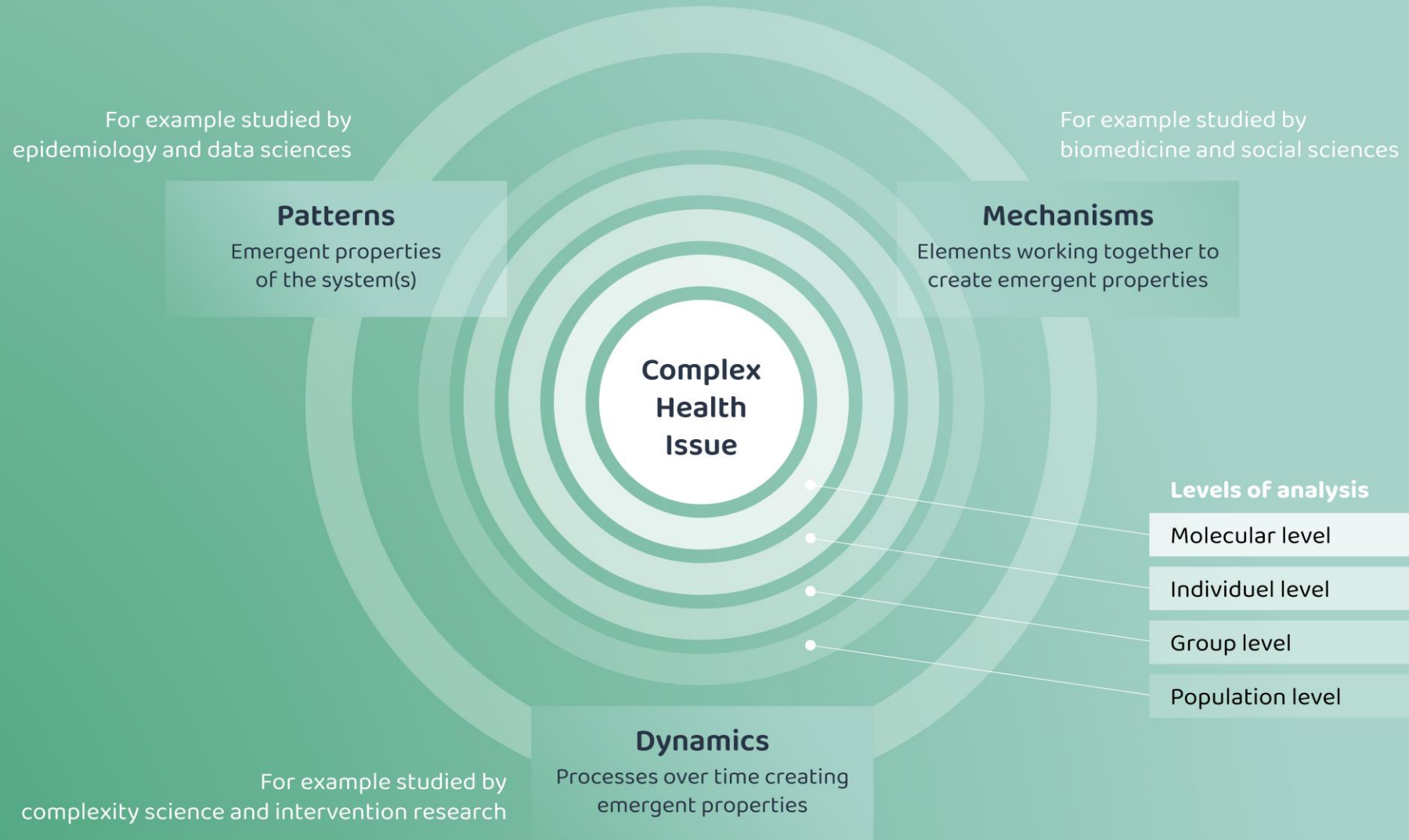
- Produces stability
- Self-correcting



Mental health crisis – understanding the dynamics



HEALTH COMPLEXITY FRAMEWORK



Why

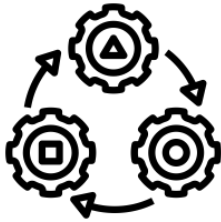
health problems emerge



Interconnected mechanisms and
dynamic change over time

How

to realise change



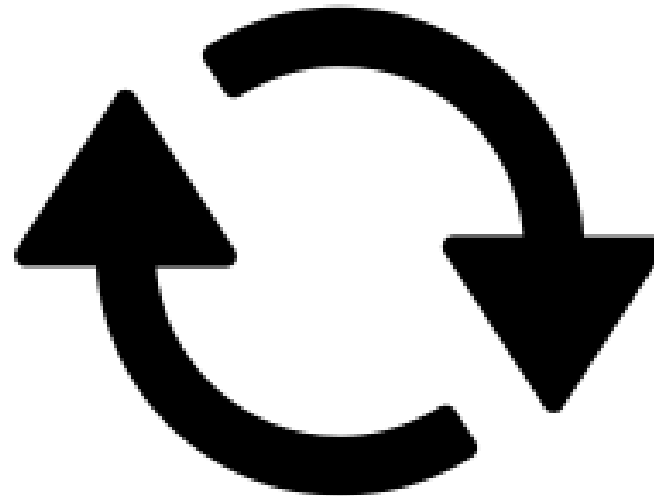
Replicating action functionality
across contexts

What

should be done



Dynamic set of actions aimed at
changing the function of the
system



EVIDENCE-BASED *complexity* PUBLIC HEALTH

Thank you for your attention!



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Med støtte fra
TrygFonden

**LUNDBECK
FOUNDATION**



COPENHAGEN HEALTH COMPLEXITY CENTER

Core research agenda on complexity

Concepts Understanding complexity	Data Studying complexity	Methods Modeling complexity	Culture Living with complexity
We will develop a conceptual toolkit for health complexity, which will revise and improve our understanding of population health	We will acknowledge that population health is an emergent property of the totality of exposures during a life-time and within networks and systems	We need a new toolbox of visual and analytical approaches to capture the high dimensionality of complex systems in public health	We will study complexity in daily life to add depth to our understanding of health complexity
Systems-oriented approach  Real-world health Viewed through the lens of complex systems  <i>Interactions, feedback & group dynamics</i>	Complete life histories  2+ million people Layers of data  <i>Health, social, neighborhood & environment</i>	Fusion of methods  AI methods & causal inference Multi-dimensional space  <i>Networks and groupings</i>	Lived experiences  The micro-dynamics of complexity Engagement research  <i>Communicating complexity</i>
Next-generation public health theory for complex phenomena	Globally unprecedented platform for real life complexity analysis in health	Novel methods for complexity analysis in public health science	A creative space for exchange between science, practice, policy and the population
 Interdisciplinarity	 International network for health complexity science	 Capacity building	