Population Health Data Science, Complexity, and Health Equity: Reflections from a Local Health Official

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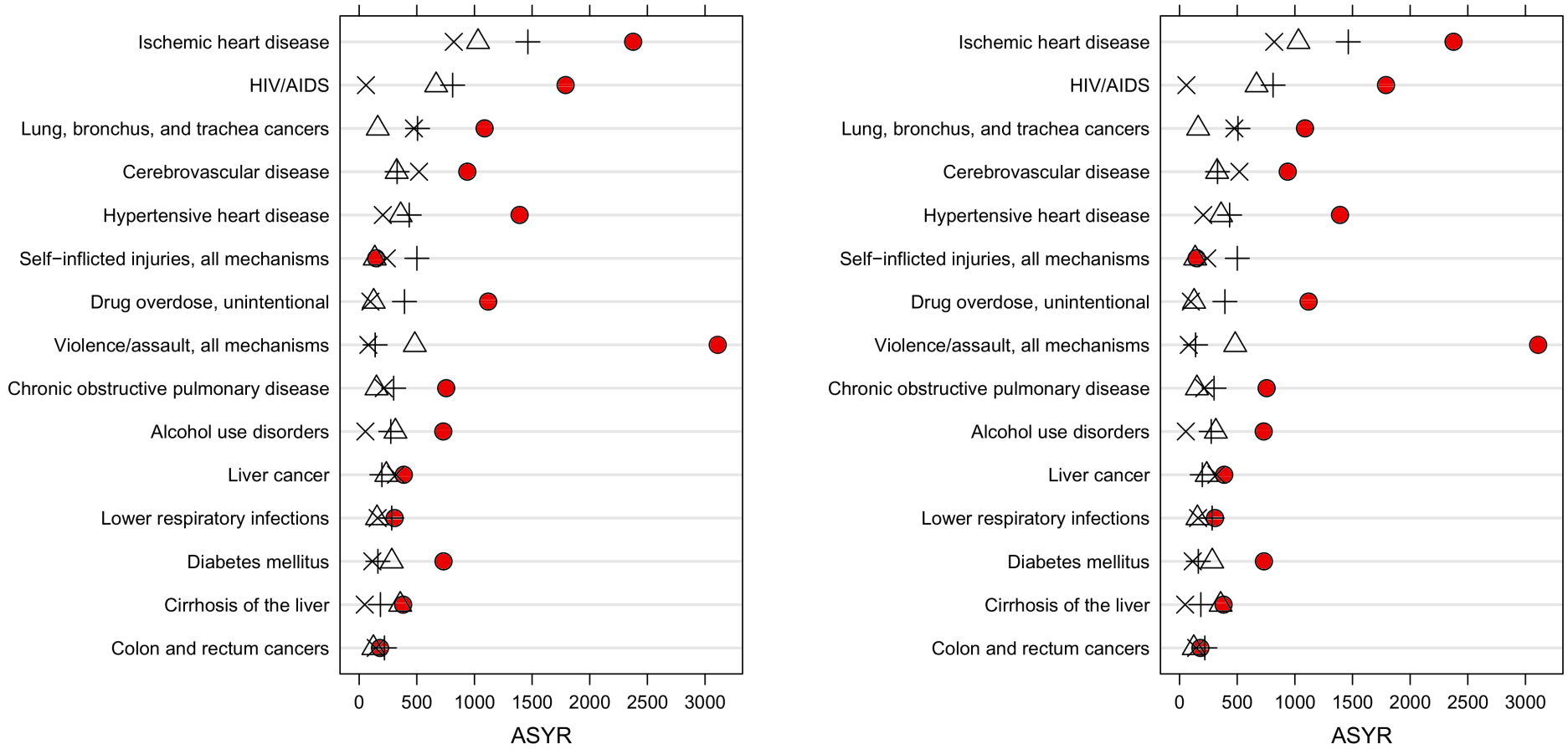
Overview

1. Introduction and background
2. Population health data science
3. Transforming complex social systems
4. Tackling population health inequities

Causes of Premature Deaths in Men & Women

San Francisco, 2003–2004 (How do we explain health inequities and resilience?)



Age-adjusted Expected Years of Life Lost (eYLL): Male (left), Female (right); ◯ Black (colored red), △ Latino, × Asian/PI, + White; Source: Aragón TJ, et al. PubMed ID: 18402698

Some definitions

Health (WHO 1946)

Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

Public Health (IOM 1988)

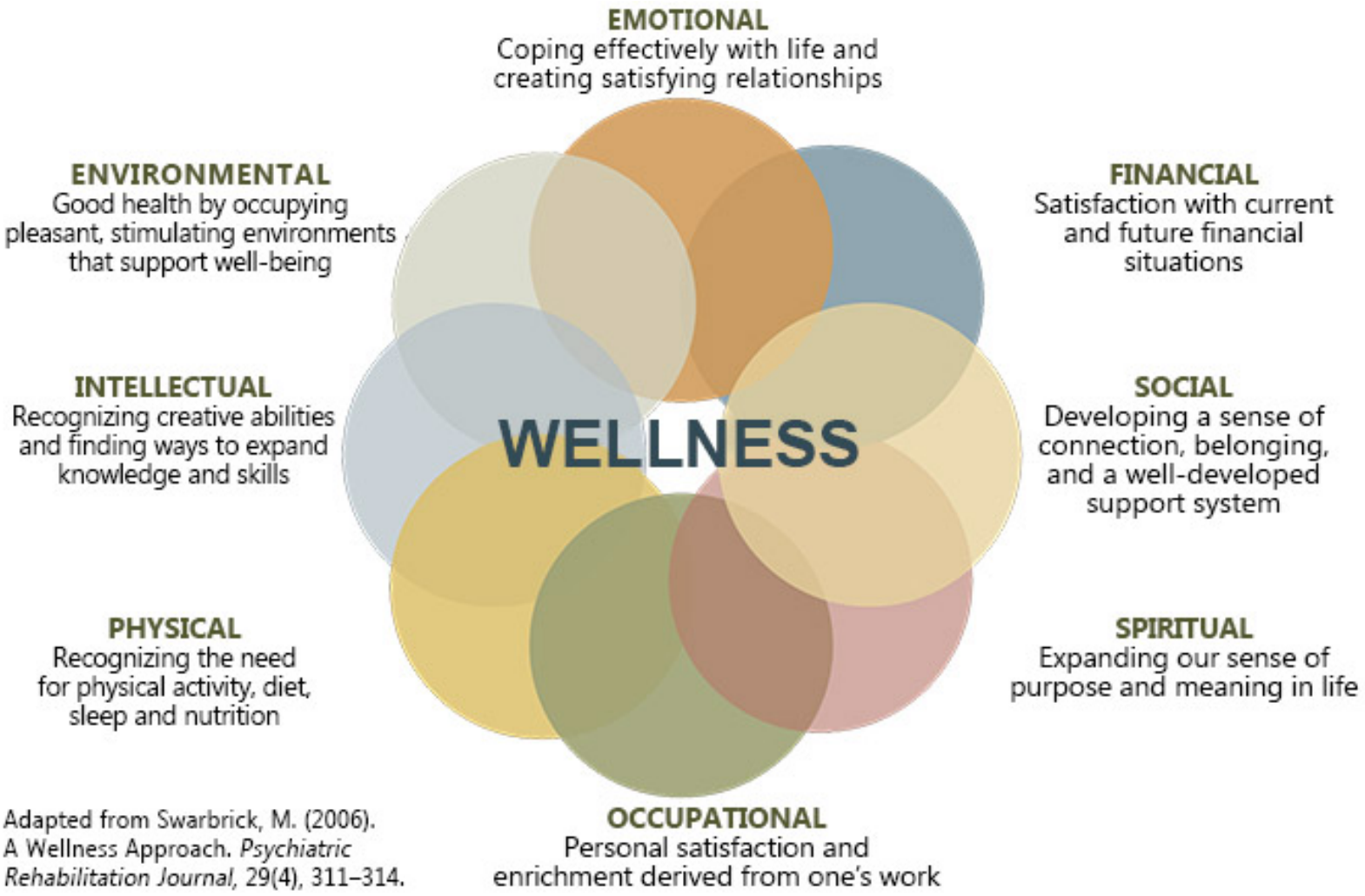
Public health is what we, as a society, do collectively to assure the conditions in which people can be healthy.

Population Health (TJA 2015)

A systems[a] framework for studying and improving the health of populations through collective action and learning.

[a] Complexity or complex adaptive systems

Health includes the 8 dimensions of wellness



Source: `http://www.samhsa.gov/wellness-initiative`

More definitions

Population Health (TJA 2015)

A systems[a] framework for studying and improving the health of populations through collective action and learning.

[a] Complexity or complex adaptive systems

Data science

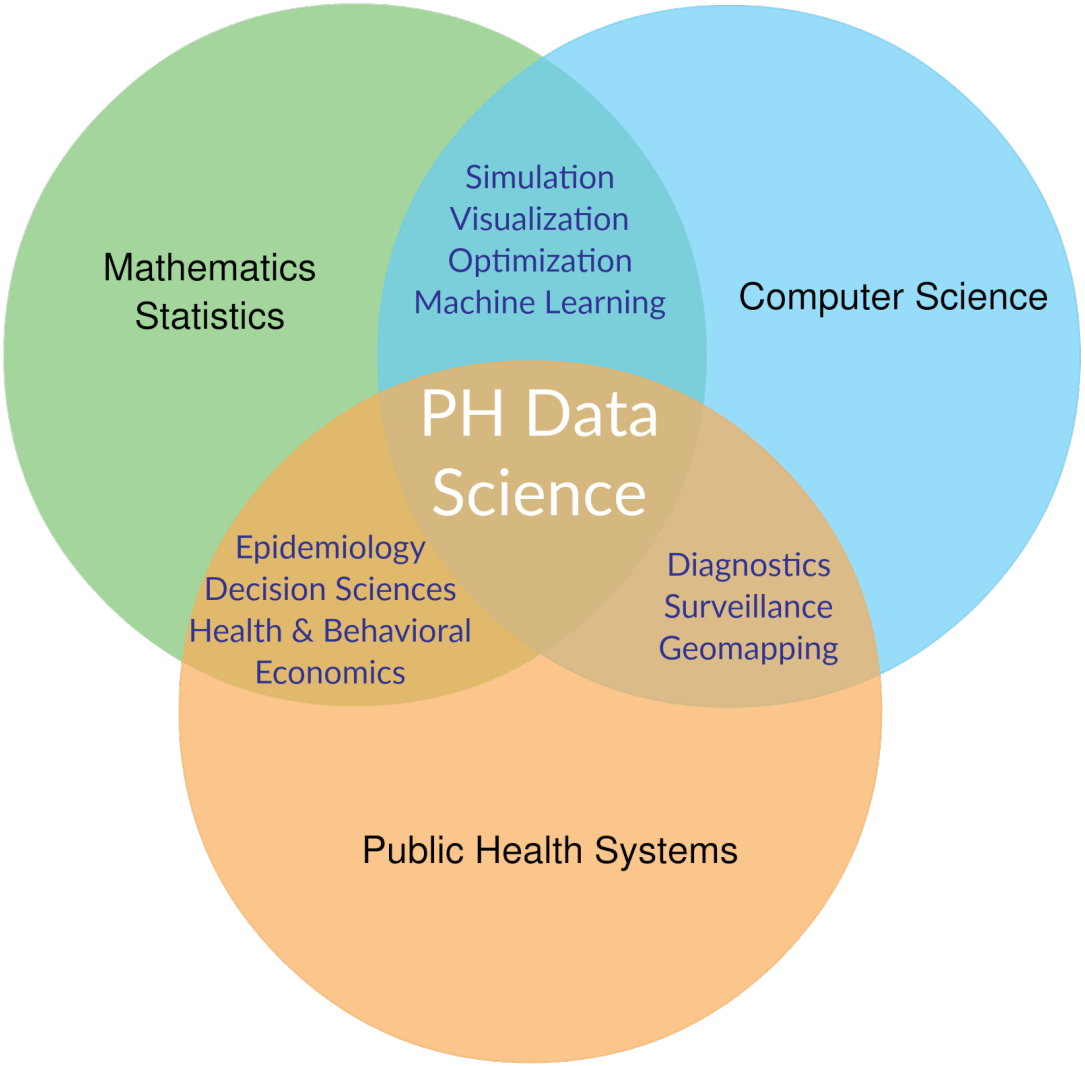
Data science is the art and science of transforming data into actionable knowledge.

Population health data science (TJA 2015)

Population health data science is the art and science of transforming health relevant data into actionable knowledge.

Population Health Data Science

Describe—Discover—Predict—Advise



Complexity and why it matters

What is a complex adaptive system?

1. A population of diverse agents, all of which are
2. connected, with behaviors and actions that are
3. interdependent, and that exhibit
4. adaptation and learning.

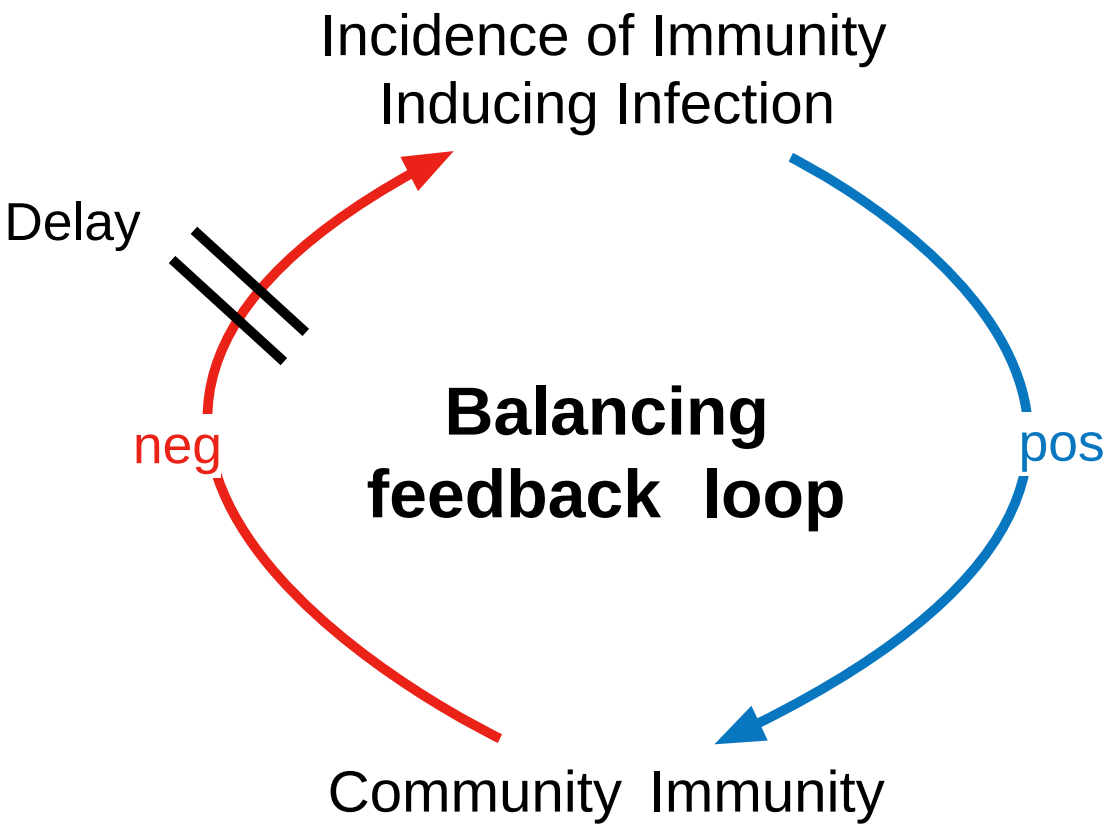
Why do we care? Complex systems . . .

- are ambiguous, deceptive, unpredictable
- are difficult to direct and control (adaptation, resistance)
- can self-organize and locally optimize (silos, tribes)
- can evolve along divergent pathways (pathway dependence)
- can produce phase transitions ("tipping points") (e.g., epidemics)
- can produce emergent phenomenon (e.g., herd immunity)

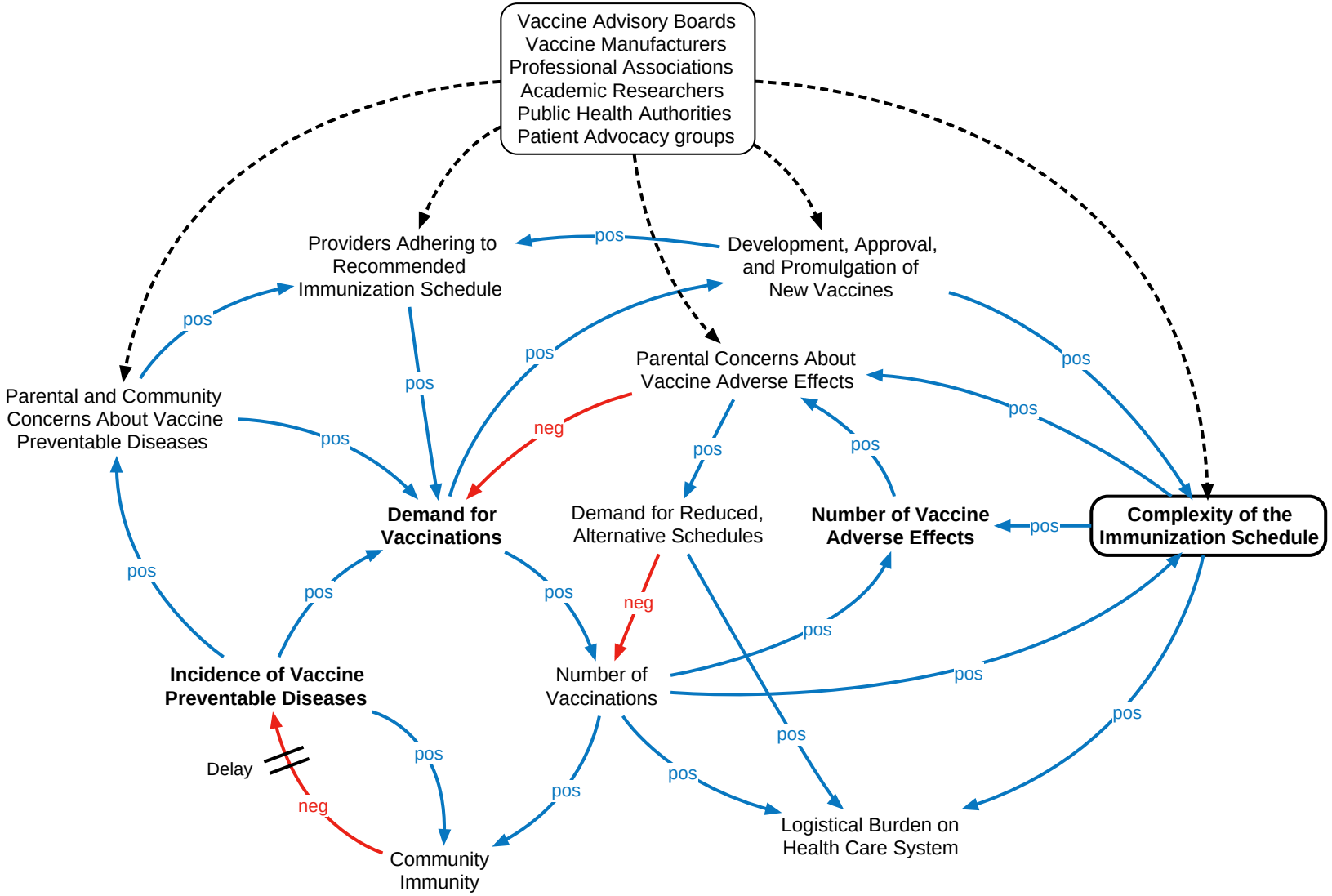
Conceptualizing systems (selected approaches)

- Causal loop diagrams
- Agent-based models
- Social network models

Creating causal loop diagram (immunization example)

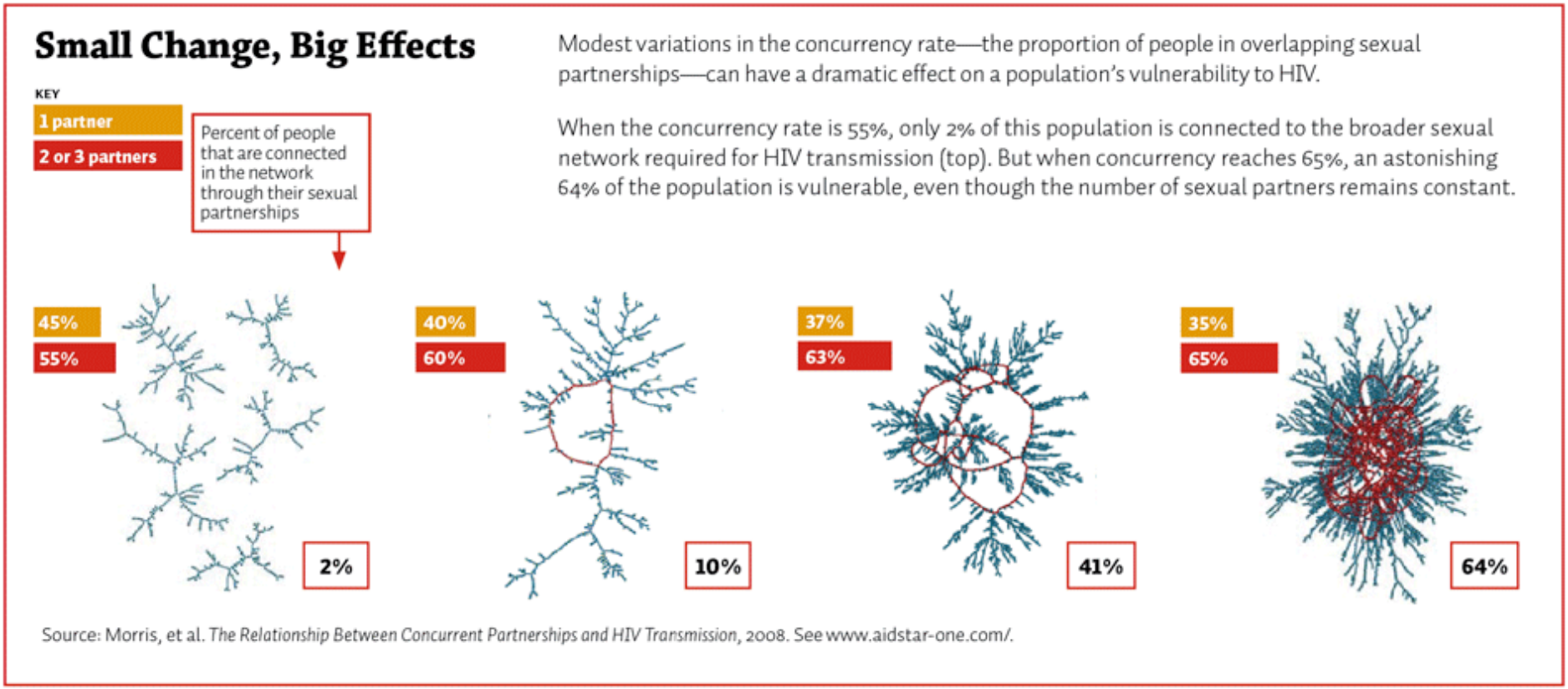


Causal loop diagram of childhood immunization system



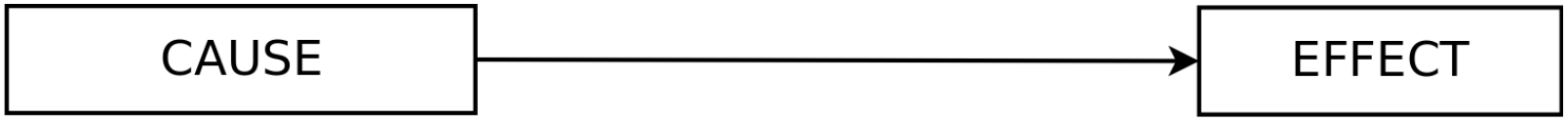
Source: TJA

Networking modeling of epidemics using R



Source: `http://www.reed.edu/reed_magazine/march2012/articles/features/morris/morris.html`
Network Modeling for Epidemics (Dr. Martina Morris, University of Washington): `http://statnet.csde.washington.edu/EpiModel/nme/index.html`

Public health tools for improving population health



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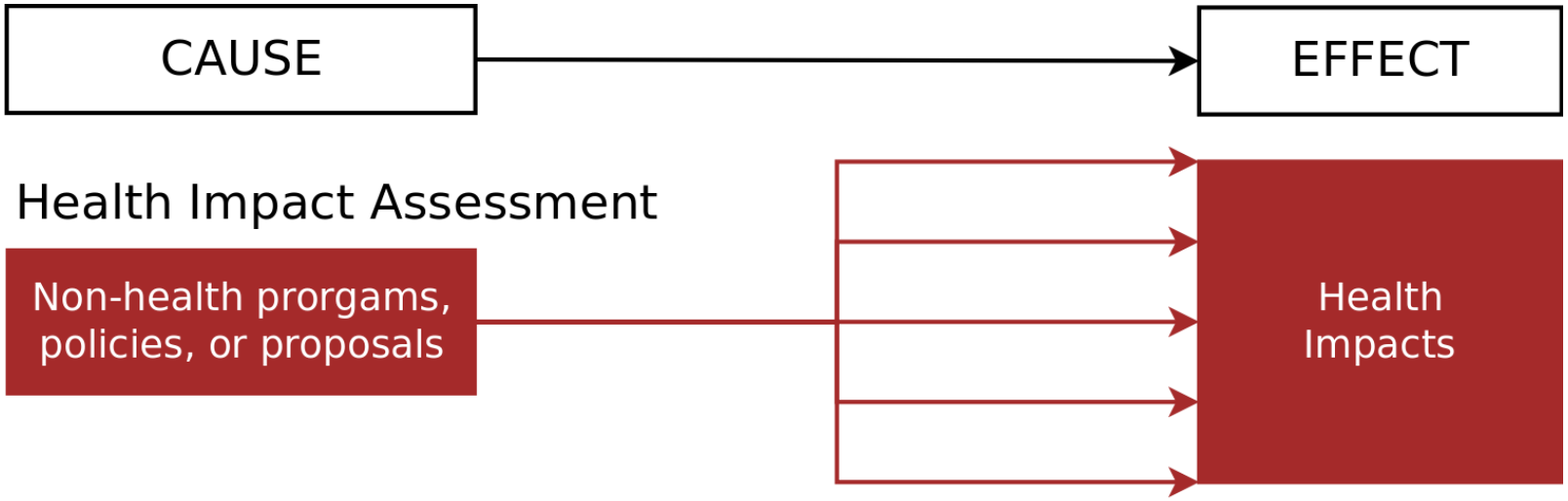

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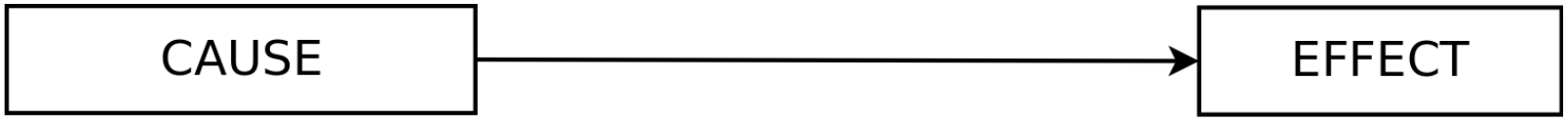


Collective Impact

Collective impact fulfills five criteria[1]

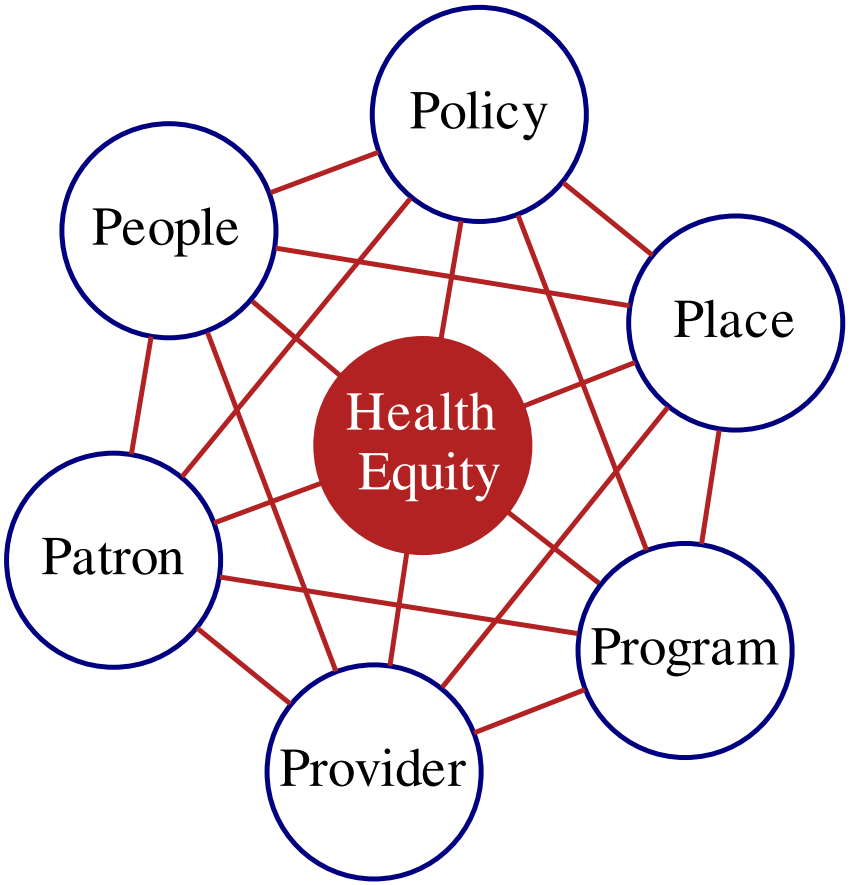
1. **Common Agenda**: All participants have a shared vision for change including a common understanding of the problem and a joint approach to solving it.
2. **Shared Measurement**: Collecting data and measuring results consistently ensures efforts remain aligned and participants hold each other accountable.
3. **Mutually Reinforcing Activities**: Participant activities must be differentiated while still being coordinated through a mutually reinforcing plan of action.
4. **Continuous Communication and Improvement**: Consistent and open communication is needed across the many players to build trust, assure mutual objectives, and continuously improve.
5. **Backbone Organization**: Collective impact requires a separate organization(s) with staff to serve as the backbone for the entire initiative and coordinate participating organizations and agencies.

[1] Adapted from `http://www.fsg.org`

What is Health Equity X (HEX) model

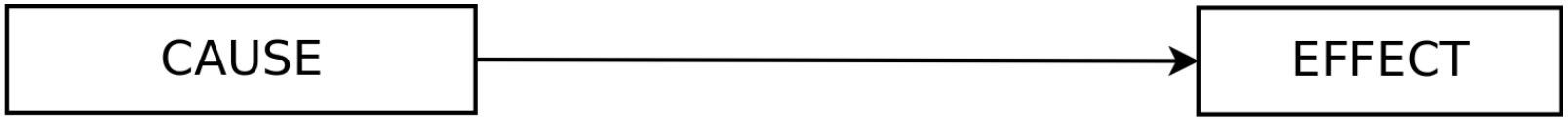
HEX[a,b] is used for planning and managing efforts to achieve results for challenges and opportunities embedded in complex social systems, including for quality improvement, health equity, and collective impact.

1. **People** (mental models, belief systems, cultural norms, "isms")
2. **Policy** (social, organizational)
3. **Place** (neighborhood, school, work, open space)
4. **Program** (program, agency, or service system)
5. **Provider** (teacher, doctor, priest)
6. **Patron** (patient, client, customer)



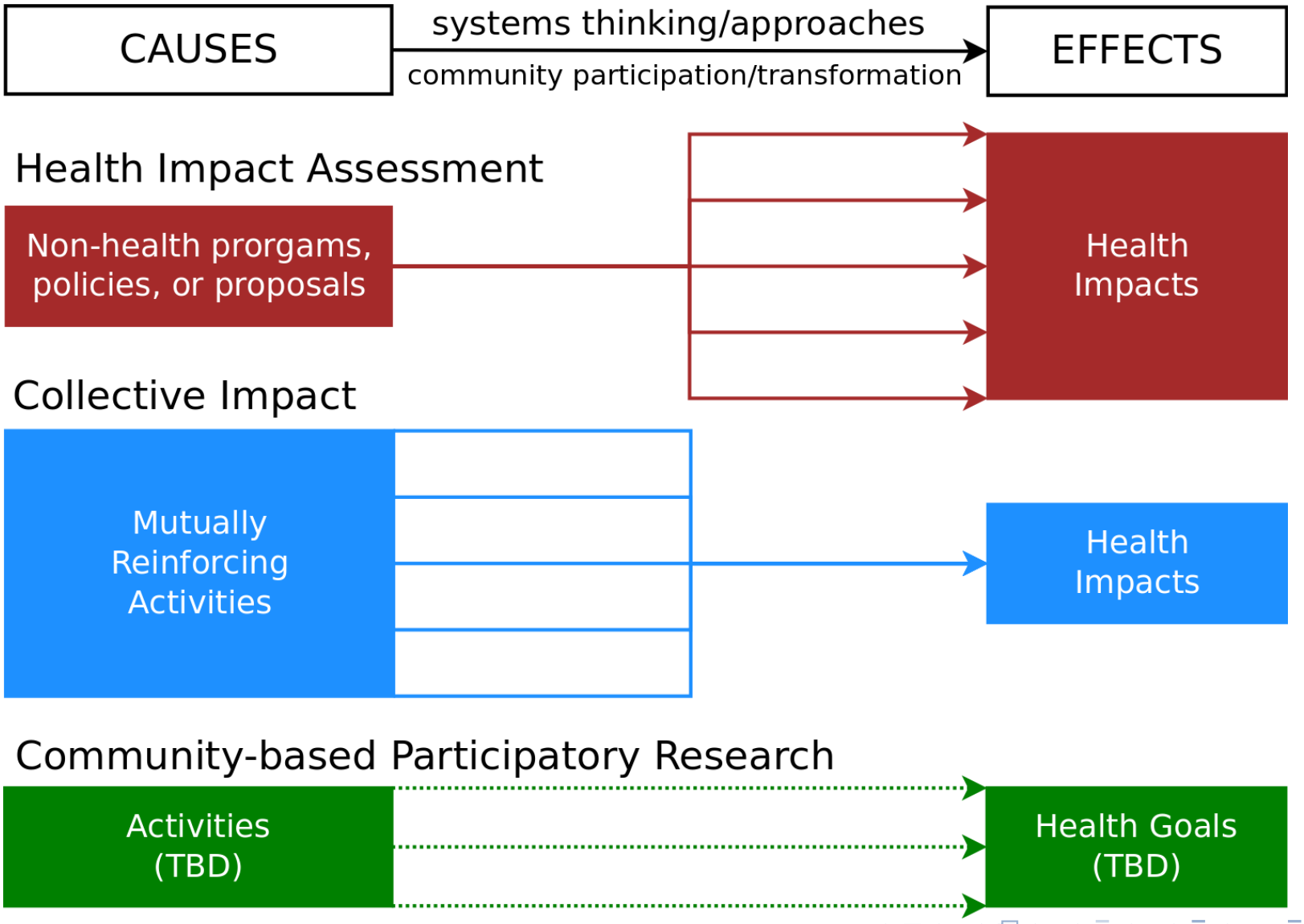
[a] HEX model was inspired by BARHII (`http://www.barhii.org`) and Dr. Tony Iton (See Pubmed ID: 25423053)
[b] A hexateron is a geometric object with 6 vertices, 15 edges, 20 triangle faces, 15 tetrahedral cells

Public health tools for improving population health



Community-based Participatory Research

Public health tools for improving population health



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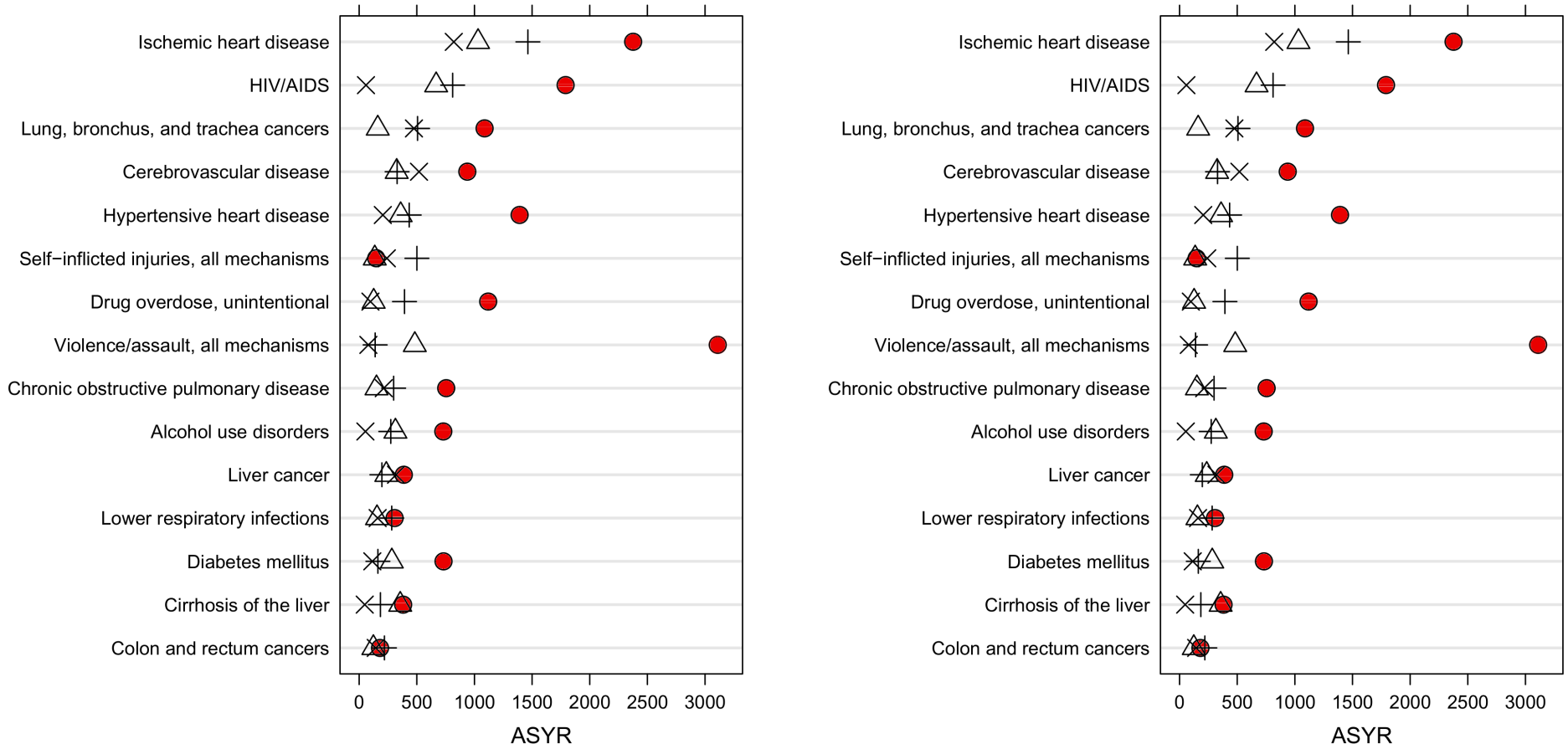
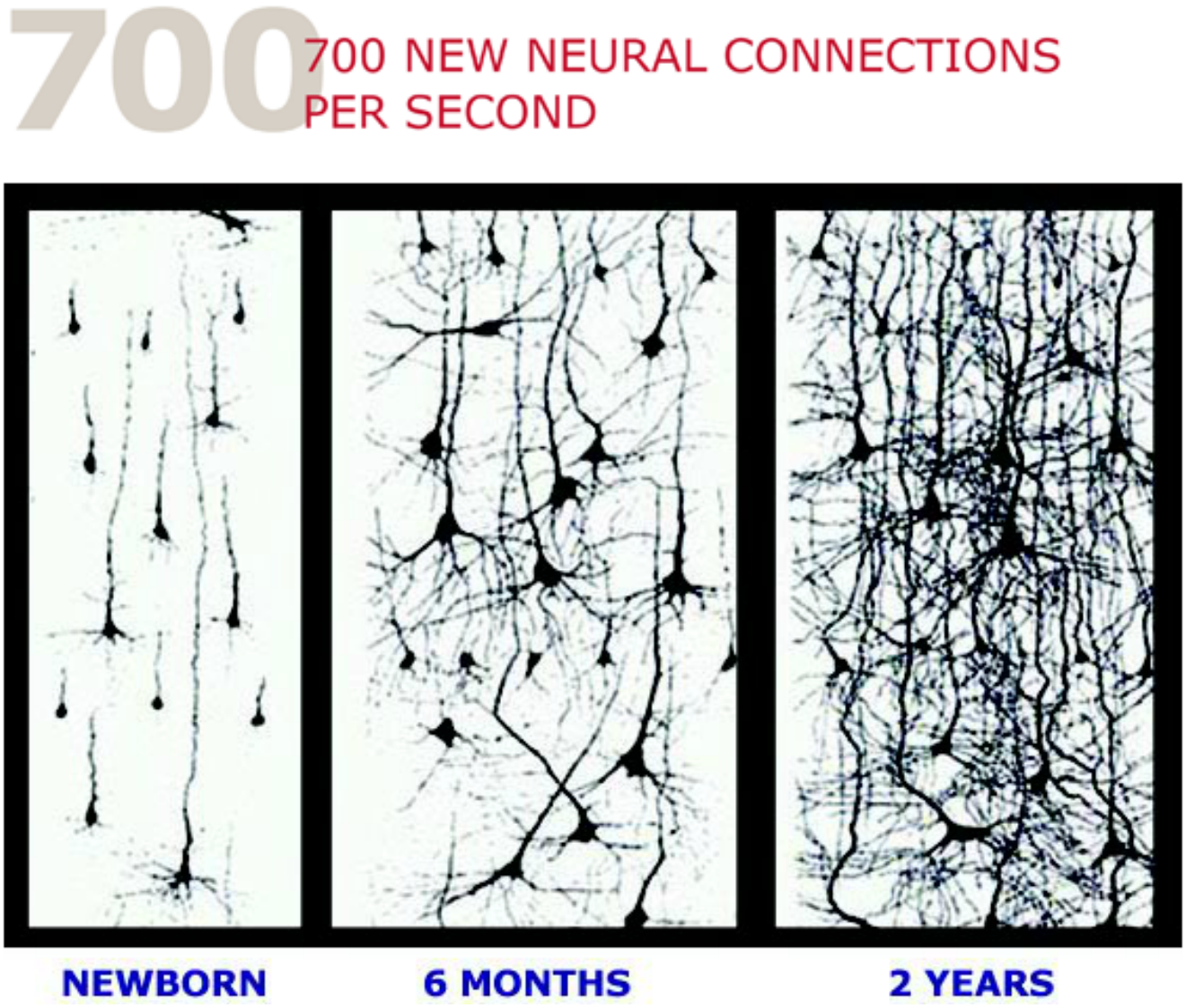


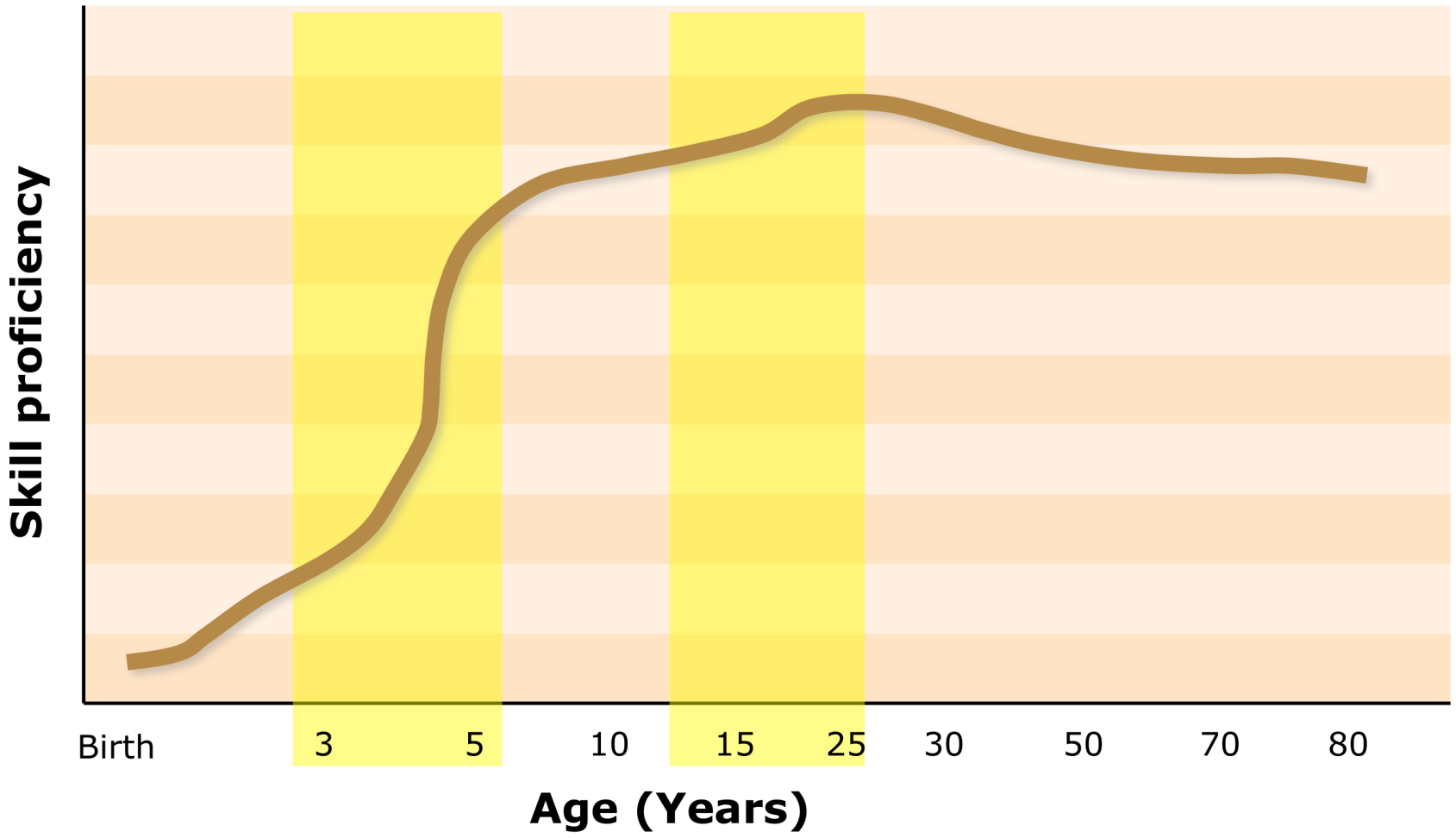
Age-adjusted Expected Years of Life Lost (eYLL): Male (left), Female (right); ◯ Black (colored red), △ Latino, × Asian/PI, + White; Source: Aragón TJ, et al. PubMed ID: 18402698

Neural connections in early childhood

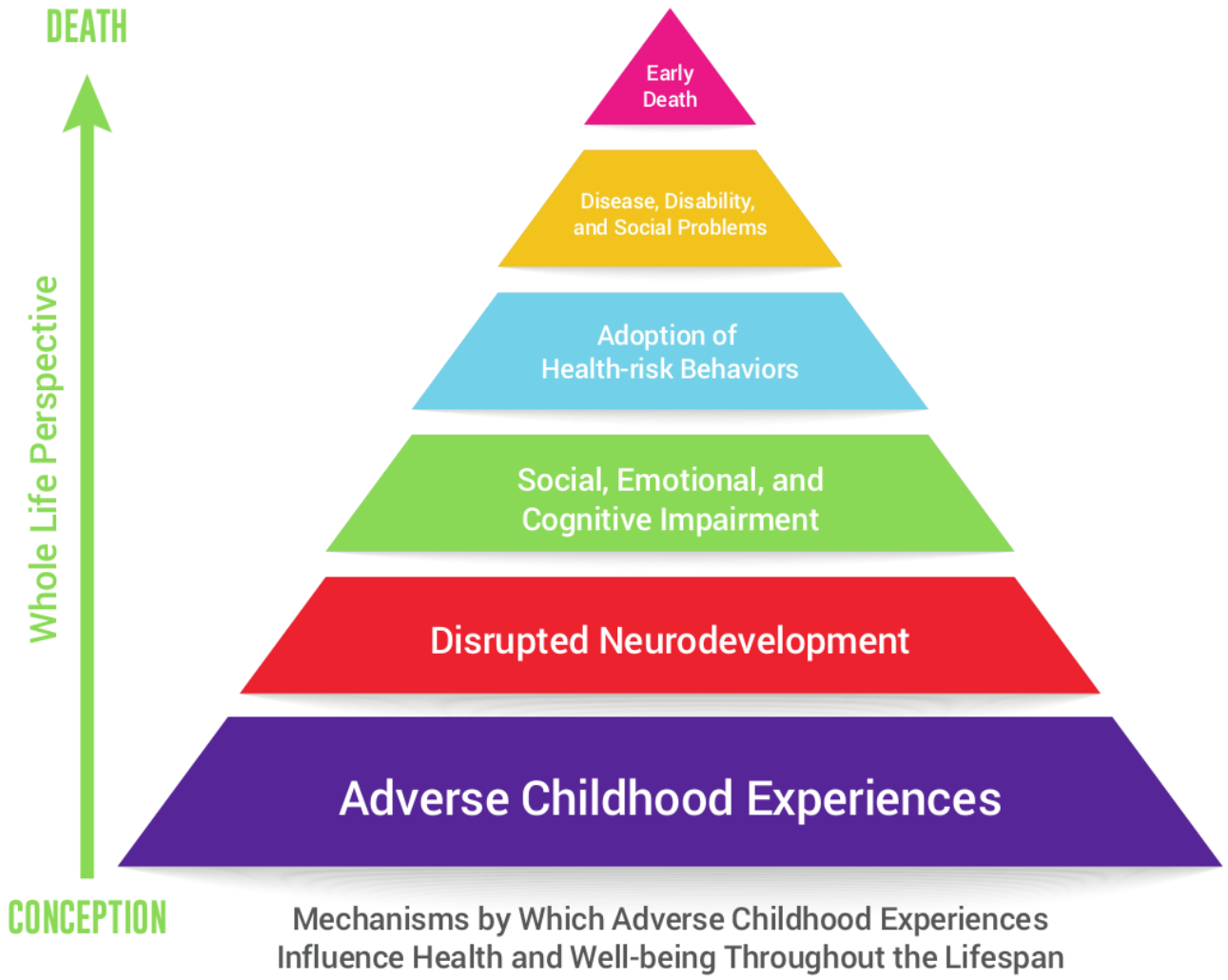


Executive function and self-regulation

Depends on working memory, mental flexibility, self-control

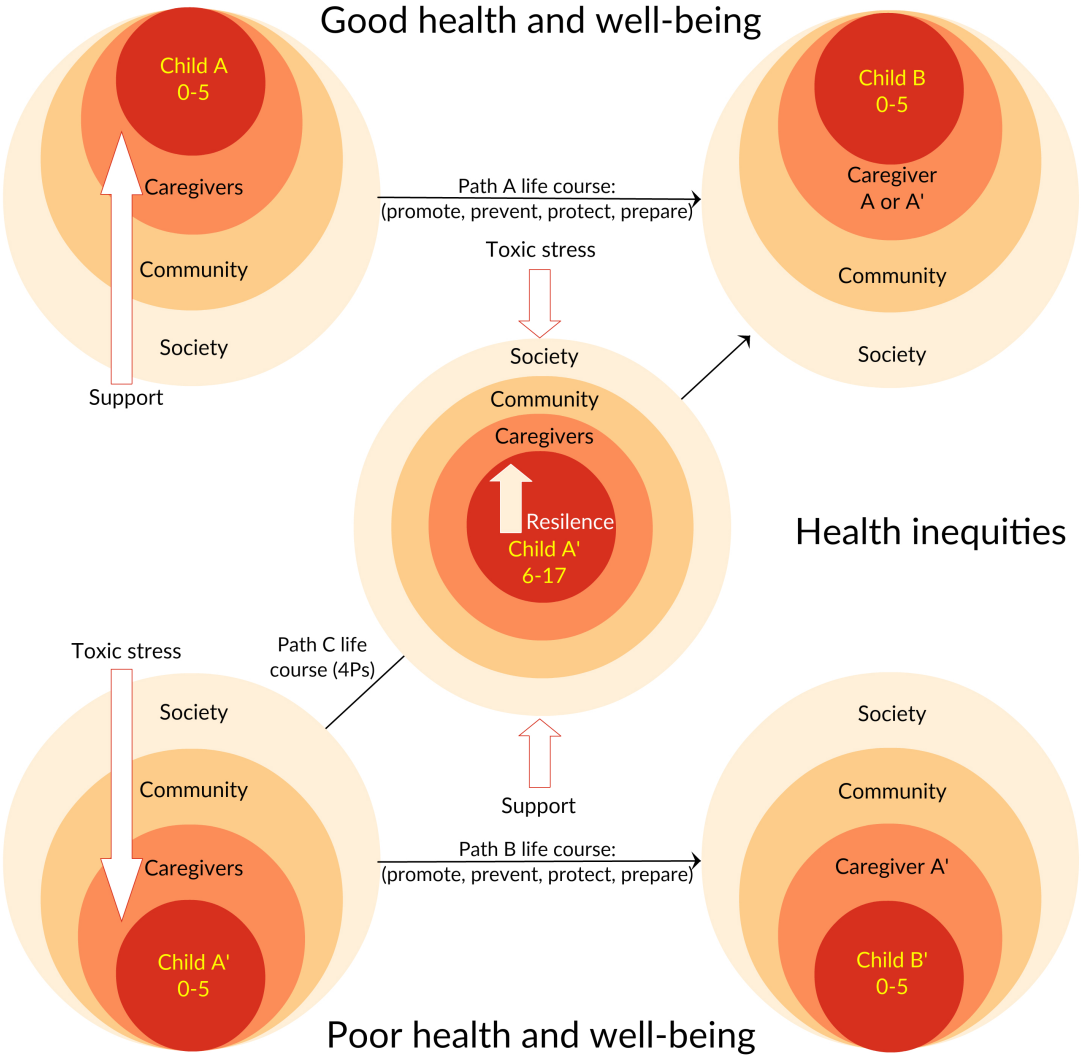


Adverse Childhood Experiences (ACEs) Pyramid



Source: Center for Youth Wellness (`http://www.centerforyouthwellness.org`)

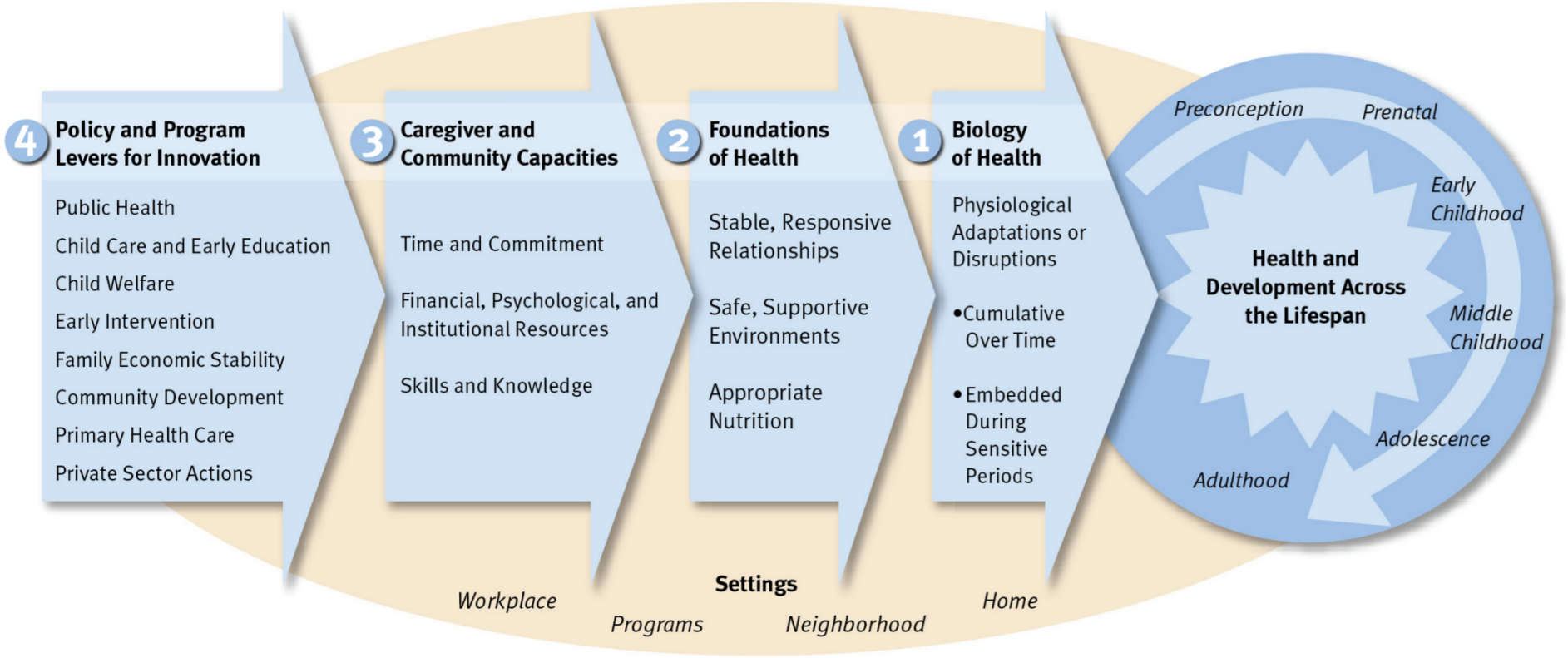
Trauma-informed Life Course (TLC) Model



A newborn child rises to better health over his or her life course by multilevel, interdependent forces that *promote* safe, nurturing relationships for healthy brain and body development, *prevent* toxic stress, *protect* against unavoidable toxic stress, and *prepare* children to be resilient. Children ages 0 to 5 are totally dependent on adult caregivers for the 4Ps, and are most vulnerable to the lifelong effects of toxic stress that alter brain, body, and behavior leading to health inequities. Source: TJA 2015

Toxic Stress! Childhood Roots of Adult Health Inequities

Re-conceptualizing Early Childhood Policies and Programs to Strengthen Lifelong Health



Source: Center for the Developing Child at `http://developingchild.harvard.edu/`

Health Equity X (HEX) model

1. **People** (mental models, belief systems, cultural norms, "isms")
2. **Policy** (social, organizational)
3. **Place** (home, neighborhood, schools, work, parks)
4. **Program** (programs, agencies, or service systems)
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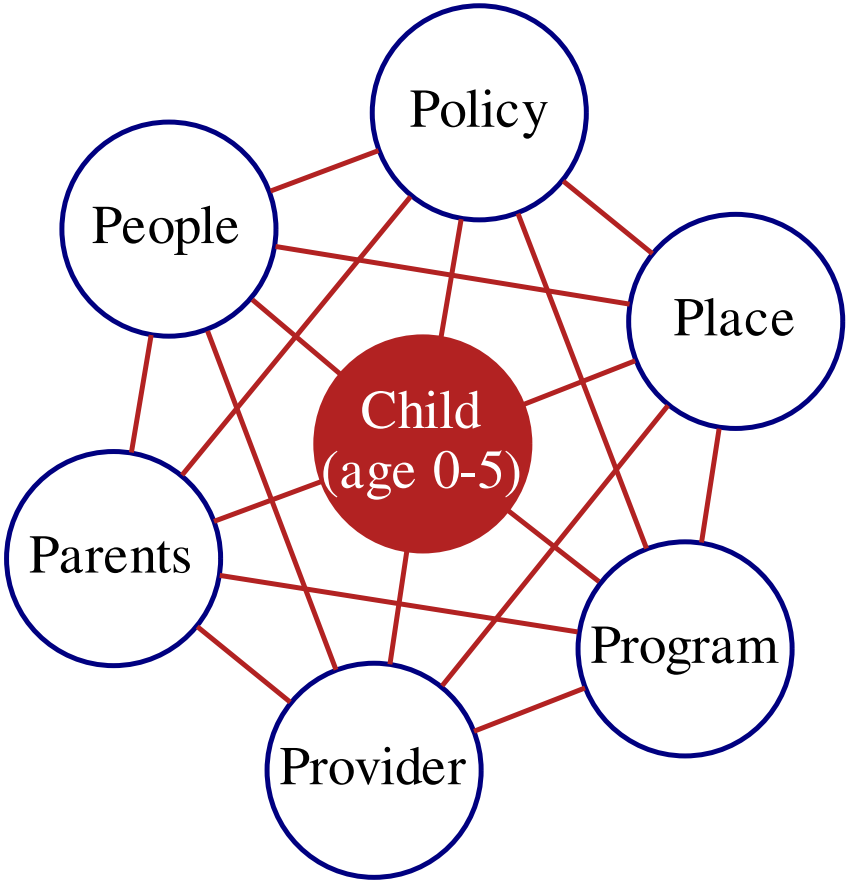
6. **Parent** (clients, customers, patients)



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Ensuring the childhood roots of health equity

Trauma-Informed Public Health Approach for Adults *and* Children

1. Prevent (toxic stress)
2. Protect (from toxic stress)
3. Prepare (by building resiliency skills)
4. Promote (healthy/enrichment opportunities)

Summary

1. Population health data science
   - Start backwards (understand individual and group decision-making!)
   - Focus on actionable knowledge (*Adivse–Predict–Discover–Describe*)
   - Focus on human-centered design ("precision public health")
2. Transforming complex social systems
   - Understand complex adaptive systems (requires humility)
   - Transform self, teams, organizations, communities (in that order: requires continuous improvement, taking risks, learning from failures)
3. Tackling population health inequities
   - Inter-generational transmission of trauma
   - Toxic stress alters brain, body, and behavior
   - Life course of trauma, racism, and discrimination
   - 4Ps of public health: prevent, protect, prepare, promote
   - 6Ps of HEX model: people, policy, place, program, provider, parents

The Raising of America (Documentary)

Early Childhood and the Future of Our Nation

http://www.raisingofamerica.org/

Selected Bibliography

1. *Trying Hard Is Not Good Enough: How to Produce Measurable Improvement of Customers and Communities* (2009), by Mark Friedman (`http://amzn.com/1439237867`). Covers practical and tested framework for implementing and improving collective impact projects.
2. *The Practice of Adaptive Leadership: Tools and Tactics for Changing Your Organization and the World* (2009), by Ronald A. Heifetz et al. (`http://amzn.com/1422105768`). Covers practical, powerful, and inspiring approach to leading change in complex environments.
3. *Complex Adaptive Systems: An Introduction to Computational Models of Social Life* (2007), by John H. Miller, et al. (`http://amzn.com/0691127026`).
4. *Network Modeling for Epidemics* (2015), by Martina Morris, et al. (`http://statnet.csde.washington.edu/EpiModel/nme/index.html`). Online resource for learning how to use R for modeling social networks and epidemics.
5. *Population Health Data Science with R* (2015, manuscript in progress), by Tomás J. Aragón. (`https://leanpub.com/u/medepi`). Covers how to use R for population health analyses. Also visit `http://medepi.com`.