

Original Scholarship

Which Priorities for Health and Well-Being Stand Out After Accounting for Tangled Threats and Costs? Simulating Potential Intervention Portfolios in Large Urban Counties

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Policy Points:

- Interventions in a regional system with intertwined threats and costs should address those threats that have the strongest, quickest, and most pervasive cross-impacts.
- Instead of focusing on an individual county's apparent shortcomings, a regional intervention portfolio can yield greater results when it is designed to counter those systemic threats, especially poverty and inadequate social support, that most undermine health and well-being virtually everywhere.
- Likewise, efforts to reduce smoking, addiction, and violent crime and to improve routine care, health insurance, and youth education are important for most counties to unlock both short- and long-term potential.

Context: Counties across the United States must contend with multiple, intertwined threats and costs that defy simple solutions. Decision makers face the

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necessary but difficult task of prioritizing those interventions with the greatest potential to produce equitable health and well-being.

Methods: Using County Health Rankings data for a predefined peer group of 39 urban US counties, we performed statistical regressions to identify 37 cross-impacts among 15 threats to health and well-being. Adding appropriate time delays, we then developed a dynamic model of these cross-impacts and simulated each of the counties over 20 years to assess the likely impact of 12 potential interventions—individually and in a combined portfolio—for three outcomes: (1) years of potential life lost, (2) fraction of adults in fair or poor health, and (3) total spending on urgent services.

Findings: The combined portfolio yielded improvements by year 20 that are considerably greater than those at year 5, indicating that the time delays have a major effect. Despite the wide variation in threat levels across counties, the list of top-ranked interventions is strikingly similar. Poverty reduction and social support were the most highly ranked interventions, even in the shorter term, for all outcomes in all counties. Interventions affecting smoking, addiction, routine care, health insurance, violent crime, and youth education also were important contributors to some outcomes.

Conclusions: To safeguard health and well-being in a system dominated by tangled threats and costs, the most important priorities for a county cannot be simply inferred from a profile of its relative strengths and weaknesses. Two interventions stood out as the top priorities for almost all the counties in this study, and six others also were important contributors. Interventions directed toward these priority areas are likely to yield the greatest impact, irrespective of the county's specifics. A significant concentration of resources in a regional portfolio therefore ought to go to these strongest contributors for equitable health and well-being.

Keywords: population-based planning, health priorities, computer simulation, quality of life, socioeconomic factors, social determinants, systems analysis, regression analysis, poverty, social support.

AFTER DECADES OF CONCERTED EFFORT TO RETHINK HEALTH priorities, there is now a growing awareness that it takes more than good health care for all people to reach their full potential for health and well-being.¹⁻⁴ Such an ambitious goal is broader than improving physical health alone: it calls for a wider commitment to enhance health, safety, economic prosperity, environmental sustainability, social justice, and democracy.^{3,5-9} Researchers have analyzed global, national, and local data in order to define the relative contributions of

health care and socioeconomic, behavioral, and environmental factors to health and well-being.¹⁰⁻¹³ They have also compiled repositories of effective interventions in every category.¹⁴⁻²³ Such effective interventions either reduce specific threats or enhance one or more of the vital conditions that everyone needs in order to reach their full potential.²⁴

Having a broad list of options, however, is often not enough to guide actions in a particular region, such as a county. When beset by multiple threats, decision makers face a crucial strategic choice: They either may confront each problem individually as it commands attention (a piecemeal approach that sometimes yields quick results but is inefficient and allows other threats to grow worse in the meantime), or they may view the whole constellation of threats collectively as a matter of system design and then craft a strategy to transform that system in ways that better safeguard the population.²⁵ For that kind of maneuver to succeed, leaders must work together as stewards of a common system and then build a portfolio of effective interventions (ie, a set of policies, programs, and practices) that can be enacted in their local context to achieve both short-term and long-term improvement.²⁶

The Centers for Disease Control and Prevention's Community Health Improvement Navigator points to more than a half dozen tools and planning frameworks that decision makers may use to prioritize interventions.²⁷ Common to almost every approach is the imperative for people from many walks of life to work together, consider information about the predicaments they face as well as the interventions that could help, and then decide for themselves how best to proceed. But we should not assume that collaboration alone will allow decision makers to choose the most important priorities. The system that produces regional health and well-being is complex, leaving even experienced and well-intentioned decision makers unsure about which interventions to select.²⁸

For example, some threats (such as violence) are conspicuous and immediate, whereas others (such as inadequate routine health care) are less obvious and take many years for the full toll to accumulate. In addition, seemingly separate issues may be connected in complicated ways. For instance, exposure to one threat (such as limited education) increases the odds of another (such as household poverty), which in turn increases the odds of still others (such as unhealthy eating, physical inactivity, smoking, addiction, violent crime, housing stress, inadequate social support, and lack of health insurance). Moreover, all these threats

together drive the demand for various urgent services, including acute care for illness or injury, addiction treatment, criminal justice services, environmental cleanup, homeless services, as well as income and food assistance.

This study introduces a practical way for decision makers to account for regional complexities such as the particular mix and magnitude of prevailing threats, as well as their interconnections, time delays, and costs. We illustrate the value of this technique by comparing the likely impact of 12 potential interventions within each county in a single, predefined peer group of 39 urban counties, home to 58 million people across the United States.

This study recognizes, as other scholars have emphasized, that the relative benefits of individual or combined interventions can be different from what one might expect and that computerized system modeling might inform the design of a sound strategy.²⁹⁻³¹ The simulation approach that we use here builds on earlier dynamic models that have revealed helpful insights into the extent to which a well-designed portfolio can improve health and well-being both nationally^{32,33} and regionally.^{34,35} Here we take the next step in this line of systems science with a new simulation model of health and well-being at the county level. This new model is simpler than previous models of regional health—for example, it does not track the intricate details of health care delivery or of population inflows and outflows—but encompasses a wider set of threats and interventions across sectors and offers a more complete accounting of urgent service spending. The methodology is also based on a common set of data available for most US counties and could thus be applied to any of these counties or to other geographies with similar data.

Methods

Study Design, Locations, and Data Sources

This study analyzes 12 potential interventions in 39 US counties. The counties are classified in the County Health Rankings (CHR) database as a predefined “peer group” by virtue of their demographic similarity and urban character (see the Online Appendix for detailed methodological procedures and Table A1 for a full list of the counties).³⁶ The counties are located in all major geographical areas of the United States: West, Midwest, South, and Northeast. All the source data come from uniform

information available through the CHR database.³⁷ These data are from the 2006-to-2015 period, from either a single year or pooled across multiple years.

Selected Threats and Metrics

Our analysis concentrates on 15 selected threats (shown in Table 1). We chose those that are widely known to undermine different aspects of health and well-being and that drive the demand for different types of urgent services. These threats reflect deficits in different types of vital conditions that all people need in order to reach their full potential (also shown in Table 1). This approach is consistent with the recommended systems approach to produce health and well-being put forward in the Healthy People 2030 Objectives for the United States (illustrated in the Online Appendix, Figure A1).³⁸ It also adheres to practical definitions developed by ReThink Health (an initiative of the Rippel Foundation) of the major strategic options for any regional portfolio of interventions.⁷ The CHR database contains useful indicators related to all the vital condition categories except reliable transportation.

Our selection of the threats listed in Table 1 involved a series of stepwise multivariate linear regressions across the peer counties to assess which specific metrics were best to include. Some concepts had more than one CHR metric available, and our regression procedure helped eliminate those that were not statistically significant. In this procedure, each threat in Table 1 took its turn as the dependent variable, with the independent variables being whichever other threats might plausibly influence the dependent variable plus the county's population size (see the Online Appendix for details on the regression procedure, including several metrics that were tested and eliminated).

Table 1 shows the minimum, maximum, and median prevalence fractions or rates for each of the selected threats across all peer counties, along with the median across all US counties (see the Online Appendix, Table A2, for a complete matrix of the 15 threats for each of the 39 counties).

Estimated Cross-Impacts and Time Delays

The regression analysis, along with relevant literature, allowed us to estimate how the selected threats were interconnected. We found 33 significant regression coefficients indicating cross-impacts among the 15

Table 1. Selected Threats to Health and Well-Being, with Summary Metrics^a

Vital Condition	Selected Threats	Metric and Primary Source in County Health Rankings	Prevalence or Ratio for 39 Counties			US County Median
			Min	Max	Median	
Variables Available for Direct Intervention in the Model						
Basic Needs for Health and Safety	No health insurance	Uninsured age <65 (Census/SAHIE 2011)	9.7%	30.5%	18.0%	17.7%
	Inadequate routine care	Diabetic not monitored (Dartmouth Atlas 2014)	9.8%	20.4%	15.0%	14.2%
	Unhealthy diet	Vegetable less than daily (BRFSS 2013-15)	13.2%	26.7%	21.3%	Not reported
	Physical inactivity	No exercise past month (BRFSS 2006-12)	14.5%	27.8%	22.0%	25.9%
	Smoking	Smoke past month (BRFSS 2006-12)	9.1%	24.0%	15.6%	21.7%
Addiction	Drug OD deaths per 100,000 (CDC WONDER 2013-15)	7.5	35.4	14.0	16.2	
Violent crime	Violent crimes per 100,000 (UCR 2010-12)	178	1,153	485	199	

Continued

Table 1. *Continued*

Vital Condition	Selected Threats	Metric and Primary Source in County Health Rankings	Prevalence or Ratio for 39 Counties			US County Median
			Min	Max	Median	
Lifelong Learning	Limited education	Not on-time HS graduation (DOE "ED facts" 2010-11)	10.1%	47.0%	23.3%	16.2%
Meaningful Work and Wealth	Poverty	Households below FPL (Census SAIPE 2012)	8.6%	21.6%	17.8%	16.3%
Humane Housing	Severe housing stress	Inadequate facilities or > 50% cost vs income (HUD CHAS 2009-13)	14.1%	28.4%	18.8%	14.0%
Thriving Natural World	Air pollution	PM 2.5 mcg per cubic meter (NEPHTN/EPA AQS 2008)	7.7	17.7	12.3	10.7
Reliable Transportation	<i>No metric available in County Health Rankings</i>					

Continued

Table 1. *Continued*

Vital Condition	Selected Threats	Metric and Primary Source in County Health Rankings	Prevalence or Ratio for 39 Countries			US County Median
			Min	Max	Median	
Belonging and Civic Muscle	Inadequate social support	Lacking social-emotional support (BRFSS 2006-12)	13.7%	26.1%	21.1%	19.6%
Further Consequences Not Subject to Direct Intervention in the Model						
Selected Summary Measures	Obesity	Self-report BMI 30+ (BRFSS 2006-12)	13.1%	32.1%	25.7%	30.4%
	Fair-poor health	Self-report fair/poor health (BRFSS 2006-12)	8.9%	19.5%	14.5%	16.5%
	Acute illness/death	Years of potential life lost before age 75 per 100,000 (NVSS 2012-14)	3,661	10,306	6,192	7,762

^aData from the County Health Rankings.³⁷

threats. In addition, we considered whether our regression analysis might have missed, or misestimated the strength of, some well-established causal links. That could happen, for example, if some multiyear delays between cause and effect were not detectable in the cross-sectional data. We determined from that review that it was necessary to add four more connections, yielding a total of 37 cross-impacts that were converted into standard epidemiological odds ratios (see the Online Appendix for additional details on the cross-impact estimation procedure and the Online Appendix, Figure A2, for a diagram of the assumed links).

We also estimated the average impact times for each of the assumed links. Guided by relevant literature, we placed each link into one of five delay categories from quickest (1 year) to slowest (15 years). The longest delay times were assigned to impacts on acute illness/death from smoking, physical inactivity, and obesity, as well as to impacts on poverty from fair-poor health (due to disability or impaired job performance) and limited education (due to limited job market potential). Table 2 shows the final set of estimated odds ratios and delay times.

Potential Interventions

We determined that 12 of the 15 selected threats were realistically modifiable through direct intervention. Those 12 threats reflect deficits in a particular vital condition and can be addressed directly through various interventions to enhance those conditions (see Table 3 for examples of potential intervention options). The three other threats (see the bottom of Table 1) are obesity, fair-poor health, and acute illness/death. To change these threats at the population level requires some kind of indirect intervention—that is, via one or more of the 12 other threats. For example, reducing obesity at the population level requires intervening through diet or physical activity, or even less directly through poverty or social support.

For illustrative purposes, this study represents all interventions that reduce a given threat using a consistent effect size of 25%. This entailed reducing the prevalence fraction for each threat (such as the physical inactivity fraction) from its initial county-specific value starting in year 2 to a value 25% lower by year 5. After reviewing the intervention literature, as well as examining the range of minimum, median, and maximum levels across the peer group (see Table 1), we concluded that it was reasonable to assume the same 25% reduction for all interventions.

Table 2. Estimated Odds Ratios and Delay Times for Cross-Impacts Among the Selected Threats

Dependent (Y) Variable	Estimated X-Y Odds Ratios and Delay Times														
	Independent (X) Variable														
	No Insur	Inad Care	Few Veg	Phys Inact	Smoke	Addict	Violent crime	Lim Educ	Poverty	Housing stress	Air Pollut	Inad Soc Supp	Obesity	YPLL	Fair-poor health
No health insurance									17.3; 1 yr			2.0; 1 yr			
Inadequate routine care	2.0; 1 yr											6.9; 1 yr			
Unhealthy eating (few)									2.8; 1 yr						
Physical inactivity									6.6; 3 yrs			7.0; 1 yr			
Smoking									20.7; 3 yrs						
Drug addiction					12.0; 3 yrs				2.4; 1 yr						
Violent crime						1.4; 1 yr			30.0; 1 yr			14.6; 1 yr			
Limited education									5.4; 3 yrs						
Poverty									5.0; 15 yrs						10.0; 15 yrs
Housing stress									3.0; 1 yr			7.2; 1 yr			
Air pollution															
Inadequate social support									3.6; 1 yr						
Obesity			3.2; 1 yr	5.5; 1 yr					3.2; 3 yrs						
YPLL			2.0; 15 yrs	3.0; 15 yrs	1.5; 1 yr	1.2; 1 yr			4.7; 1 yr		1.1; 1 yr		2.0; 15 yrs		4.0; 6 yrs
Fair-poor health	2.1; 6 yrs	3.7; 6 yrs	2.0; 12 yrs	2.1; 12 yrs					2.6; 6 yrs			5.5; 6 yrs	1.4; 12 yrs		

Cells with solid borders are estimated from supplemental research, not from regression analysis; cells with dashed borders have odds ratios modified from the initial regression-based value to align with supplemental research.

For this strategic analysis, we did not estimate the costs to implement specific programs, policies, and practices that might result in those 25% reductions. Such intervention costs vary widely in real life, and benchmarks for investment do not yet exist. However, we did estimate the likely economic impact on subsequent spending for urgent services, some of which may be averted as a result of the simulated interventions, as described next.

Estimated Service Spending

In this analysis, urgent service spending is driven by the demand for six types of services that rise or fall with the changing levels of specific threats. These services include (1) hospital visits driven by acute

Table 3. Examples of Potential Interventions

Vital Condition	Selected Threats	Examples of Potential Interventions ^{14-23, 27}
Basic Needs for Health & Safety	No health insurance	–Expand insurance eligibility and enrollment –Restrict allowable costs of insurance
	Inadequate routine care	–Enable provider adherence to guidelines –Support self-care –Reduce wait times
	Unhealthy diet	–Increase access to fruits and vegetables –Reduce availability of junk foods
	Physical inactivity	–Enable walking, biking, and public transit –Reduce screen time
	Smoking	–Enact comprehensive tobacco control
	Addiction	–Restrict, tax, and deter use of drugs and alcohol –Early intervention in medical settings –12-step and other relapse prevention
	Violent crime	–Prevent domestic abuse and gun violence –Teach nonviolent conflict –Strengthen community policing
Lifelong Learning	Limited education	–Tutoring by peers or by adults –Coaching by consultant teachers –Summer and after-school programs
Meaningful Work & Wealth	Poverty	–Living wage ordinances –Enable college attendance and graduation –Enable technical education and work experience –Employee stock ownership and savings plans
Humane Housing	Severe housing stress	–Affordable housing –Inclusionary zoning, rent control, and assistance –Offer housing subsidies or tax credits

Continued

Table 3. Continued

Vital Condition	Selected Threats	Examples of Potential Interventions ^{14-23, 27}
Stable Natural Environment	Air pollution	<ul style="list-style-type: none"> -Reduce toxic emissions -Enable people to live close to jobs and services
Reliable Transportation	<i>No appropriate metric available for this analysis</i>	<ul style="list-style-type: none"> -Affordable public transportation -Low-cost ride sharing -“Complete streets” policies -Transit-oriented community development
Belonging & Civic Muscle	Inadequate social support	<ul style="list-style-type: none"> -Strengthen civic associations and civic participation -Youth mentoring by older adults -Trauma-informed community-building -Dismantle discrimination and social exclusion

illness; (2) substance-abuse treatment services driven by addiction; (3) criminal justice services such as police, court, and incarceration driven by violent crime; (4) homeless services driven by severe housing stress; (5) environmental remediation and regulatory enforcement driven by air pollution; and (6) income and food assistance driven by poverty. We assumed that when any of these six threats declined as the result of an intervention, the associated urgent service cost would decline in the same proportion.

We calculated the per-capita cost coefficients for each of these spending categories based on public budgets for one prototypical county in the peer group (King County, WA; see Online Appendix Table A3 for the assumed spending coefficients). For consistency, we used the same cost coefficients for all 39 peer counties.

Simulation Modeling

We simulated intervention scenarios using VensimTM software based on standard principles of system dynamics modeling, as seen in similar

studies.^{30,32-35} For each of the 39 counties, we initialized the model in a status quo equilibrium, with no interventions and all outcome variables (including all 15 selected threats) unchanging at their initial values as indicated by the CHR data.

We then ran the same battery of intervention tests for all 39 counties, which consisted of testing each intervention alone and then testing all of them in a combined portfolio. Simulated interventions move the model out of its initial equilibrium, and the cross-impacts shown in Table 2 cause further changes in model outputs, progressing by quarter-year time increments, for the rest of the 20-year simulation period.

Outcome Measures

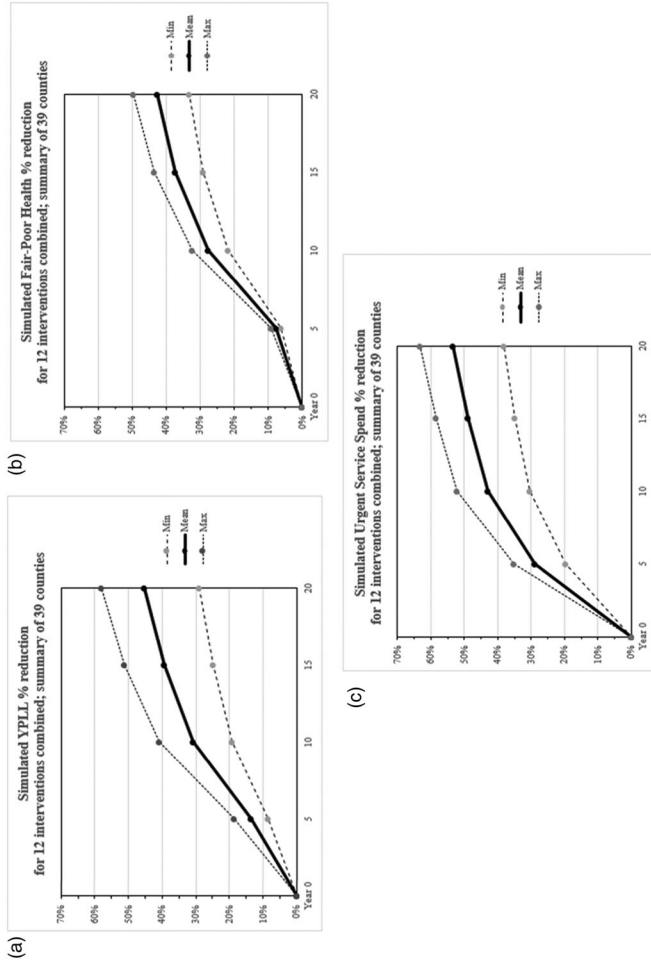
This analysis focused on three principal goals: (1) extending the length of life, measured by years of potential life lost (YPLL, expressed as a rate per 100,000 population, as seen in Table 1); (2) enhancing the quality of life, measured by the fraction of the 18-and-over population in fair-poor health (also seen in Table 1); and (3) reducing the cost of urgent services, measured by the total spending on urgent services (the sum of the six categories just described expressed in 2014-equivalent dollars per capita). Like all model variables, each outcome metric is simulated quarterly over the 20-year period, but for convenience, we report the results here at 5-year intervals. Also, all results are expressed as changes relative to the initial values.

Results

The results of the simulated intervention testing may be considered on a county-by-county basis or summarized statistically across all 39 counties, and by considering each intervention separately or the combined portfolio.

Figure 1 considers only the combined portfolio, summarized across the 39 counties. The line graphs show the trajectories of the minimum, mean, and maximum percentage reduction in each of the three outcome variables. The mean here has not been adjusted by county population size, thus putting all counties on an equal statistical footing. YPLL (which starts at a mean rate of 6,368 per 100,000) is reduced by a mean of 14% by year 5, 31% by year 10, and 45% by year 20. Fair-poor health

Figure 1. Simulated Percentage Reductions in (a) YPLL, (b) Fair-Poor Health, and (c) Total Urgent Service Spending for a Combined Portfolio of 12 Interventions, with Min/Mean/Max Summary Across 39 Counties



(which starts at a mean of 0.143 prevalence) is reduced by a mean of 8% by year 5, 28% by year 10, and 43% by year 20. Urgent service spending (which starts at a mean of \$8,811 per capita) is reduced by a mean of 29% by year 5, 43% by year 10, and 53% by year 20 (see Online Appendix Tables A4-A9 and Figures A3-A5 for additional intervention impact results for the combined portfolio, as well as for each intervention individually).

Impacts of this magnitude add up to significant savings in lives, quality of life, and dollars. Consider the 39 counties taken together, with a total population of 57.6 million (see Online Appendix Table A1) and an 18-and-over population of perhaps 77% of that (as is the case nationally), or 44.3 million. The starting YPLL rate of 6,368 corresponds to 3.7 million years of life lost prematurely, and a 45% reduction would represent a savings of 1.7 million life-years annually. The starting fair-poor health prevalence fraction of 0.143 corresponds to 6.3 million unhealthy adults, and a 43% reduction would represent an improvement in quality of life for 2.7 million people. The starting urgent spending rate of \$8,811 per capita corresponds to \$508 billion, and a 53% reduction would represent a savings of \$269 billion annually.

For all three outcomes, the combined intervention portfolio yielded improvements by year 20 that are considerably greater than those at year 5, indicating that delayed cross-impacts have a major effect. The effect of delays is most pronounced for fair-poor health, which can be influenced only indirectly through interventions that primarily alter slow-moving rates of chronic disease progression. The effect of delays is least pronounced for urgent service spending because several of its drivers (ie, addiction, violent crime, poverty, housing stress, air pollution) are susceptible to direct intervention and thus more rapid change.

After gaining the high-level view of impacts from a combined portfolio, we now turn to the relative contributions of each individual intervention and to what extent the patterns of impact are the same or different across the 39 counties.

Because counties do not have infinite budgets to intervene in every conceivable way all at once, they must concentrate on a few priorities that are perceived as the most important. One approach, for example, might be to concentrate on those areas in which the county ranks lower relative to its peers (Online Appendix Table A10 presents the rankings for each county for all the selected threats that are subject to direct intervention). If such relative weaknesses were the basis for intervention

portfolio selection, these priorities would vary idiosyncratically from one county to another, and there would be no such thing as “generally most important” priorities for intervention.

A detailed, county-by-county look at the simulated impact of each intervention, however, leads to a different conclusion. Instead of idiosyncratic priorities, these data reveal substantial uniformity among the counties. Consider, for example, Table 4, which for each of the 39 counties shows the four individual interventions that are projected to do the most to enhance health-related quality of life (ie, reduce fair-poor health) by year 10. For all 39 counties, the two most impactful kinds of interventions are those addressing social support and poverty, with routine care also in the top four for all counties. In addition, health insurance is in the top four for 34 of the counties, and physical activity is in the top four for five of the counties.

We constructed tables similar to Table 4 for all three outcomes at years 5, 10, and 20 (see Online Appendix Tables A11-A19). Table 5 summarizes the full array of results. It shows that the poverty intervention is always one of the strongest contributors, even in the shorter term, and by year 20 is ranked one or two for all outcomes in all counties. Social support also is always one of the top-ranked interventions and by year 20 is ranked one to three for all outcomes and all counties.

With regard to extending years of life (ie, reducing YPLL), other interventions in the top four for all or most counties include those addressing addiction (years 5 and 10), violent crime (year 5), air pollution (year 5), smoking (years 10 and 20), and youth education (year 20). With regard to enhancing quality of life (ie, reducing the fraction in fair-poor health), the other dominant interventions are routine care (years 5, 10, and 20) and health insurance (years 5, 10, and 20). With regard to reducing urgent service spending, the other dominant interventions are those addressing violent crime (years 5, 10, and 20), addiction (years 5 and 10), and youth education (year 20).

Discussion

Significance

Counties across America must contend with multiple, intertwined threats and costs that defy simple solutions. Regional decision makers thus face a necessary but difficult task of choosing intervention

Table 4. Four Most Impactful Interventions with Respect to Fair-Poor Health at Year 10, by County (1 = Best)

The 4 Intervention Types Most Reducing Fair-Poor Health in Year 10 (1 = Best)

County	Health Insurance	Routine Care	Diet	Physical Activity	Smoking	Addiction	Crime	Youth Education	Poverty	Housing Stress	Air Pollution	Social Support
Alameda, CA	4	3							2			1
Alexandria, VA	4	3							2			1
Allegheny, PA	4	3		4					2			1
Bexar, TX	4	3							2			1
Cook, IL	4	3							2			1
Cuyahoga, OH	4	3							2			1
Dallas, TX	3	4							2			1
Davidson, TN	4	3							1			2
Denver, CO	4	3							2			1
Duval, FL	4	3							2			1
Erie, NY	4	3		4					2			1
Franklin, OH	4	3							2			1
Fulton, GA	4	3							2			1
Hamilton, OH	4	3							2			1
Harris, TX	4	3							2			1
Hartford, CT	4	3							2			1
Hennepin, MN	4	3		4					2			1
Hillsborough, FL	4	3							2			1
Jackson, MO	4	3							2			1
Jefferson, AL	4	3							2			1

Continued

Table 4. Continued

The 4 Intervention Types Most Reducing Fair-Poor Health in Year 10 (1 = Best)												
County	Health Insurance	Routine Care	Diet	Physical Activity	Smoking	Addiction	Crime	Youth Education	Poverty	Housing Stress	Air Pollution	Social Support
King, WA	4	3							2			1
Maricopa, AZ	4	3							2			1
Marion, IN	4	3							2			1
Mecklenburg, NC	4	3							2			1
Monroe, NY	4	3		4					2			1
Multnomah, OR	4	3							1			2
Orange, CA	4	3							2			1
Orange, FL	4	3							2			1
Pinellas, FL	4	3							2			1
Ramsey, MN	4	3							2			1
Richmond, NY	4	3		4					2			1
Riverside, CA	4	3							2			1
Sacramento, CA	4	3							2			1
Salt Lake, UT	4	3							2			1
San Francisco, CA	4	3							2			1
Santa Clara, CA	4	3							2			1
Tarrant, TX	4	3							2			1
Travis, TX	4	3							2			1
Virginia Beach, VA	4	3							2			1
<i>Total, avg 1-4</i>	<i>34</i>	<i>39</i>	<i>0</i>	<i>5</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>39</i>	<i>0</i>	<i>0</i>	<i>39</i>

Table 5. Summary of Most Impactful Interventions at Years 5, 10, and 20, Indicating High Uniformity of Results Across the 39 Countries^a

Top-Ranked Intervention Categories and Number of Counties (Out of 39) ^a			
Goals and Measures	Year 5	Year 10	Year 20
Extend Years of Life (<i>Measure: Years of Potential Life Lost</i>)	Poverty (39; #1)	Poverty (39; #1)	Poverty (39; #1)
	Addiction (39; #2/3)	Addiction (39; #2/3/4)	Social Support (39; #2/3)
	Violent Crime (35; #2/3/4)	Social Support (39; #2/3/4)	Smoking (39; #2/3/4)
	Air Pollution (29; #2/3/4)	Smoking (39; #2/3/4)	Youth Education (23; #3/4)
	Smoking (10; #3/4)	Physical Activity (1; #4)	Physical Activity (13; #3/4)
Enhance Quality of Life (<i>Measure: Percent in fair or poor health</i>)	Social Support (5; #4)	Addiction (5; #4)	Addiction (5; #4)
	Social Support (39; #1)	Social Support (39; #1/2)	Poverty (39; #1/2)
	Poverty (39; #2/3)	Poverty (39; #1/2)	Social Support (39; #1/2)
	Routine Care (39; #2/3/4)	Routine Care (39; #3/4)	Routine Care (39; #3/4)
	Insurance (39; #3/4)	Insurance (34; #3/4)	Insurance (34; #3/4)
Reduce Cost of Urgent Services (<i>Measure: Total spending on urgent services</i>)	Physical Activity (5; #4)	Physical Activity (5; #4)	Physical Activity (8; #4)
	Poverty (39; #1/2)	Poverty (39; #1)	Youth Education (7; #4)
	Violent Crime (39; #1/2)	Violent Crime (39; #2/3)	Poverty (39; #1)
	Social Support (39; #3)	Social Support (39; #2/3)	Social Support (39; #2)
	Addiction (39; #4)	Addiction (36; #4)	Violent Crime (39; #3)
		Youth Education (36; #4)	Youth Education (36; #4)
		Youth Education (3; #4)	Smoking (3; #4)

^aSee Online Appendix Tables A11-A19 for complete lists of county-specific intervention rankings

priorities to safeguard health and well-being. Effective system change in such circumstances requires broad stewardship, sound strategy, and sustainable financing, guided by shared values.³⁹ Most of the research and scientific guidance available to decision makers, however, does not adequately account for the way that seemingly separate threats are, in fact, connected, how long it takes for their effects to play out, which interventions could contribute the most, or what the economic benefits could be.

This study used commonly available data and simulation modeling to analyze the prospects for county-level system change. Our analysis accounts for 37 cross-impacts and time delays among a selected set of 15 threats in 39 peer counties. The corresponding simulation model allowed us to play out, for each of the peer counties, 20 years of potential intervention impacts and then to assess the extent to which people were likely to live longer, healthier lives and avoid adversities that require costly urgent services.

Our findings may help system stewards work together better across sectors and negotiate a more balanced portfolio of interventions for equitable health and well-being.^{6,40} Our methodology partially addressed a long-standing desire to account for the magnitude and significance of multiple, simultaneous drivers, famously characterized by Greg Stoddart as a “fantasy equation.”⁴¹

Our study also answers a question originally posed by David Kindig about whether “locally customized population health policy packages” might be developed based on a “community’s particular profile of strengths and weaknesses.”⁴² Our results suggest that idiosyncratic strengths and weaknesses (comparing a county with its peers) might not be the best place to look when selecting intervention priorities.

Limitations

This analysis has several noteworthy limitations. First, it focused on only 1 of 89 predefined groups of peer counties in the United States as identified in the CHR database. The 39 urban counties in this analysis encompass about 58 million people, or 18% of the total US population. Compared with US counties overall, the peer group studied here has some median threat levels somewhat better and others somewhat worse than the national average (see Table 1). It would be worthwhile

to repeat this analysis for other peer groups to discover whether the relative intervention rankings differ for those counties with different characteristics.

Although this study considered 15 selected threats, others do exist. We chose ones that span many dimensions of health and well-being, as well as almost all categories of vital conditions. These choices, however, were constrained by the availability of CHR metrics. With additional data from other sources, this same analysis could encompass a wider array of threats. Had there been common measures of walkability, complete streets, or access to cars and public transit, for example, we could have included the vital condition of reliable transportation. Also, the intervention priorities that surfaced here could have been enriched had we been able to include threats such as hate crimes, adverse childhood experiences, and sense of powerlessness. Because the pool of interventions was incomplete, the outcomes in this report likely underestimated the full potential of interventions to enhance health and well-being.

Similarly, the 20-year time horizon in this analysis is appropriate for the selected threats and interventions. But if we had had data on early childhood experiences such as pre-K enrollment, then we would have used a longer time horizon to track the full effects over time.

It may be possible to improve upon the statistical approach of stepwise regression based on cross-sectional data from a single pooled time period. Further work with cross-sectional data might be enhanced by the use of structural equation modeling,⁴³ and the use of existing longitudinal data could open the possibility of using techniques like Kalman filtering for a more advanced dynamic parameter estimation.⁴⁴

Our representation of a status quo equilibrium enabled a straightforward interpretation of results, but it does not reflect the fact that threat levels are prone to change over time, even without intervention. Consequently, our results could overestimate or underestimate some intervention impacts, although we expect that our broader findings regarding the most important interventions would not be affected. Those findings relate primarily to the structure of cross-impacts among the threats, and not so much to a county's particular mix of threat levels.

We reported aggregate results by county but were unable to examine subgroup differences (eg, by race, class, or sex). This obscured potentially stark differences among those who bear the greatest burden from existing threats and among those who might benefit the most from potential interventions. That said, most, if not all, of the threats addressed in this

analysis tend to fall most heavily on historically disadvantaged people. Consequently, these same people could benefit the most from the 12 interventions we have described. Arguably, then, all 12 interventions tend toward creating greater equity across subgroups.

The interventions we tested here do not represent specific programs, initiatives, or policies but, rather, the combined effect of all efforts to minimize a particular threat. For instance, in real life, an intervention to improve routine health care may have complementary components that involve both health care providers and patients. Conversely, a single multifaceted initiative could counter two or more threats at once. For instance, strong civic efforts to create a more inclusive economy could simultaneously counter multiple threats by reducing poverty, strengthening social support, reducing housing stress, and making health insurance more accessible.

Although we estimated savings in urgent service spending as a result of a simulated intervention, we did not calculate the implementation costs of the interventions themselves. Other analysts, such as the Washington State Institute for Public Policy, have cataloged many interventions of the type described here and have shown that some of the most effective ones are relatively inexpensive to implement, with costs of less than \$100 per beneficiary, whereas other effective interventions cost thousands of dollars per beneficiary.²⁰ Also, with regard to urgent service spending, although we assumed fixed cost coefficients across the 39 counties for the sake of easy comparison, counties may vary with regard to how fully or how cost-effectively they respond to urgent needs. Looking in greater detail at how much the different counties actually spend on urgent services, and at the costs of their selected interventions to enhance vital conditions, could be a step toward eventually setting much-needed benchmarks for investment to enhance population health and well-being.⁴⁵

Conclusions

Scores of interventions have been shown to deliver some value for health and well-being,¹⁴⁻²³ and each may be worthwhile to enact in particular circumstances. The most important interventions in any given county, however, are not necessarily apparent when looking at a simple profile of relative strengths and weaknesses. Indeed, our analysis

suggests that the list of top-ranked interventions is strikingly similar across (1) different outcome measures (mortality, morbidity, and costs); (2) different time periods (from 5 to 20 years); and (3) different counties. Regardless of county-to-county differences, interventions that expand meaningful work and wealth as well as belonging and civic muscle (thereby reducing poverty and strengthening social support) yield consistently better results than other interventions. These efforts address threats that are so pernicious and deeply entangled that they ought to be top priorities for concentrated investment virtually everywhere.

When setting priorities, regional decision makers often focus on an intervention's direct effectiveness as the chief concern. But all the potential interventions in this analysis had *identical* effect sizes (ie, a 25% reduction in the selected threat). What is it, then, other than the initial direct effect that explains the apparent uniform importance of certain interventions? From a systems standpoint, there are a few basic reasons why an intervention may be among the most important across most counties. Logically, in a system filled with interdependent threats and costs, an intervention can do more to enhance overall performance when the threat it affects has cross-impacts that are (1) stronger, (2) more diverse, and (3) quicker.

Thus, in this study, the interventions to reduce poverty and to strengthen social support ranked highest in every county because all or almost all the other selected threats are connected through them; most of their odds ratios are strong; and many of their impacts are rapid. Several other interventions in this study had powerful (though not quite as powerful) systemwide consequences, and they, too, yielded consistently strong results across peer counties. Those included interventions directed toward (1) smoking and addiction—to extend years of life; (2) routine care and insurance—to enhance self-rated health; and (3) violent crime—to reduce spending on urgent services. Also, when looking over a longer 20-year time frame, youth education ranked among the highest contributors to multiple goals.

The striking uniformity in our findings also suggests that policy design and strategic investment might be easier and require less customizing than one might think. If policymakers do not need unique technical analyses for each county, the task of selecting high-priority interventions could be streamlined. There will always be a need for some customization, but this analysis suggests that virtually all intervention

portfolios ought to devote a significant concentration of resources to expand economic and social inclusion because they are so critical for ensuring equitable health and well-being.

References

1. Braveman P, Egerter S, Williams DR. The social determinants of health: coming of age. *Annu Rev Public Health*. 2011;32:381-398.
2. Commission to Build a Healthier America. *Beyond Health Care: New Directions to a Healthier America*. Princeton, NJ: Robert Wood Johnson Foundation; 2009.
3. US Department of Health and Human Services. Healthy People 2030 Framework. 2019. <https://www.healthypeople.gov/2020/About-Healthy-People/Development-Healthy-People-2030/Framework>. Accessed December 27, 2018.
4. Roy B, Riley C, Sears L, Rula EY. Collective well-being to improve population health outcomes: an actionable conceptual model and review of the literature. *Am J Health Promotion*. 2018;32:1800-1813.
5. Evans RG, Stoddart GL. Producing health, consuming health care. *Soc Sci Med*. 1990;31:1347-1365.
6. Kottke TE, Stiefel M, Pronk NP. "Well-being in all policies": promoting cross-sectoral collaboration to improve people's lives. *Prev Chronic Dis*. 2016;13.
7. ReThink Health. Negotiating a well-being portfolio. 2018. https://www.rethinkhealth.org/wp-content/uploads/2018/10/RTH-WellBeingPortfolio_InstructionsSummary_10222018.pdf. Accessed December 28, 2018.
8. Policy Link. *The Equity Manifesto*. Oakland, CA: Policy Link; 2018.
9. Woolf SH, Purnell JQ. The good life: working together to promote opportunity and improve population health and well-being. *JAMA*. 2016;315(16):1706-1708.
10. McGovern L, Miller G, Hughes-Cromwick P. The relative contribution of multiple determinants to health. Health Affairs Health Policy Brief. August 21, 2014. <https://doi.org/10.1377/hpb20140821.40448711>.
11. Park H, Roubal AM, Jovaag A, Gennuso KP, Catlin BB. Relative contributions of a set of health factors to selected health outcomes. *Am J Prev Med*. 2015;49:961-969.
12. Ezzati M, Hoorn SV, Lopez AD, et al. Comparative quantification of mortality and burden of disease attributable to selected risk factors. In Lopez AD, Mathers CD, Ezzati M, Jamison DT, Murray

- CJL, eds. *Global Burden of Disease and Risk Factors*. Washington, DC: World Bank; 2006:chap. 4.
13. Muennig P, Fiscella K, Tancredi D, Franks P. The relative health burden of selected social and behavioral risk factors in the United States: implications for policy. *Am J Public Health*. 2010;100:1758-1764.
 14. Community Preventive Services Task Force. The Community Guide: what works to promote health. 2016. <http://thecommunityguide.org/index.html>. Accessed October 29, 2017.
 15. Center on Budget and Policy Priorities. What works to reduce poverty. 2016. <http://www.cbpp.org/what-works-to-reduce-poverty>. Accessed March 10, 2016.
 16. Federal Reserve Bank of San Francisco and L.I.I. *What Works for America's Communities*. San Francisco, CA: Federal Reserve Bank of San Francisco and L.I.I. Fund; 2012.
 17. Centers for Disease Control and Prevention. The 6|18 initiative: accelerating evidence in action. 2017. <https://www.cdc.gov/sixteen/>. Accessed October 29, 2017.
 18. Centers for Disease Control and Prevention. Health impact in 5 years. 2017. <https://www.cdc.gov/policy/hst/hi5/index.html>. Accessed October 29, 2017.
 19. County Health Rankings and Roadmaps. *What Works for Health?* Madison, WI: University of Wisconsin Population Health Institute and Robert Wood Johnson Foundation; 2018.
 20. Washington State Institute for Public Policy. About WSIPP. 2017. <http://www.wsipp.wa.gov/About>. Accessed October 29, 2017.
 21. Partnership for Prevention. National Commission for Prevention Priorities. 2017. <http://www.prevent.org/Initiatives/National-Commission-on-Prevention-Priorities.aspx>. Accessed October 29, 2017.
 22. Public Health Alliance of Southern California. California healthy places index policy actions. 2018. <https://healthyplacesindex.org/policy-actions/>. Accessed December 19, 2018.
 23. Health Affairs. Policy briefs. <https://www.healthaffairs.org/briefs>. Accessed January 26, 2019.
 24. Well-Being Legacy. The vital conditions. 2018. <https://www.well-beinglegacy.org/vital-conditions>. Accessed December 28, 2018.
 25. Milstein B. No more fragmentation: crafting a comprehensive strategy for regional health and well-being. 2018. In Rippel Foundation, *The ReThinker's Blog*. <https://www.rethinkhealth.org/the-rethinkers-blog/no-more-fragmentation-crafting-a-comprehensive-strategy-for-regional-health-and-well-being/>. Accessed August 15, 2019.

26. ReThink Health. A pathway for transforming health and well-being through regional stewardship. 2018. Rippel Foundation. <https://www.rethinkhealth.org/resources-list/pathway/>. Accessed August 15, 2019.
27. Centers for Disease Control and Prevention. Community health improvement navigator. 2015. <https://www.cdc.gov/CHInav/>. Accessed December 27, 2018.
28. Sterman JD. Learning from evidence in a complex world. *Am J Public Health*. 2006;96:505-514.
29. Galea S, Riddle M, Kaplan GA. Causal thinking and complex system approaches in epidemiology. *Int J Epidemiol*. 2010;39:97-106.
30. Homer JB, Hirsch GB. System dynamics modeling for public health: background and opportunities. *Am J Public Health*. 2006;96:452-458.
31. Metzler M. Social determinants of health: what, how, why, and now. *Prev Chronic Dis*. 2007;4:A85.
32. Milstein B, Homer J, Briss P, Burton D, Pechacek T. Why behavioral and environmental interventions are needed to improve health at lower cost. *Health Aff*. 2011;30:823-832.
33. Milstein B, Homer J, Hirsch G. Analyzing national health reform strategies with a dynamic simulation model. *Am J Public Health*. 2010;100:811-819.
34. Homer J, Milstein B, Hirsch G, Fisher E. Combined regional investments could substantially enhance health system performance and be financially affordable. *Health Aff*. 2016;35:1435-1443.
35. Mahamoud A, Roche B, Homer J. Modelling the social determinants of health and simulating short-term and long-term intervention impacts for the city of Toronto, Canada. *Soc Sci Med*. 2013;93:247-255.
36. Bohm M, Boothe V, Chen Z. Peer county methodology used by the Community Health Status Indicators 2015 web application. 2015. www.countyhealthrankings.org/sites/default/files/resources/CHSIpeerMethodology.pdf. Accessed December 27, 2018.
37. County Health Rankings and Roadmaps. Rankings data and documentation. 2018. <http://www.countyhealthrankings.org/explore-health-rankings/rankings-data-documentation>. Accessed December 28, 2018.
38. Pronk NP, Kottke T, Milstein B, Rossom R, Stiefel M. *Health and Well-Being: A Brief to Inform Development of Healthy People 2030*. Washington, DC: US Department of Health and Human Services; 2019.
39. ReThink Health. 10 essential practices for transforming health and well-being through regional stewardship.

2018. Rippel Foundation. https://www.rethinkhealth.org/wp-content/uploads/2018/12/RTH-10EssentialPractices_1212018.pdf. Accessed August 16, 2019.
40. Kindig DA, Milstein B. A balanced investment portfolio for equitable health and well-being is an imperative, and within reach. *Health Aff (Millwood)*. 2018;37:579-584.
 41. Stoddart G. *The Challenge of Producing Health in Modern Economies*. Toronto, Canada: Canadian Institute of Advanced Research; 1995.
 42. Kindig DA. Locally customized population health policy packages? *Improving Population Health Blog*. 2011.
 43. Hovmand PS, Chalise N. Simultaneous linear estimation using structural equation modeling. In Rahmandad H, Rogelio O, Osgood N, eds. *Analytical Methods for Dynamic Modelers*. Cambridge, MA: MIT Press; 2015:chap. 3.
 44. Eberlein R. Working with noisy data: Kalman filtering and state resetting. In Rahmandad H, Rogelio O, Osgood N, eds. *Analytical Methods for Dynamic Modelers*. Cambridge, MA: MIT Press; 2015:chap. 4.
 45. Kindig D. From health determinant benchmarks to health investment benchmarks. *Prev Chronic Dis*. 2015;12:E41.

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Supplementary Material

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Appendix. Detailed Methodological Procedures