USING THE SYSTEM DYNAMICS MODEL TO INFORM CHRONIC DISEASE PREVENTION EFFORTS

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PLACE MATTERS CONFERENCE
PORTLAND, OR

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Purpose of Today's Session

- Systems Dynamics Models can show how projected rates of chronic diseases may be altered, depending on the number and type of best-practice interventions
- Learn how Washington DOH has used the SDM to inform strategic planning efforts

System Dynamics Model: Background

- Designed as a strategic planning and decision-support tool
- Simulates alternative futures under different scenarios for system improvements
- Models created for diabetes, asthma, tobacco & obesity; latest cardiovascular disease model (PRISM) is more comprehensive CD model
- Design teams included modeling expert Jack Homer, Bobby Milstein (Syndemics Branch, CDC), state partners, and various consultants

Washington Diabetes Prevention & Control Program

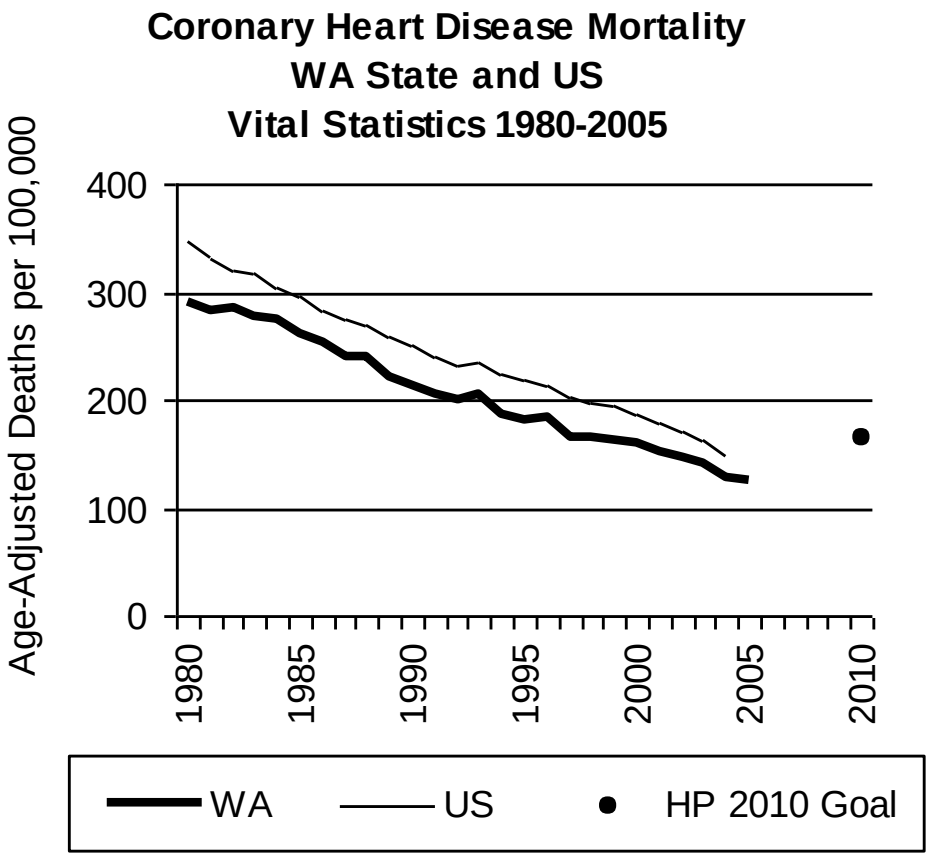
- Purpose:
  - Use "Aha's" from WA-specific SDM to critically review current focus of DPCP program
- Audience:
  - DPCP Manager & Staff; CDPU Epidemiologist, Leadership Team
- Time: 2 3-hour sessions; ongoing discussion over a 2 year period.
- Format: Facilitated discussion of levers currently addressed by the DPCP vs the levers that should be addressed, based on new information

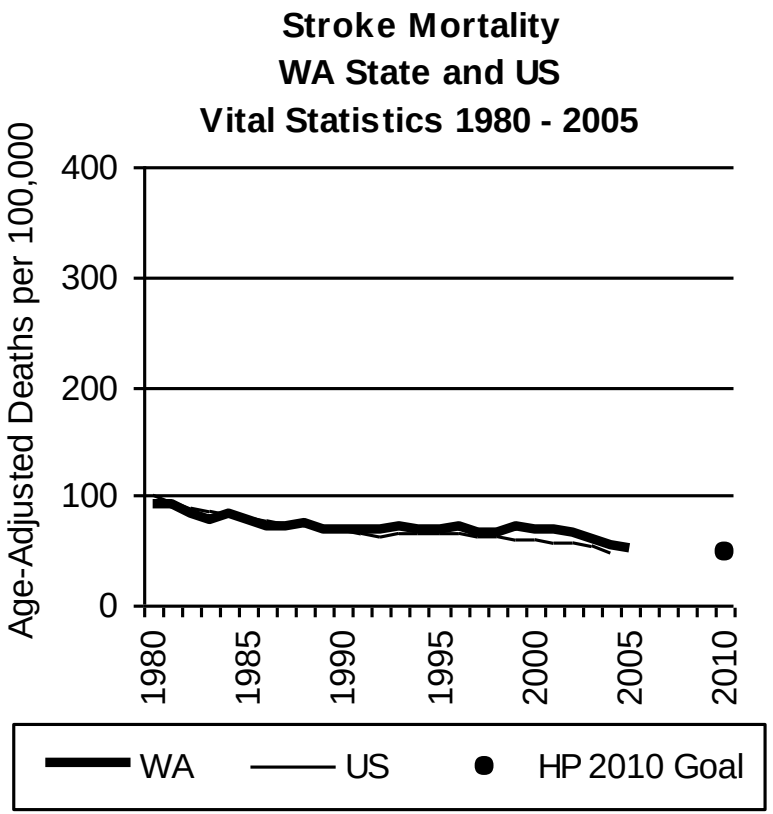
- Results
  - Acknowledgement that prediabetes and other high risk "pre-chronic" conditions must be addressed
  - Strong commitment to improving care for those with diabetes remains
  - Difficult to do both with existing level of federal funding
- Lesson Learned: Shifting direction is an ongoing process that takes time & effort

PRISM System Dynamics Model

Washington State Department of Health

Trends in Cardiovascular Disease Mortality



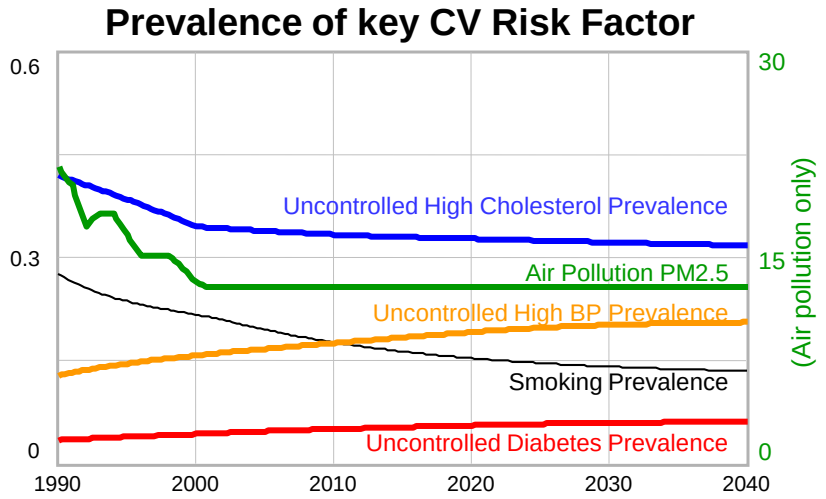


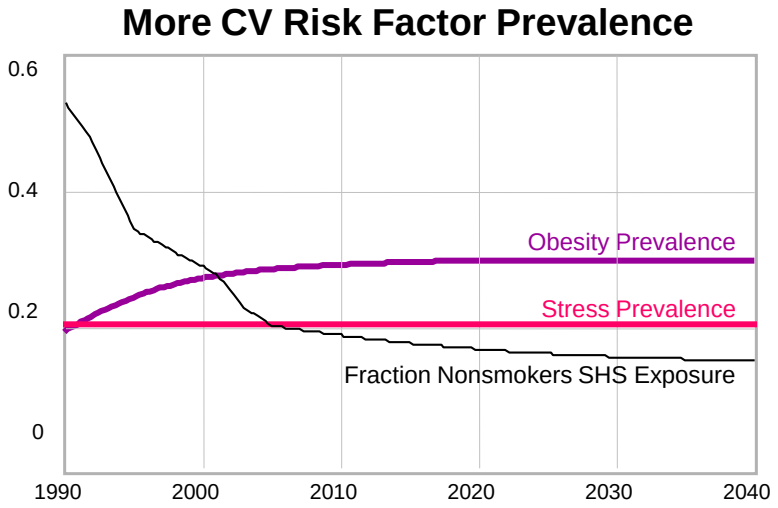
- 28% decline in CV deaths due to *better emergency response & acute care*
- 11% in CV event prevalence due to *decreases in* ***2.5 pm air pollution***, ***smoking*** *and* ***uncontrolled cholesterol***

Likely Futures for CV Risk Factors

CV risk model incorporates:

- Downward trends, 1990-2004:
  - Fraction workplaces allowing smoking (1990-2003)
  - Air pollution (1990-2001)
  - CV event fatality (1990-2003)
  - Youth smoking (rise 1991-99, decline 1999-2003)
- Upward Trends, 1990-2004:
  - Obesity
  - High BP
  - Diabetes





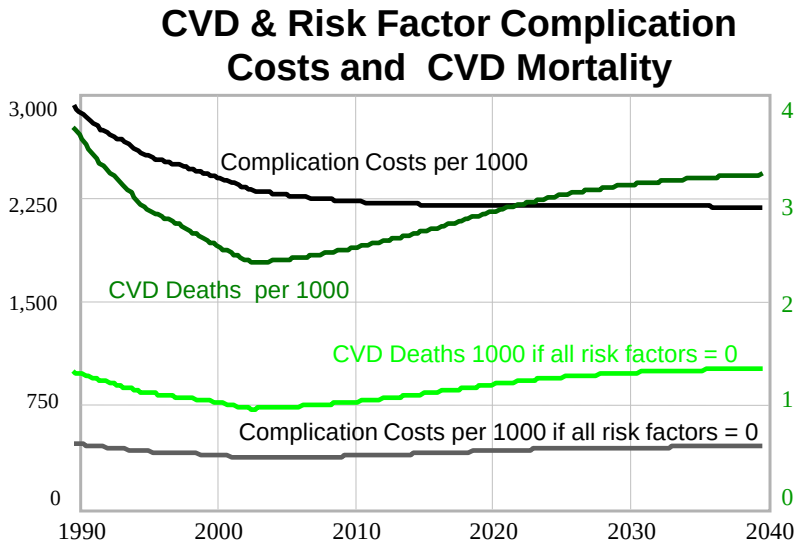
How will the future trends in CV risk factors & conditions affect CV deaths and costs?

Despite decreases in the prevalence of air pollution and smoking, we see increases in

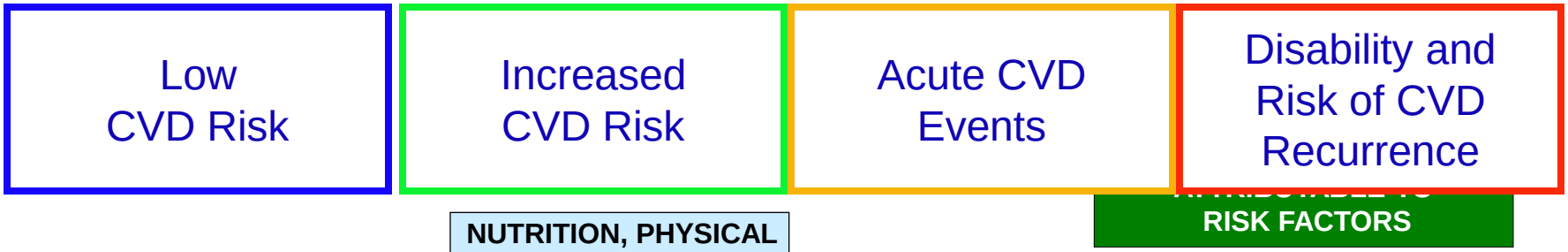
- ✧ obesity,
- ✧ hypertension,
- ✧ and diabetes

What actions can we take to create a different future?

These increases, combined with an aging population will soon lead to an upswing in CV deaths –a reverse of current trends.



CV System Dynamics Model:



LOCAL CONTEXT

- Eating & activity options
- Smoking policies
- Socioeconomic conditions
- Environmental policies
- Health care options
- Support service options
- Media and events

NUTRITION, PHYSICAL ACTIVITY & STRESS

- Salt intake
- Saturated/Trans fat intake
- Fruit/Vegetable intake
- Net caloric intake
- Physical activity
- Chronic stress

UTILIZATION OF SERVICES

- Behavioral change
- Social support
- Mental health
- Preventive health

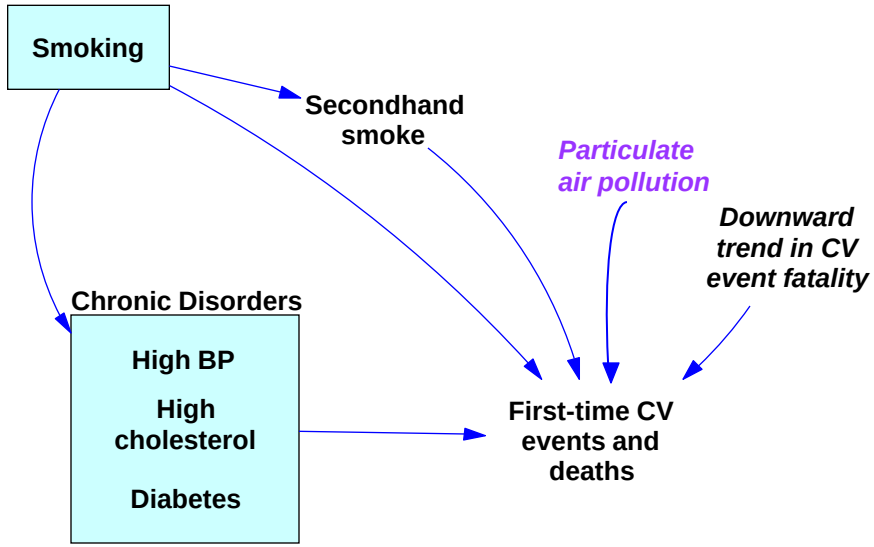
CVD RISK FACTOR PREVALENCE & CONTROL

- Hypertension
- High cholesterol
- Diabetes
- Obesity
- Smoking
- Secondhand smoke
- Air pollution exposure

ESTIMATED FIRST-TIME CVD EVENTS

- CHD (MI, Angina, Cardiac Arrest)
- Stroke
- Total CVD (CHD, Stroke, CHF, PAD)

PRISM System Dynamics Model



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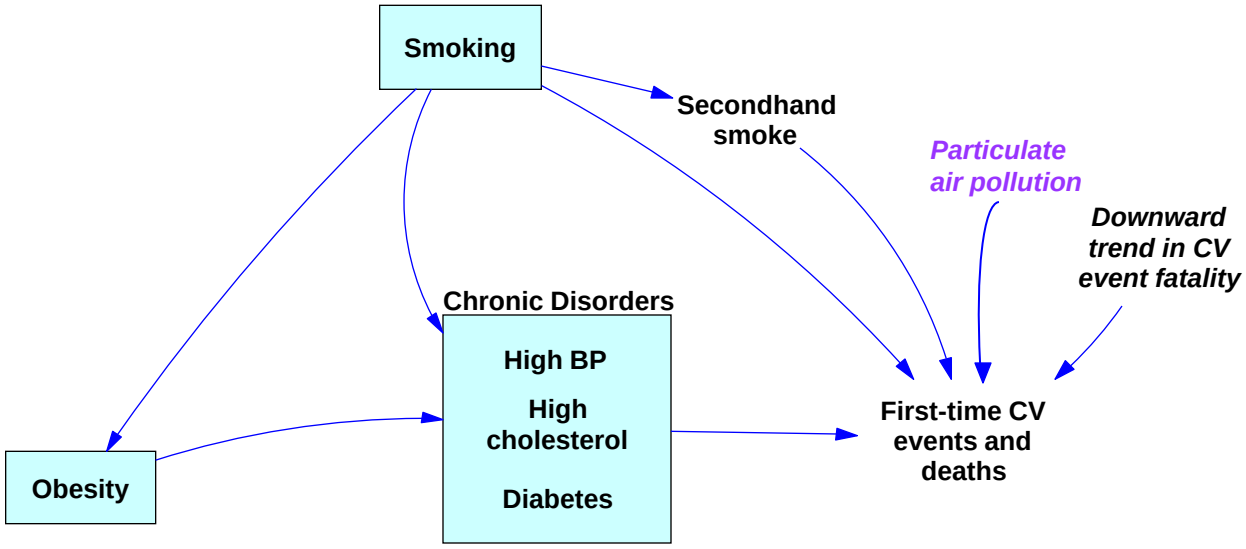

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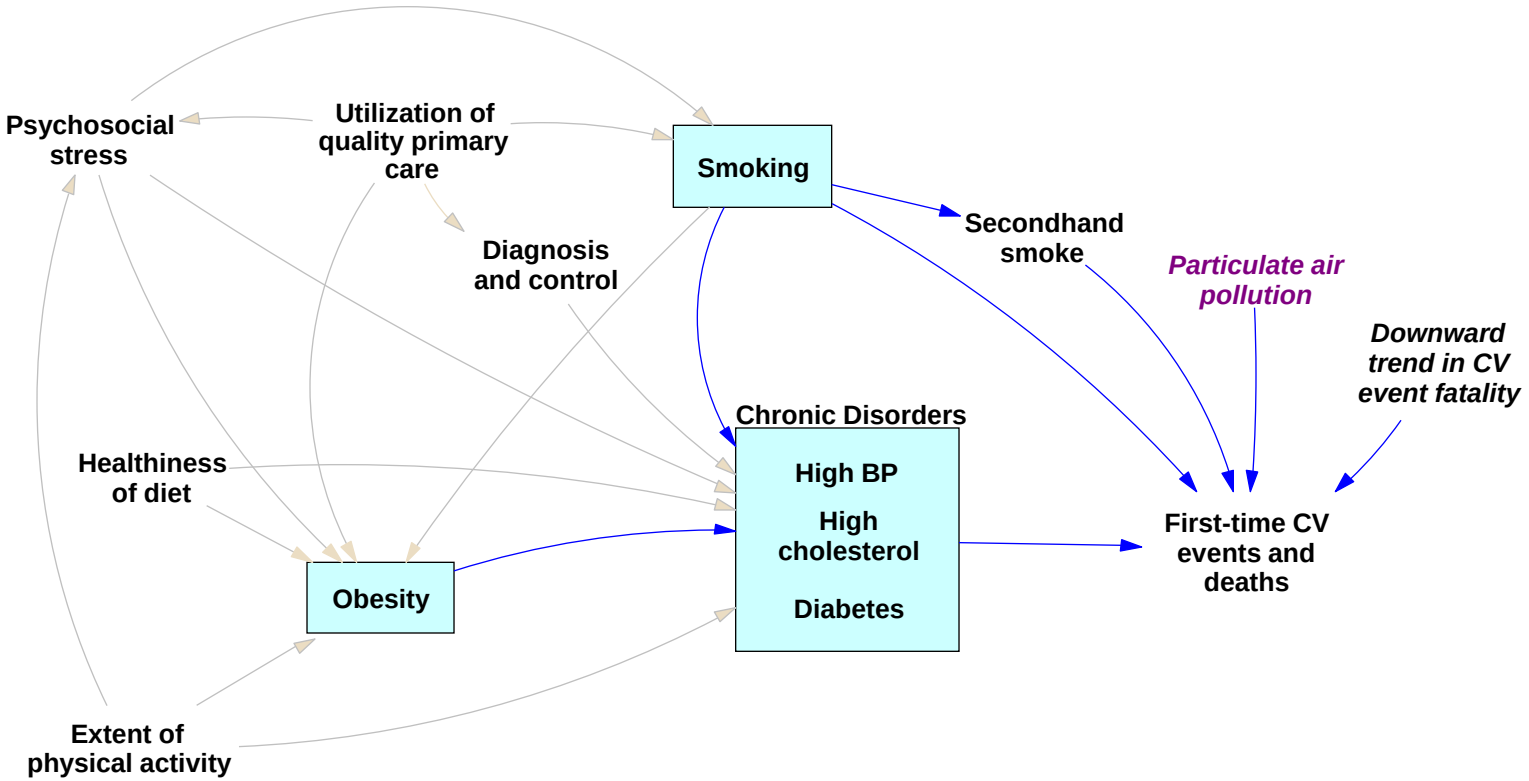

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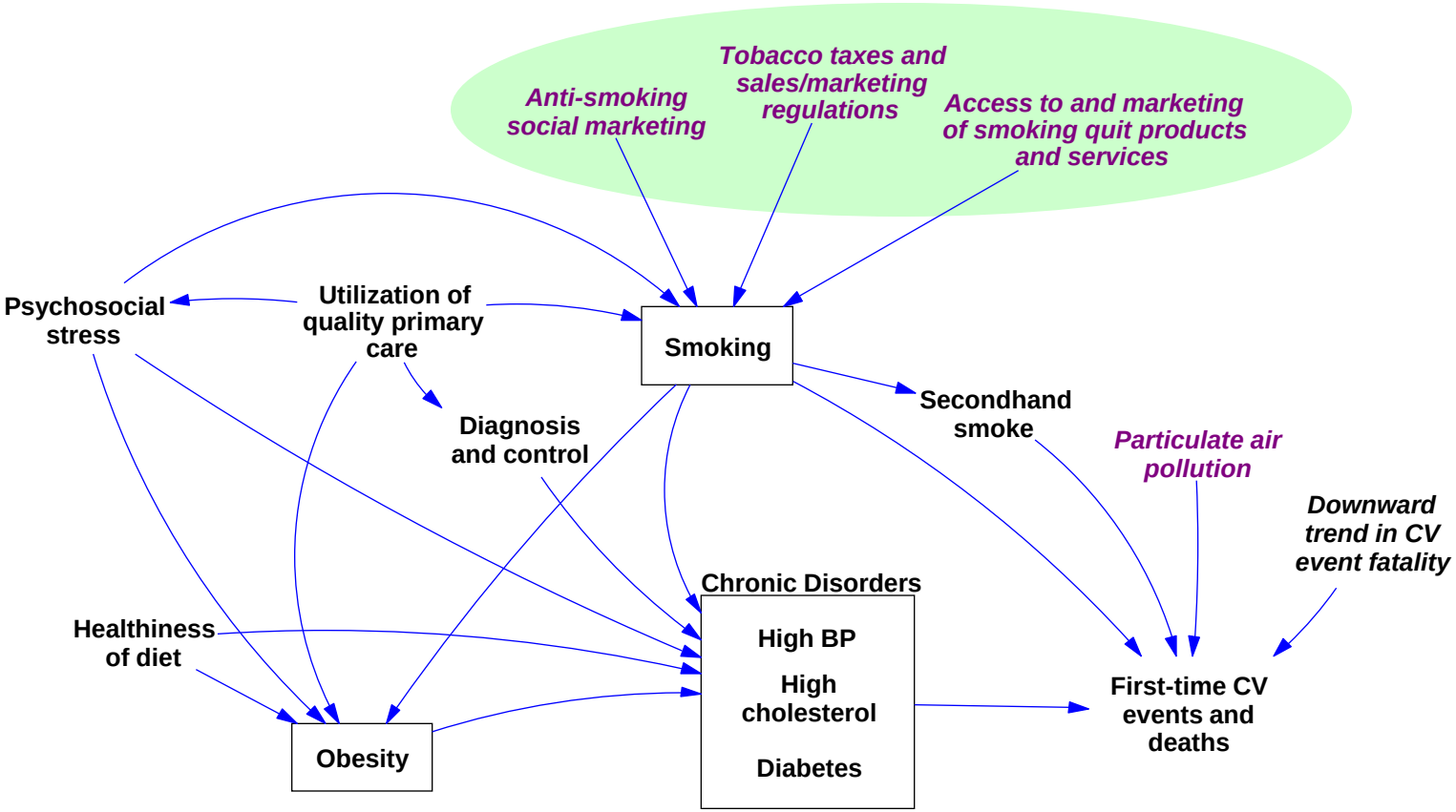

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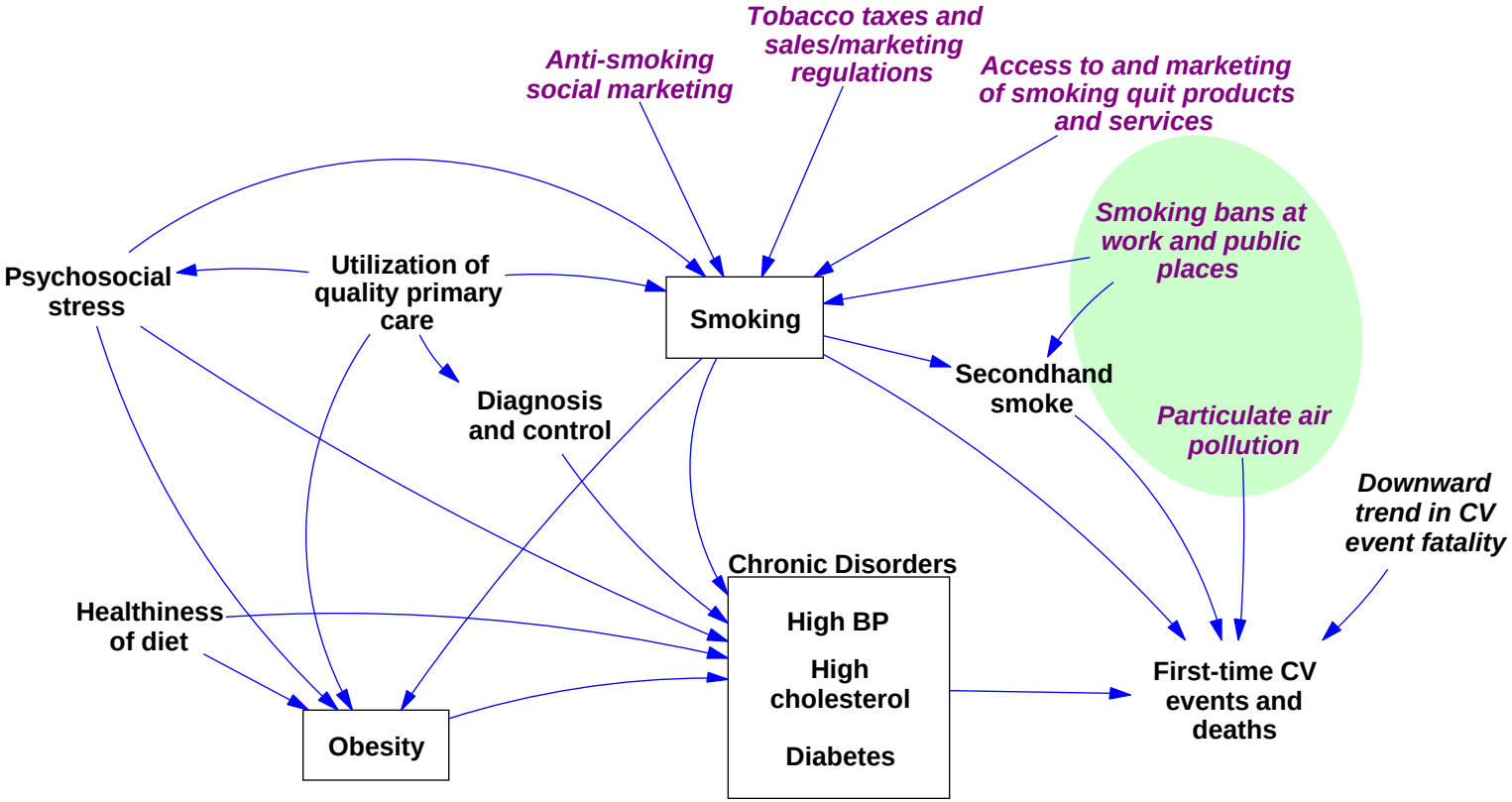

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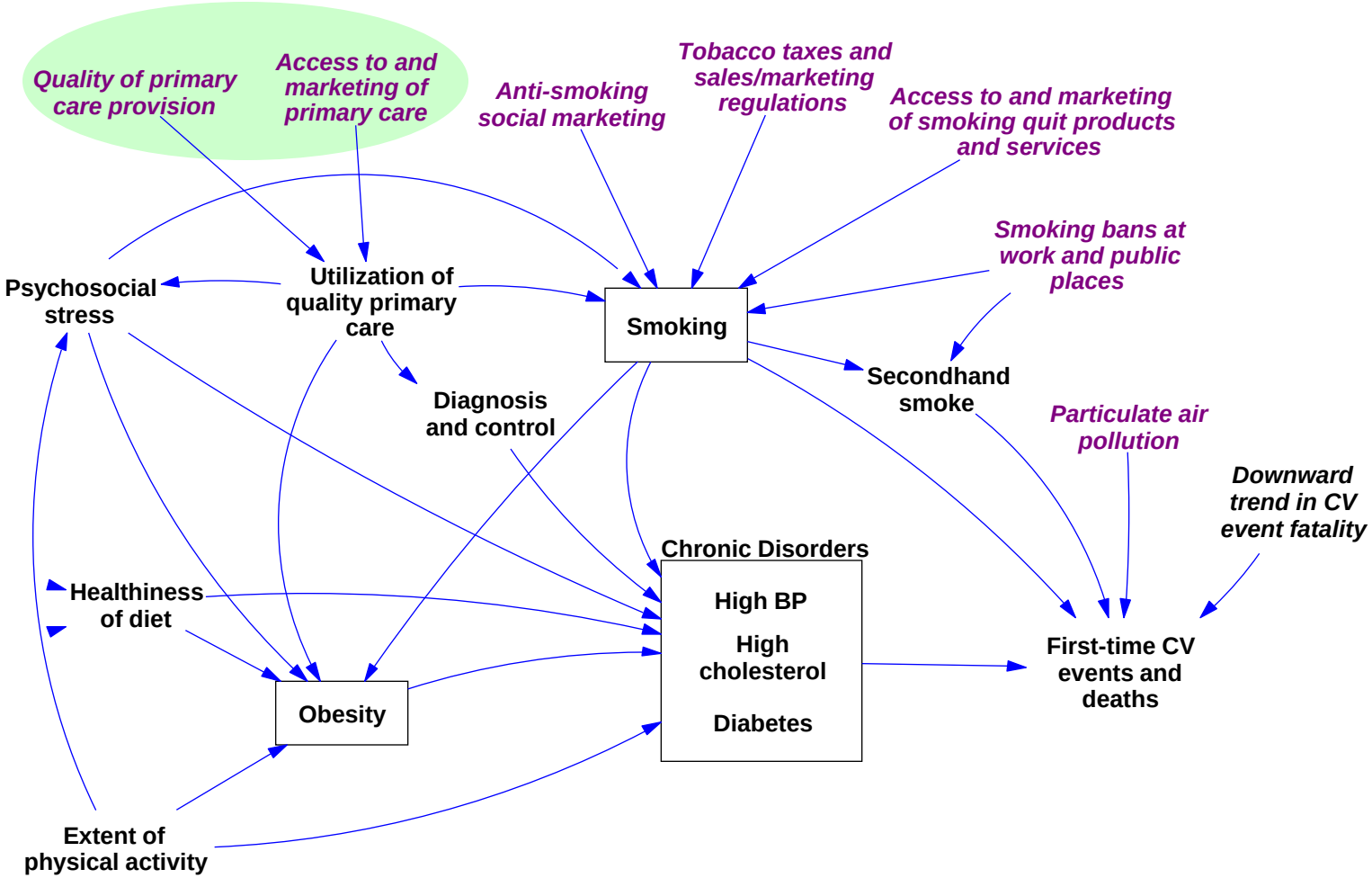

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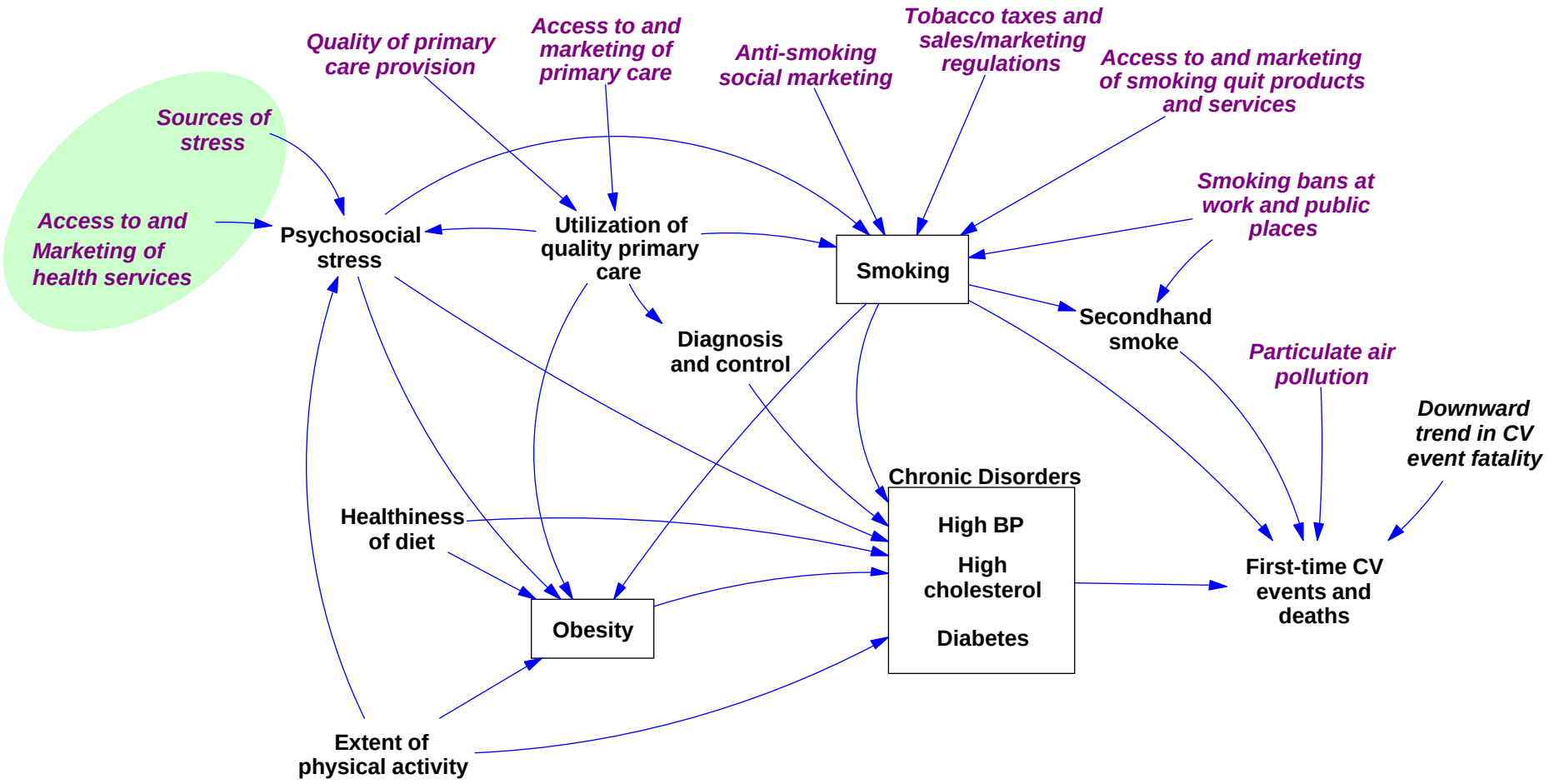

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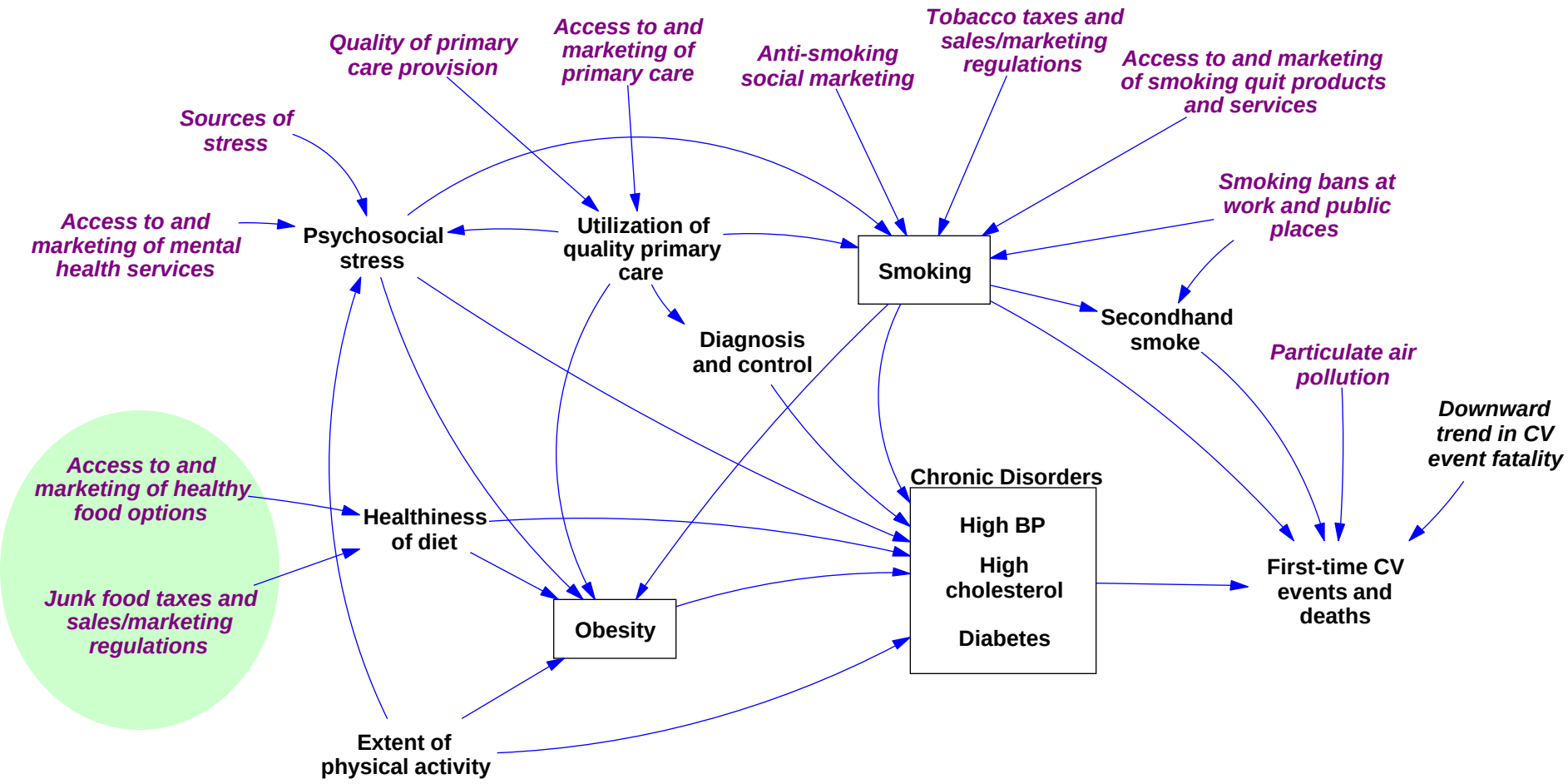

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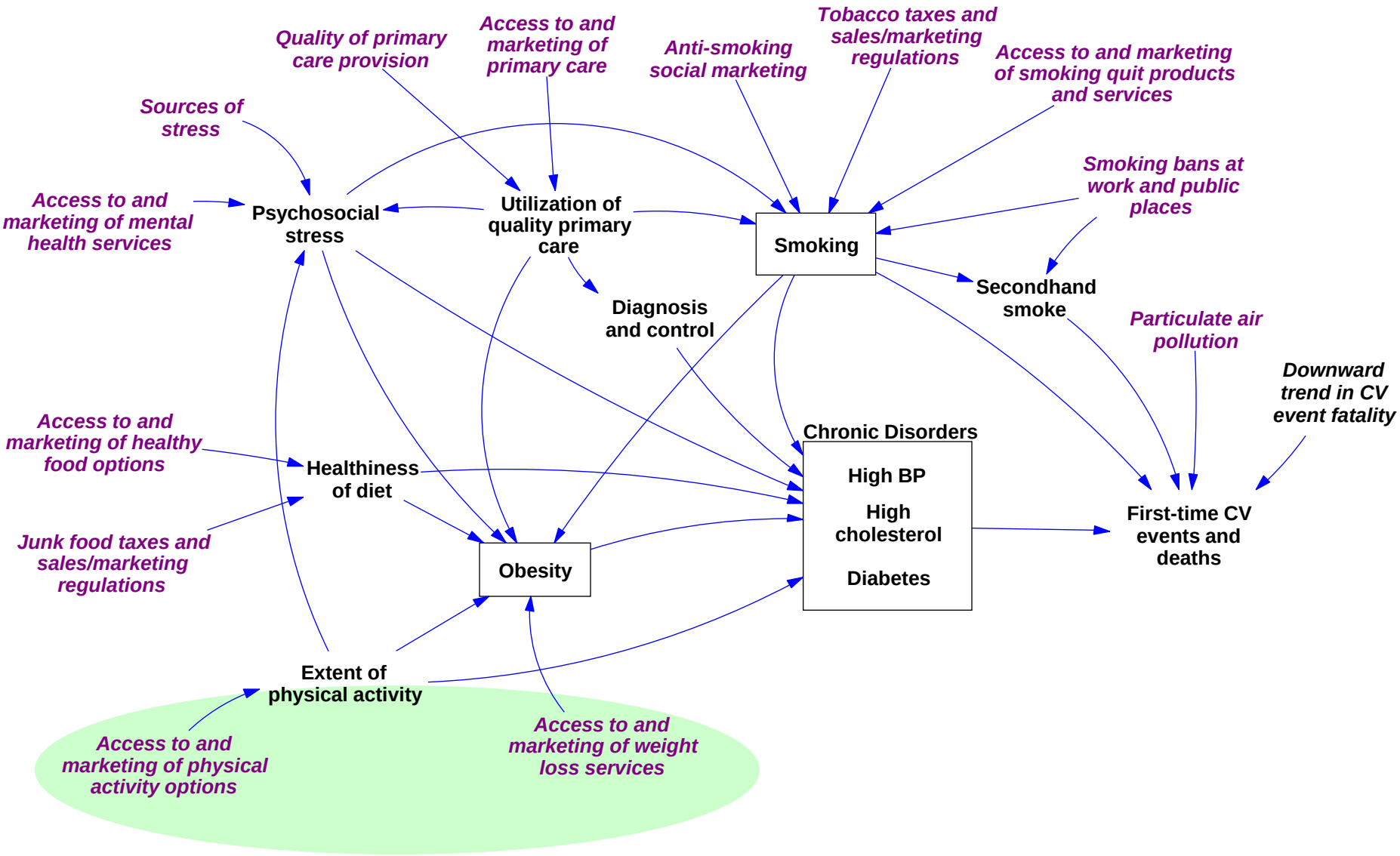

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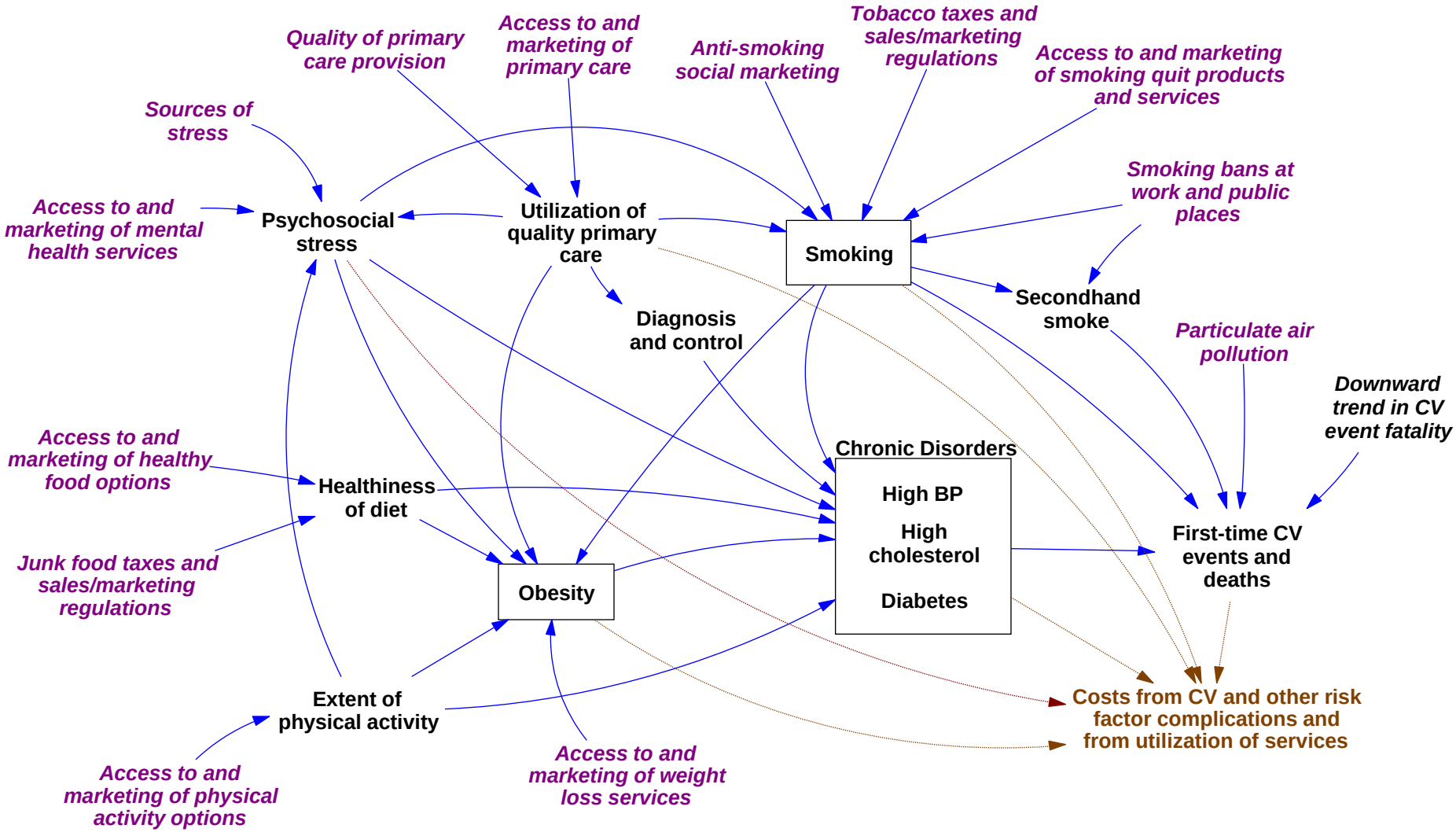


Different Modeling Approaches For Different Purposes

Logic Models **(flowcharts, maps or diagrams)**	System Dynamics **(causal loop diagrams, stock-flow structures, simulation studies, action labs)**	Forecasting Models **(regression models, Monte Carlo models)**
• Articulate steps **between actions and anticipated effects**	• Improve understanding **about the plausible effects of a policy over time** • **Focus on** patterns of change over time **(e.g., long delays, better before worse)** • Test dynamic hypotheses **through simulation studies** • **Inspire action through** visceral, game-based learning	• Make accurate forecasts **of key variables** • **Focus on precision of** point predictions and confidence intervals

What would happen if we addressed all these Interventions?

Care

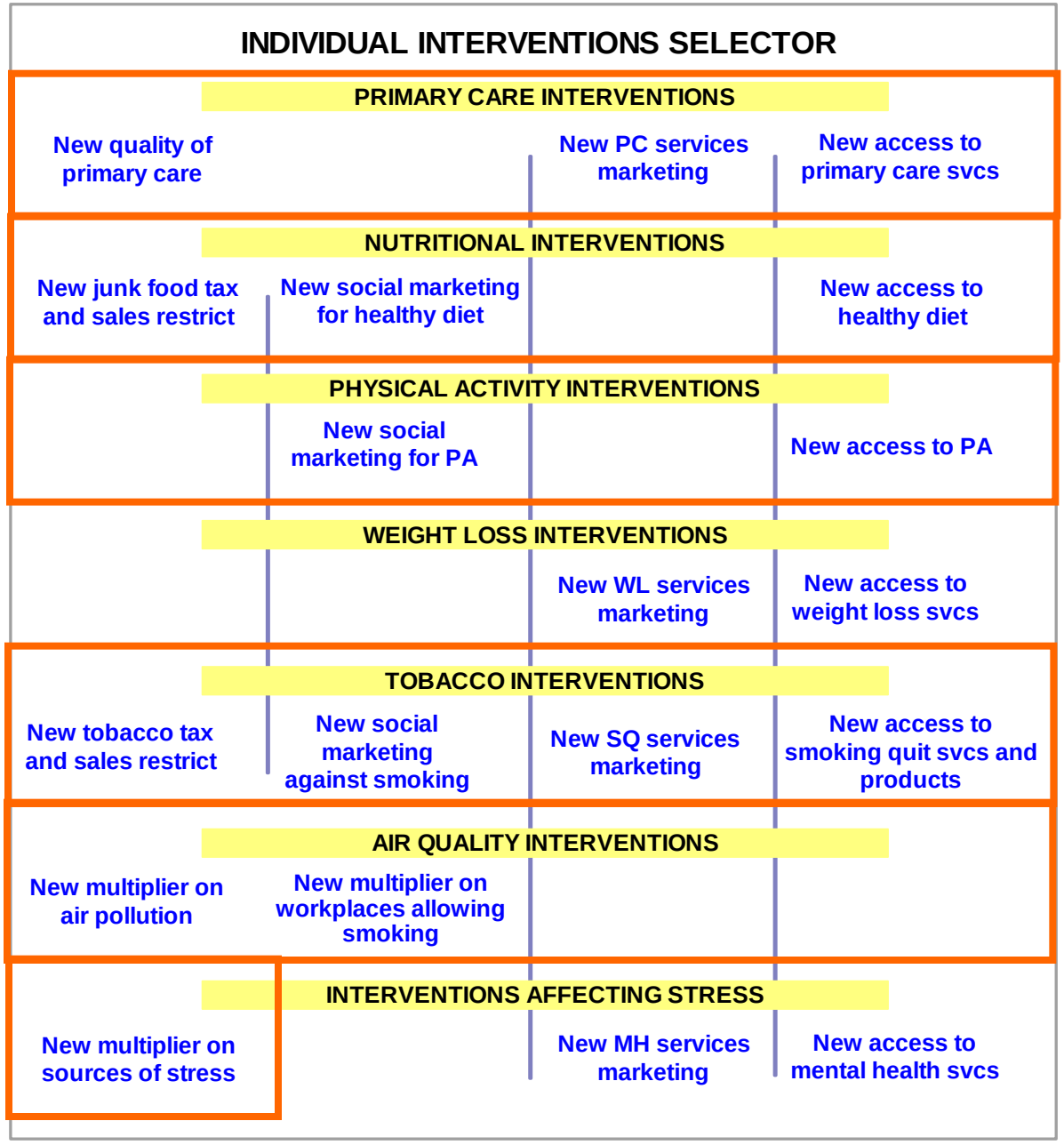
- Primary Care Quality = 75%
- PC Marketing = 100%
- PC Access = 100%

Lifestyle

- Physical Activity Access = 100%
- Physical Activity Social Marketing = 100%
- Access to Healthy Nutrition = 100%
- Healthy Nutrition Social Marketing = 100%
- Stress Multiplier = 50%

Air

- Tobacco Tax = 100%
- Marketing Against Smoking = 100%
- Air Pollution Multiplier = 50%
- Smoking Bans = 100%



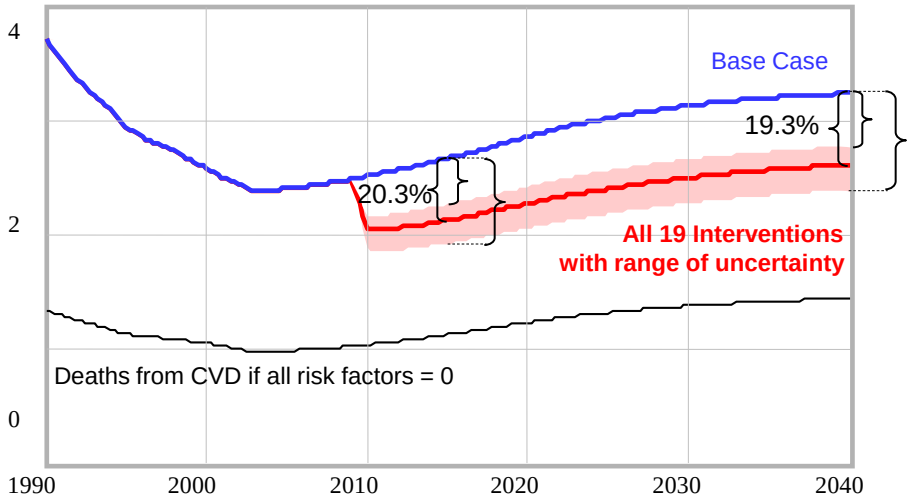
Potential Futures

% Decrease from Base case

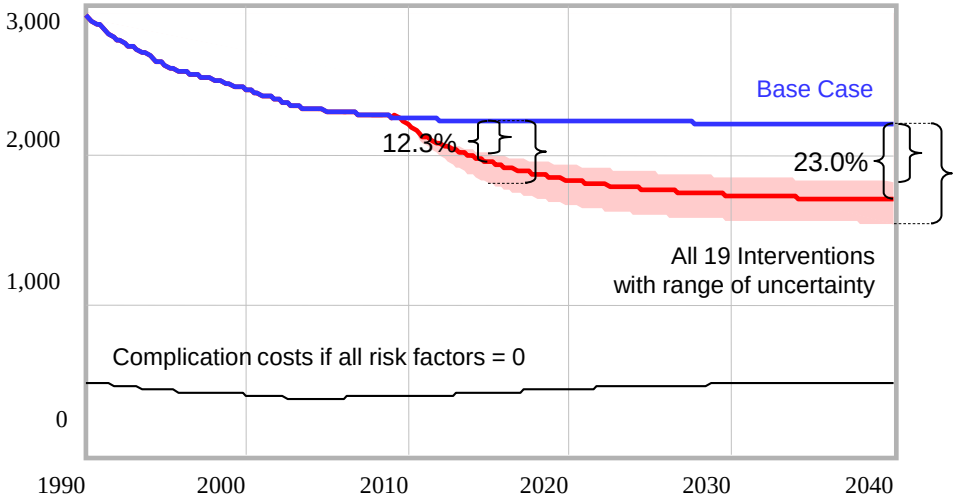
	2015		2040	
	Mort	Cost	Mort	Cost
Uncertainties at minimum impact				
Nominal results				
Uncertainties at maximum impact				

There are significant gains even at the least effective end of the uncertainty range.

Deaths from CVD per 1000

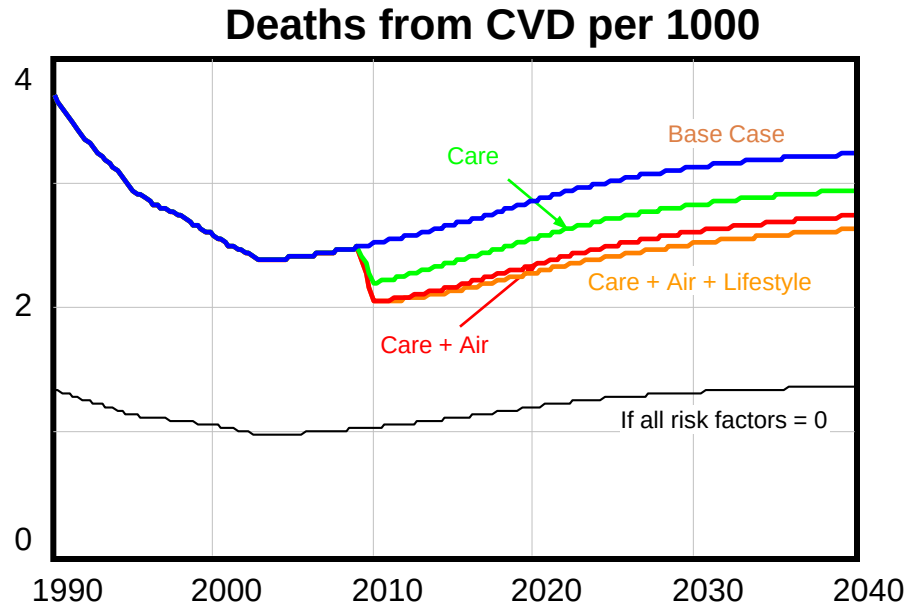


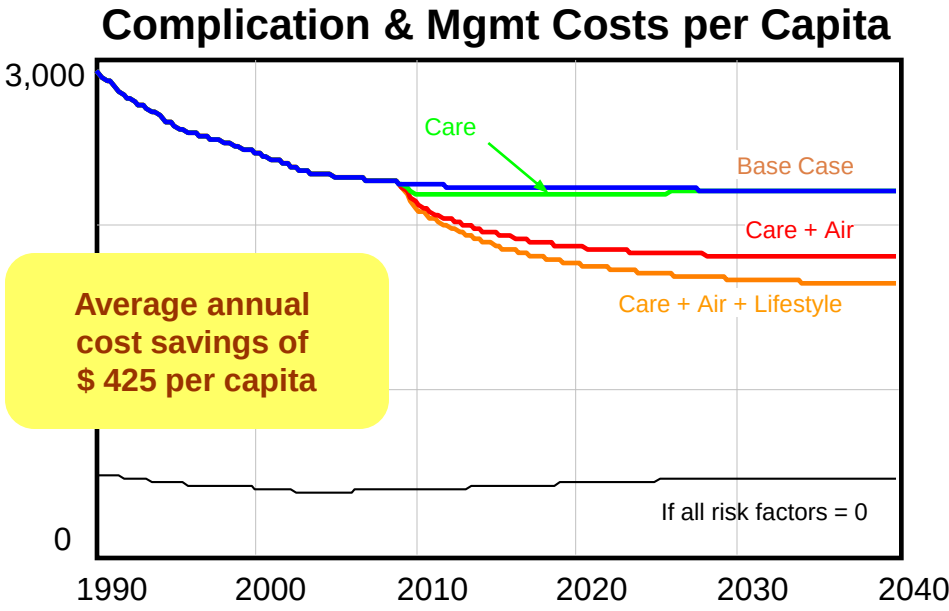
CV & Risk Factor Complication Costs per Capita



Comparing Care, Air & Lifestyle Interventions

- **Care** provides
  - Quick and sustained reduction in CV events,
  - …but little cost savings ($25 per capita for 30 years)
- **Air** provides
  - Quick and growing reduction in CV events,
  - Major cost savings ($300 per capita for 30 years).
- **Lifestyle** provides
  - Growing CV event reductions over time, but little immediately
  - Substantially increasing cost savings over time (average, $100 per capita)



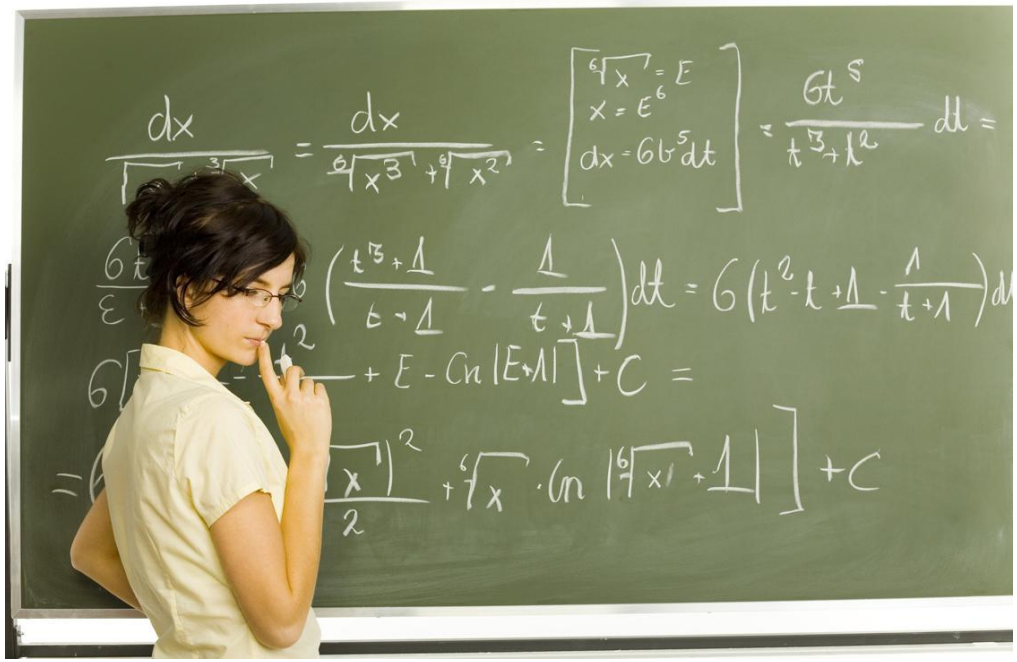


What do YOU think?

Of the 19 Intervention Options:

- Which 5 will have the biggest impact on CV first events & deaths by 2040? By 2015?

- Which 5 will have the biggest impact on CV Costs by 2040? By 2015?



Simulation results for individual interventions - grouped by area

	Single Intervention	Test value	Deaths/ thou 2015	Complic $/capita 2015	Mgmt + Complic $/cap 2015	% Δ Complc $/ thou 2015	% Δ Deaths/ thou 2015	% Δ Comp & Mgmt $/ thou 2015	Deaths/ thou 2040	Complic $/capita 2040	Mgmt + Complic $/cap 2040	% Δ Complc $/ thou 2040	% Δ Deaths/ thou 2040	% Δ Comp & Mgmt $/ thou 2040
	Base case	-	2.657	1,928	2,216	-	-	-	3.228	1,897	2,196	-	-	-
PRIMARY CARE	Quality of Primary Care	0.75	2.510	1,840	2,184	-4.6%	-5.5%	-1.4%	3.088	1,818	2,181	-4.2%	-4.3%	-0.7%
	Primary care services marketing	1	2.627	1,911	2,217	-0.9%	-1.1%	0.0%	3.200	1,881	2,201	-0.8%	-0.9%	0.2%
	Access to primary care	1	2.586	1,886	2,219	-2.2%	-2.7%	0.1%	3.161	1,859	2,209	-2.0%	-2.1%	0.6%
HEALTHY DIET	Social marketing healthy diet	1	2.654	1,926	2,213	-0.1%	-0.1%	-0.1%	3.217	1,889	2,186	-0.4%	-0.3%	-0.5%
	Junk food tax & sales restrict	1	2.656	1,927	2,215	-0.1%	0.0%	0.0%	3.224	1,894	2,193	-0.2%	-0.1%	-0.1%
	Access to healthy diet	1	2.646	1,920	2,206	-0.4%	-0.4%	-0.5%	3.193	1,870	2,162	-1.4%	-1.1%	-1.5%
PHYSICAL ACTIVITY	Social marketing for physical activity	1	2.652	1,924	2,211	-0.2%	-0.2%	-0.2%	3.213	1,885	2,181	-0.6%	-0.5%	-0.7%
	Access to physical activity	1	2.635	1,910	2,192	-0.9%	-0.8%	-1.1%	3.160	1,841	2,125	-3.0%	-2.1%	-3.2%
WEIGHT LOSS	Weight loss services marketing	1	2.656	1,927	2,219	-0.1%	0.0%	0.1%	3.225	1,894	2,196	-0.2%	-0.1%	0.0%
	Access to weight loss services	1	2.654	1,925	2,229	-0.2%	-0.1%	0.6%	3.213	1,884	2,197	-0.7%	-0.5%	0.0%
TOBACCO	Social marketing against smoking	1	2.617	1,810	2,097	-6.1%	-1.5%	-5.4%	3.142	1,629	1,928	-14.1%	-2.7%	-12.2%
	Tobacco tax & sales restrict	1	2.627	1,862	2,149	-3.4%	-1.1%	-3.0%	3.177	1,754	2,053	-7.5%	-1.6%	-6.5%
	Smoke quit services marketing	1	2.653	1,923	2,215	-0.3%	-0.2%	0.0%	3.223	1,888	2,190	-0.5%	-0.2%	-0.3%
	Access to smoke quit services	1	2.647	1,916	2,213	-0.6%	-0.4%	-0.1%	3.216	1,875	2,181	-1.2%	-0.4%	-0.7%
AIR QUALITY	Air pollution multiplier	0.5	2.531	1,876	2,165	-2.7%	-4.7%	-2.3%	3.135	1,860	2,163	-2.0%	-2.9%	-1.5%
	Workplaces allowing smoking multiplier	0	2.644	1,906	2,194	-1.1%	-0.5%	-1.0%	3.218	1,860	2,160	-2.0%	-0.3%	-1.6%
STRESS	Multiplier on sources of stress	0.5	2.643	1,916	2,185	-0.6%	-0.5%	-1.4%	3.2	1,868	2,145	-1.5%	-0.9%	-2.3%
	Access on mental health services	1	2.655	1,926	2,311	-0.1%	-0.1%	4.3%	3.224	1,892	2,288	-0.3%	-0.1%	4.2%
	Mental health services marketing	1	2.657	1,928	2,223	0.0%	0.0%	0.3%	3.227	1,896	2,203	-0.1%	0.0%	0.3%

Effective Interventions for United States

	Biggest Impact After 10 years (2015)	Biggest Impact After 35 years (2040)
CVD Deaths Per 1000	1. Quality of Primary Care (-5.5%) 2. Air Pollution Multiplier (-4.7%) 3. Access to Primary Care (-2.7%) 4. Social Mktg Anti-Smoking (-1.5%) 5. Tobacco Tax and Sales Restrictions (-1.1%)	1. Quality of Primary Care (-4.3%) 2. Air Pollution Multiplier (-2.9%) 3. Social Mktg Anti-Smoking (-2.7%) 4. Access to Physical Activity (-2.1%) 5. Access to Primary Care (-2.1%)
Complication & Management Costs	1. Social Mktg Anti-Smoking (-5.4%) 2. Tobacco Tax & Sales Restrictions (-3.0%) 3. Quality of Primary Care (-1.4%) 4. Air Pollution Multiplier (-2.4%) 5. Stress Reduction (-1.4%)	1. Social Mktg Anti-Smoking (-12.2%) 2. Tobacco Tax and Sales Restrictions (-6.5%) 3. Access to Physical Activity (-3.2%) 4. Stress Reduction (-2.3%) 5. Access to Healthy Diet (-1.5%)

Effective Interventions for United States

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Interventions: Quick vs Long-term Impact

Quick Impact:

- Increase Primary Care Quality from 54% to 75%
- Cut Air Pollution by half

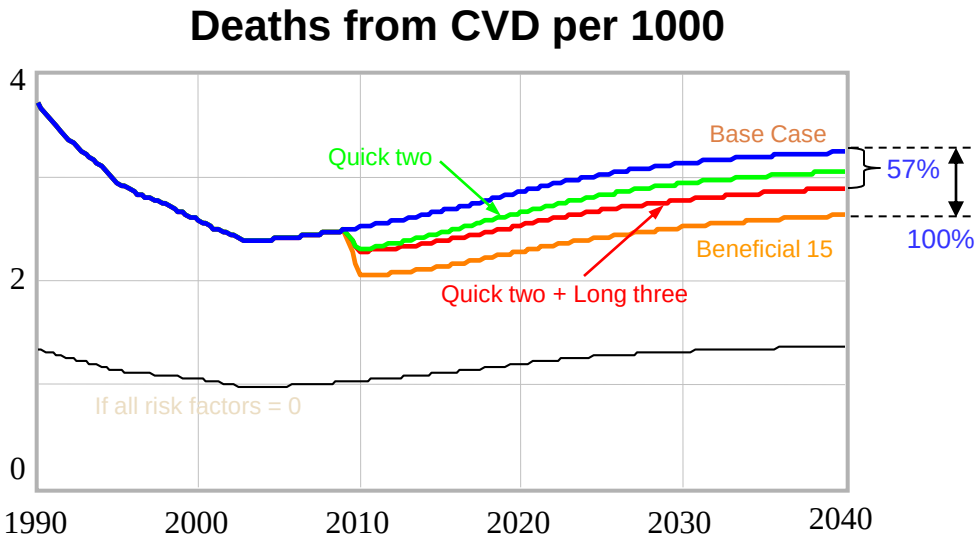
Impact takes longer:

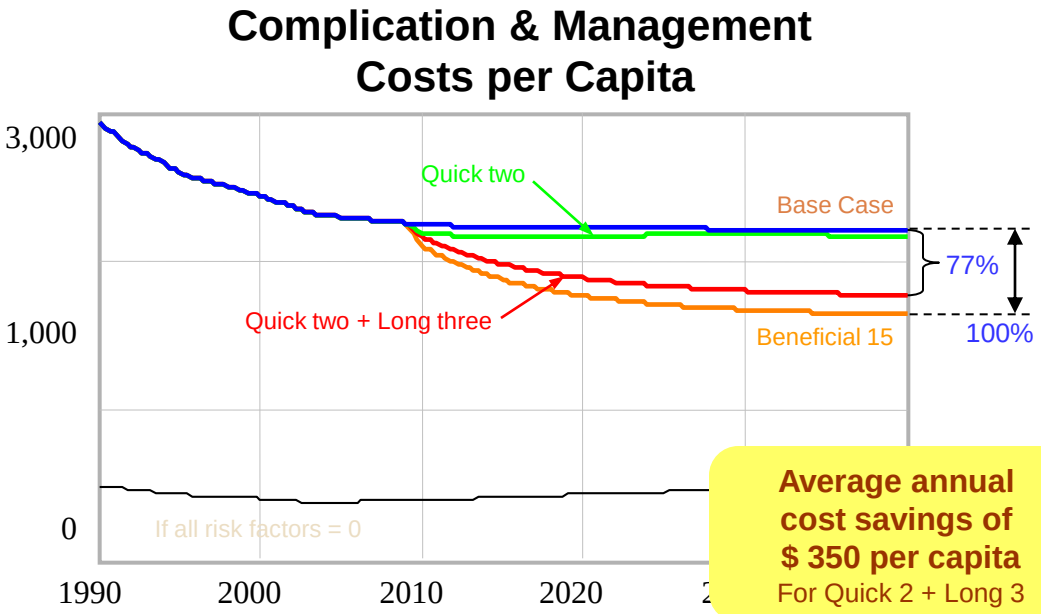
- Increase Social Marketing Against Tobacco from 0 to 100% of maximum.
- Increase Tobacco Tax and Sales Restrictions from 50% to 100%
- Increase Access to Physical Activity from 70% to 100%

These five interventions would provide:

~ 77% of cost savings achieved by 15 interventions

~ 57% of mortality reduction





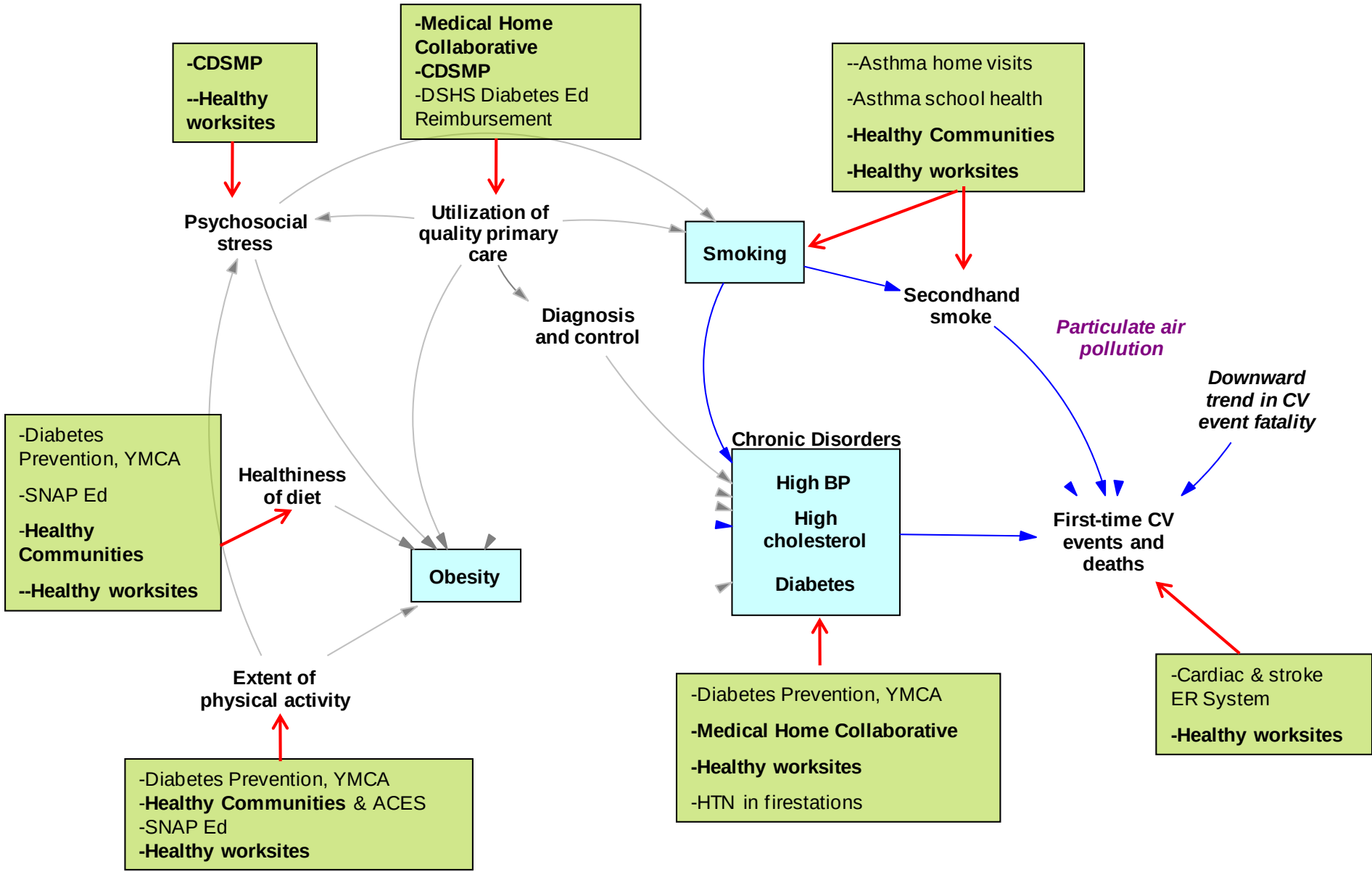
Average annual cost savings of $ 350 per capita
For Quick 2 + Long 3

Washington Chronic Disease Prevention Unit

- Purpose:
  - Use SDM to facilitate planning in an integrated chronic disease prevention unit
- Audience:
  - CDPU Director, Managers and staff from Asthma, Diabetes, Heart Disease and Stroke, Nutrition & Physical Activity programs
- Time: multiple sessions, including day-long PRISM training at NACDD Academy
- Format: Facilitated discussion, small group work over 3 years

- Results
  - Overlaid current work on our Map to see where current work is focused
  - Defined our desired future & Brainstormed potential strategies to impact levers
- Lesson Learned: SDM shows how our work may be strategically aligned to impact levers most effectively

How CDPU addresses factors in the PRISM SDM



Contact Information

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