

Assessing and Forecasting Population Health

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UCLA



HEALTH FORECASTING AT UCLA

Health Forecasting is

- a sister project of Health Impact Assessment, both based at the UCLA School of Public Health
- a collaborative effort between UCLA, Los Angeles County Department of Public Health, California Department of Public Health
- conceived and principally led by Dr Fielding
- fully supported by foundation grants, supporting a small staff of 1-3 researchers

Funding from

- The California Endowment
- The Robert Johnson Foundation
- UniHealth Foundation (local Los Angeles foundation supporting hospitals)
- Placer County (small county in California)

Target audience

- Local Health Departments
- Foundations
- Legislators and legislative analysts
- Advocacy groups

DEVELOPING A CALIFORNIA HEALTH FORECAST

Need for health forecasting...

- Policy makers want to know the likely effects of possible laws, regulations, programs and other actions on health of the population over time
- Large disparities in health outcomes—limited knowledge on how policy decisions affect these
- Health providers and health agencies need info on health trends and changes in disease burdens
- No other authoritative source of information on key health trends
- California rapidly changing unique socio-demographic population mix

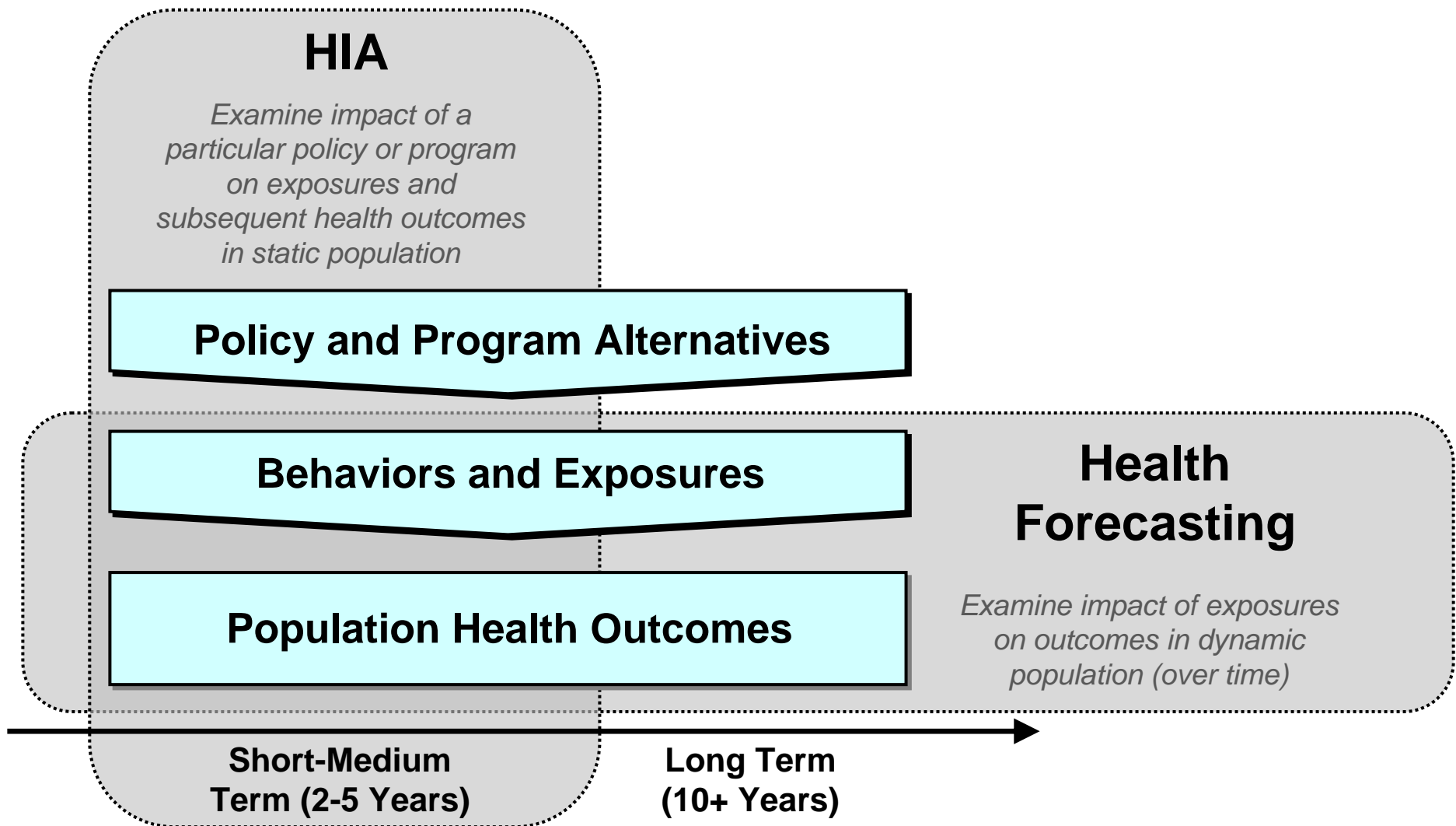
...and improved modeling capability...

- Advances in data collection, such as the California Health Interview Survey and Los Angeles County Health Survey
- Increased computing capability --allows for cost effective micro-simulation models
- More epidemiological studies to support modeling
- Future population health is more easily predicted than outcomes in many other sectors (economics, agriculture, weather etc.)

...provide the right environment for a California Health Forecast

A framework that helps users to anticipate the future impact of current decisions and actions on health outcomes

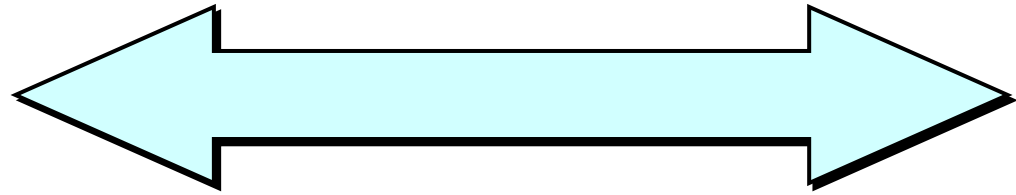
THE RELATION BETWEEN HEALTH IMPACT ASSESSMENT AND HEALTH FORECASTING AT UCLA



COMBINING SCOPE OF HIA AND HEALTH FORECASTING REMAINS A CHALLENGE

**Ad hoc/
Tailored HIA**

**Uniformly
Applicable Model**



**Small/Local
Populations**

**Large/Regional
Populations**

Narrowly targeted programs
Relevant geographic challenges,
e.g. Built Environment
Interactions between individuals
and environment
Need for specifically defined
exposures/risks

Broadly applicable policies
Assume uniformity across regions
Exposures may be averaged

ENABLING DECISION MAKERS TO MAKE MORE INFORMED DECISIONS USING HEALTH FORECASTING

The model aims to allow **decision makers** in health related fields to answers questions at **various levels of detail** – primarily addressing **chronic disease conditions**

How will mortality rates in the state of California (or any county) change over time?

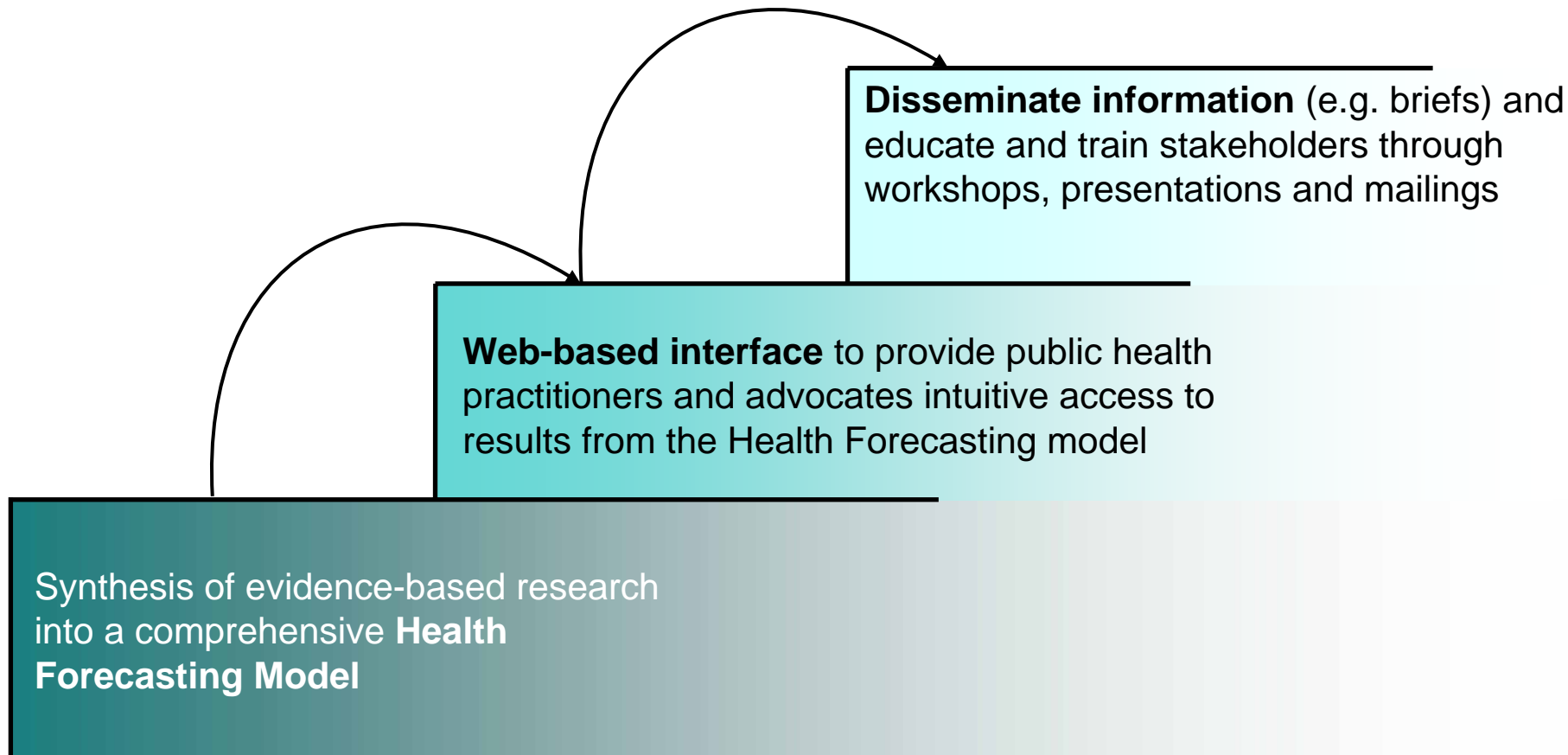
What is the incidence or prevalence of disease X in different counties in California, and how is this expected to change in the next 10 years?

How much of the differences in disease incidence rates and other key health outcomes across ethnic and geographic segments can be attributed to known factors?

10 years from now, what will be the effect of a public health intervention Y on the health outcomes for different ethnic and racial groups in Ventura County and Los Angeles County?

DEVELOPING THE MODEL AND DISSEMINATING THE RESULTS

First we determined feasibility and built a prototype model; disseminating the results has required the development of additional tools



INTUITIVE INTERFACE – ENABLING STAKEHOLDERS TO USE MODEL RESULTS FOR LOCAL POPULATIONS

The full model will be maintained at UCLA by project team – users can request scenarios to be simulated.

A **user friendly interface** that uses static model output to enable users to perform analysis on a local communities or counties. Users may input **community specific demographic information**, and the interface provides tables and graphics based on modeling results.

The **website** is a primary means of wide distribution of tools, results, and analyses

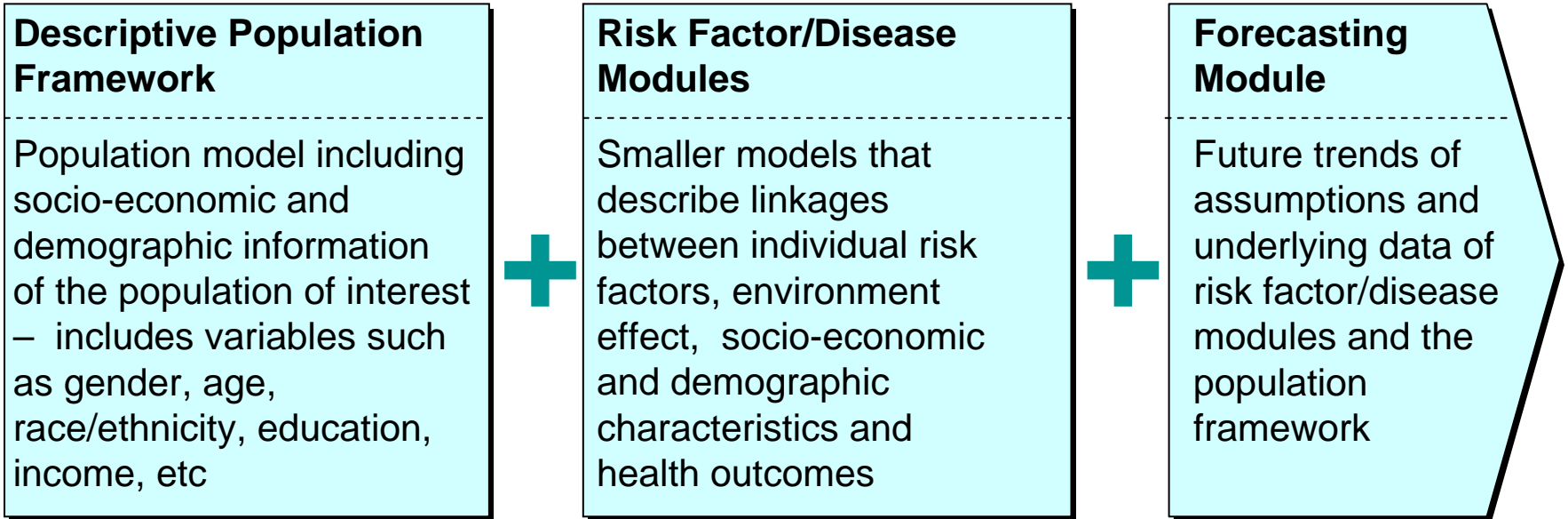
- Baseline forecasts
- Technical documentation
- Simplified version of the model that can be used by local health officers, their staffs and other stakeholders.



APPLICATIONS OF THE FORECASTING MODEL

- **Evaluate research questions about the association between sets of variables that can not be observed directly through surveys, e.g. estimates of life time expenditures associated with levels of physical activity and weight,**
- **Inform debate on important policy issues in public health through issue briefs,**
- **Support community advocacy to strengthen local communities and efforts to improve population health – intuitive access via web-based interface (www.health-forecasting.org), and**
- **Provide analysis on the long term impact of proposed policies and programs.**

BUILDING THE PROTOTYPE MODEL



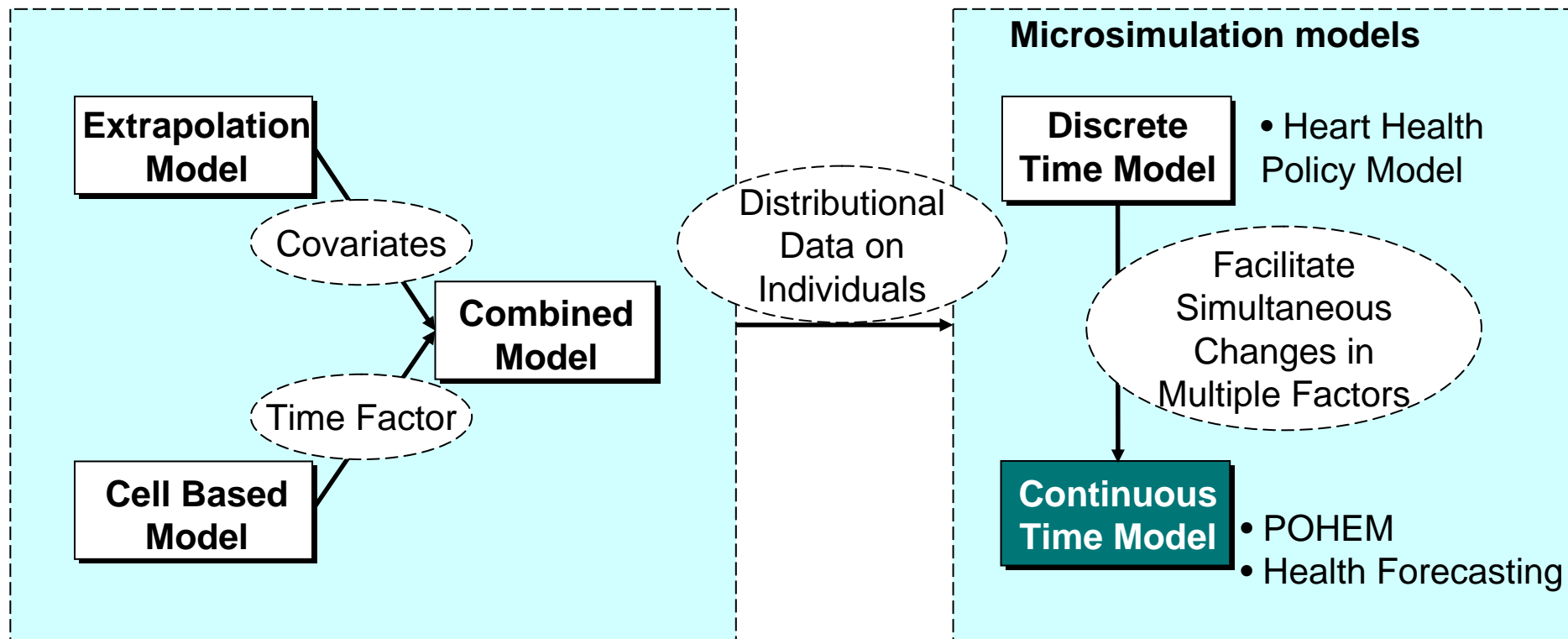
The model is built around a continuous time microsimulation setting, allowing for inclusion of joint distributions as well as analysis of complex interactions, and distributional information on outcomes

The model focuses on the relation between exposures/risk factors and outcomes; no summary statistics. Outcome are disease incidence, prevalence, mortality, etc.

ENABLING SYNTHESIS OF ALL THE DATA AT THE INDIVIDUAL LEVEL WITH MICROSIMULATION

Aggregate Level Models: Information on joint distributions is generally not incorporated into the model, potentially creating bias in the estimates

Individual Level Models: Information on joint distributions can easily be incorporated into the model



○ Data Extension

□ Type of Model – Based on Organization of the Data

PROTOTYPE MODEL: INITIAL COMPONENTS

The Descriptive Population Framework

What will happen to patterns of mortality (and likely disease burden) over time based on substantial changes in demography due to:

- Changes in age distribution of different ethnic/racial groups based on current populations
- Immigration
- Marriage rates
- Birth rates

Risk Factor – Physical Activity and Obesity

Physical Activity and Obesity are risk factors for many chronic diseases. They are associated with each other and each impact morbidity, mortality and related medical outcomes in different ways

Ameliorable through:

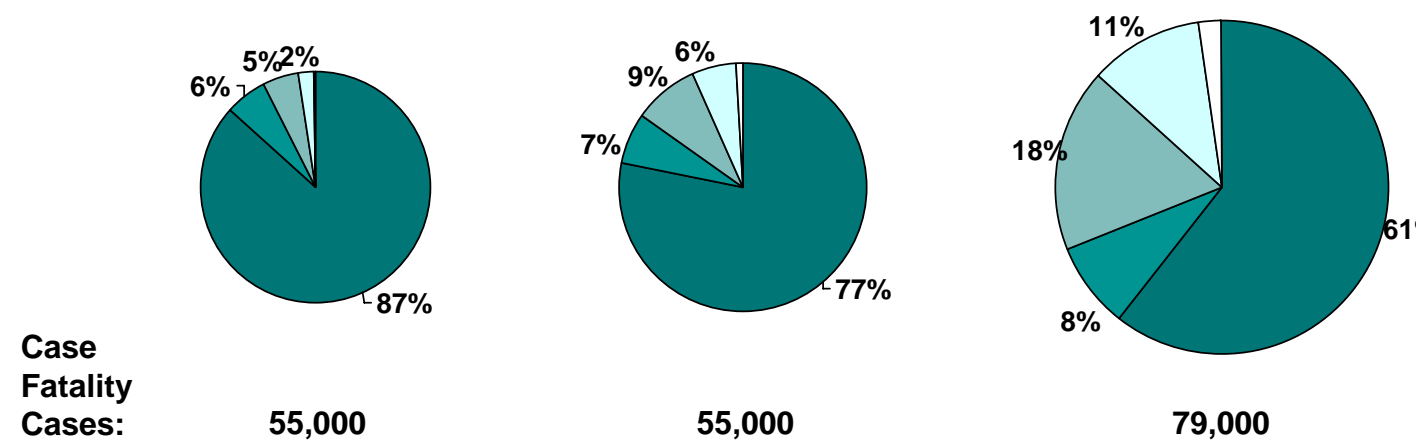
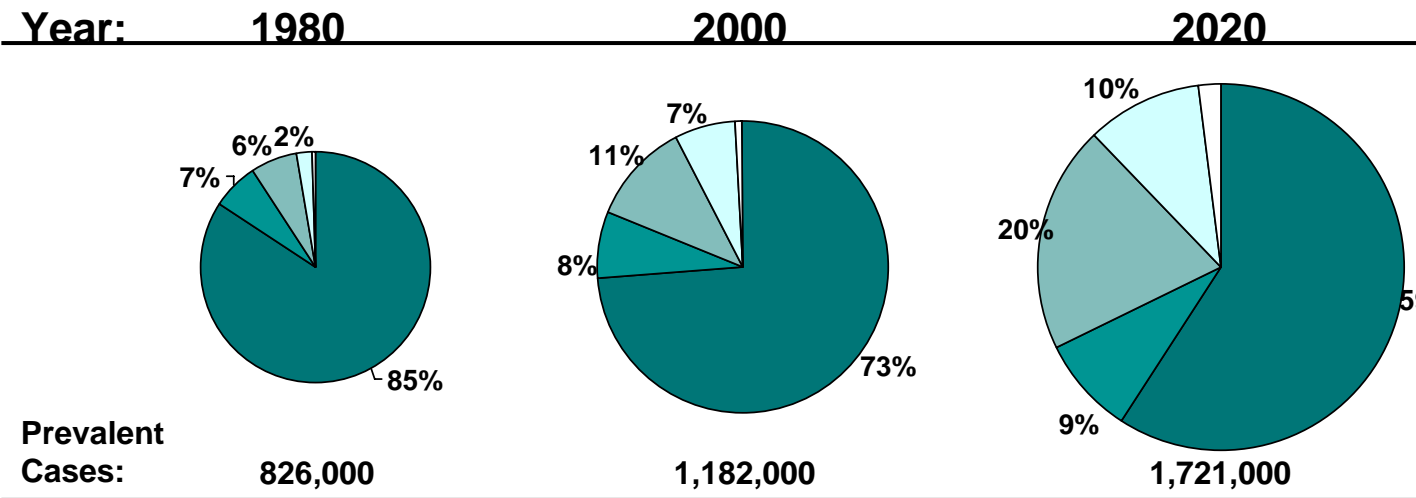
- Individual interventions (medical care system, spas, gyms, home)
- Environmental interventions (worksite, school, community)
- Nutrition interventions

Health Outcomes – Coronary Heart Disease

What is the disease burden of a specific disease on different population groups, and how does this develop over time.

Coronary Heart Disease is the leading cause of death in the United States, while mortality has been reduced significantly during the last 30 years. Still both incidence and mortality can be reduced further through changing people's behavior.

CORONARY HEART DISEASE IS INCREASINGLY IMPACTING AGING MINORITY POPULATIONS



APPLICATIONS OF MODEL

Primary prevention versus treatment – Physical activity and CHD

- Use the model to simulate the impact of different physical activity patterns and levels in the population and compare those to alternative scenarios that target a reduction in case fatality
- Objective is to show the impact of different approaches on CHD incidence, prevalence and case mortality as well as mortality from other causes
- Using the model show that small improvements in physical activity improves mortality (life expectancy), reduces disease (CHD), and increases years lived without CHD; reduction in case fatality rates improves mortality, but increases prevalence, and does no change years lived without CHD

Address impact of Ozone and PM2.5 on local population health

- Placer County DHS(~300,000 people, east of Sacramento, CA) requested the assessment of the impact of changes in Ozone and PM2.5 on population health to support advocacy
- Simulated air quality data and changes in O3 and PM2.5 under different scenario, and impact on asthma, other health outcomes, but also missed days of school and missed days of work

VALIDATION AND SENSITIVITY

Validation

- Limited experience validating the forecasting component of the model, however model can be updated as new data becomes available. E.g. estimates for CHD incidence and prevalence were based on data through 2001, and incorporated into model in 2003/2004; however new data released in 2005 showed a marked reduction in CHD incidence as well as CHD case fatality requiring revision to underlying to rates
- The risk factor component of the model have been cross validate with other models where relevant

Sensitivity

- Users of the model have rarely requested sensitivity analyses of the results; generally this is done in the form of simulating different what-if scenarios
- Uncertainty on the parameters can be incorporated by multivariate sampling on the parameters domain

BARRIER FREE HOMES

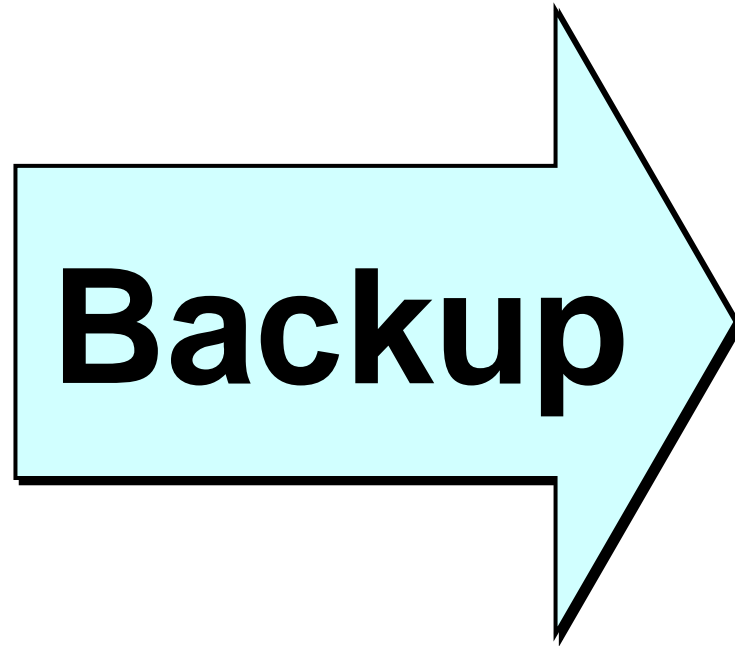
Case analysis of increase of number of people living in a barrier free home

For simple case would need:

- 'Exposure' -> probability of living in a barrier free home, versus a regular home
- Risk of a fall conditional on type of home (or total falls and relative risk)
- Scenario -> probability of living a barrier free home in the case scenario
- Mortality conditional on fall (optional)

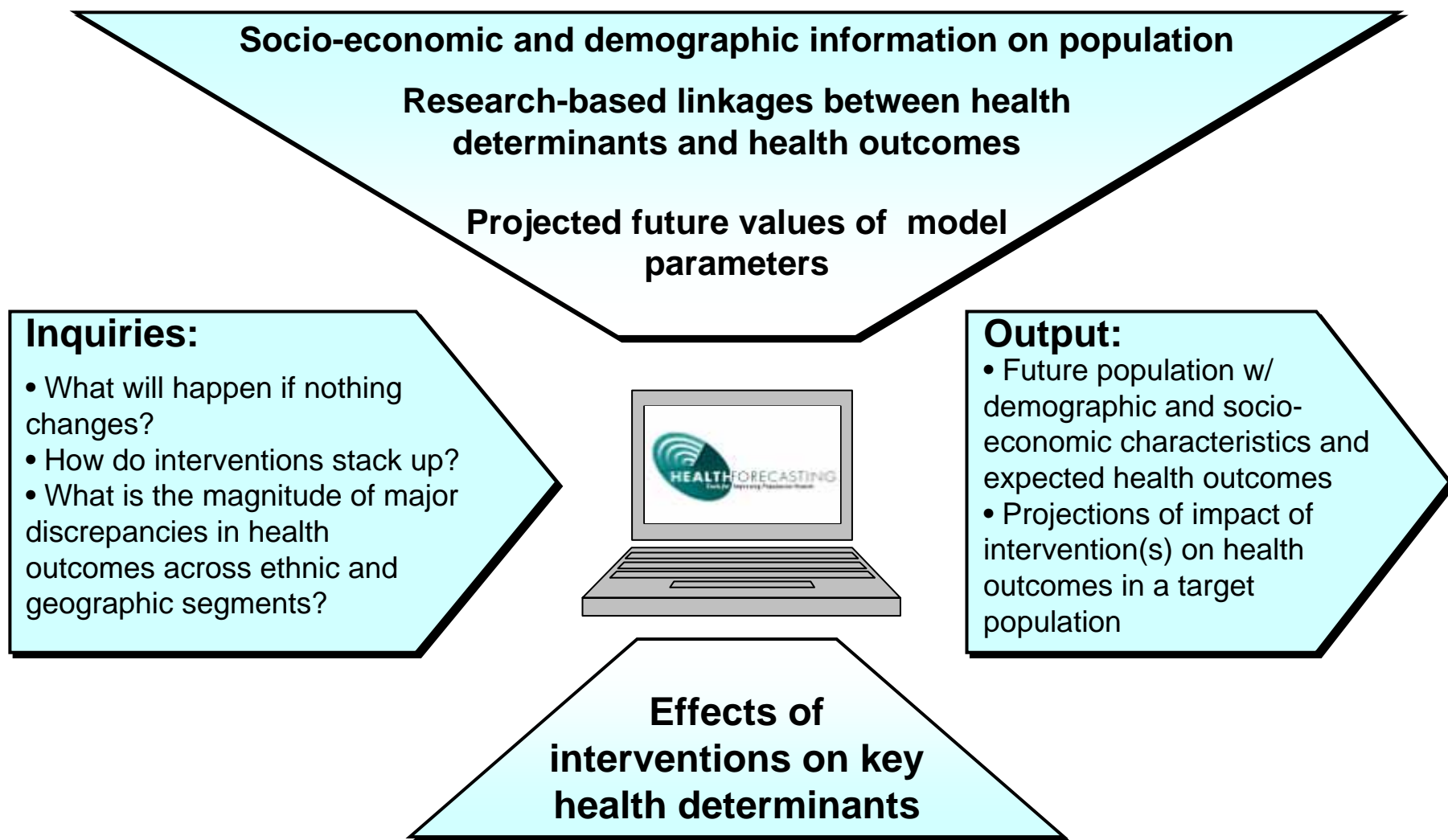
Simulation would generate

- Number of falls in each year for reference as well as the scenario
- Number of deaths for reference as well as the scenario
- Related outcomes



Backup

HEALTH FORECASTING – A TOOL FOR HEALTH IMPACT ASSESSMENT IN A DYNAMIC ENVIRONMENT



EXAMPLE – MODELLING THE IMPACT OF OBESITY ON MEDICAL EXPENDITURES

Overweight and Obesity in California

Observations

- BMI levels have increased steadily since the early 1980s
- Increases are seen among all groups but are most pronounced among younger people and Latinos
- Individual BMI levels are highly correlated over time
- BMI and Physical Activity are negatively correlated



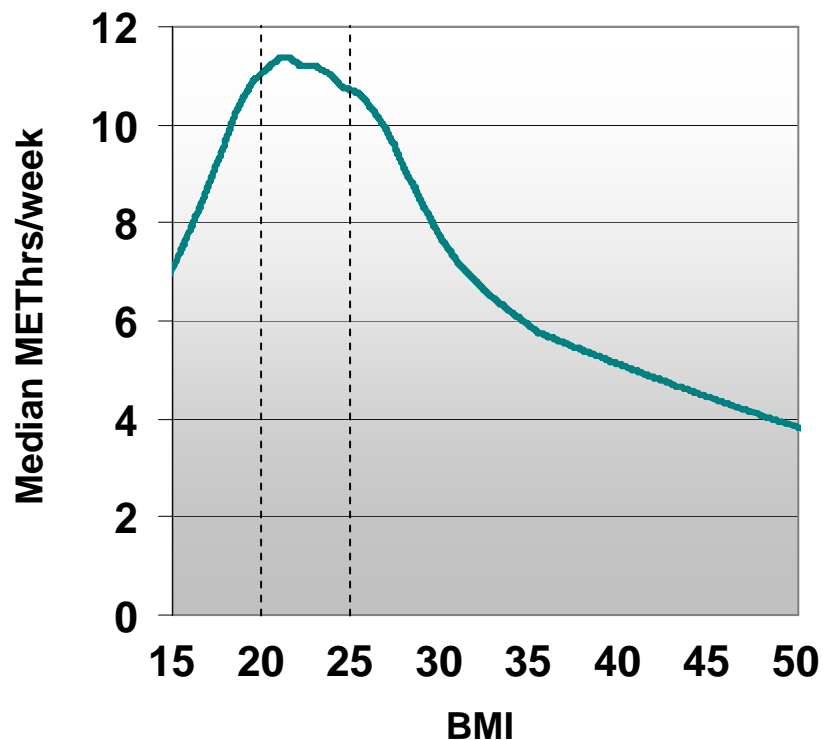
Model Implementation

- Individual BMI levels are determined by gender, ethnicity, age, previous BMI and Physical Activity
- BMI impacts mortality through a relative risk function derived from the literature. RR of BMI on mortality decreases as age increases and are gender specific
- BMI trends in the model with three scenarios
 1. Decline to 1984 levels by 2025
 2. Stable at 2005 levels
 3. Continued increase through 2025

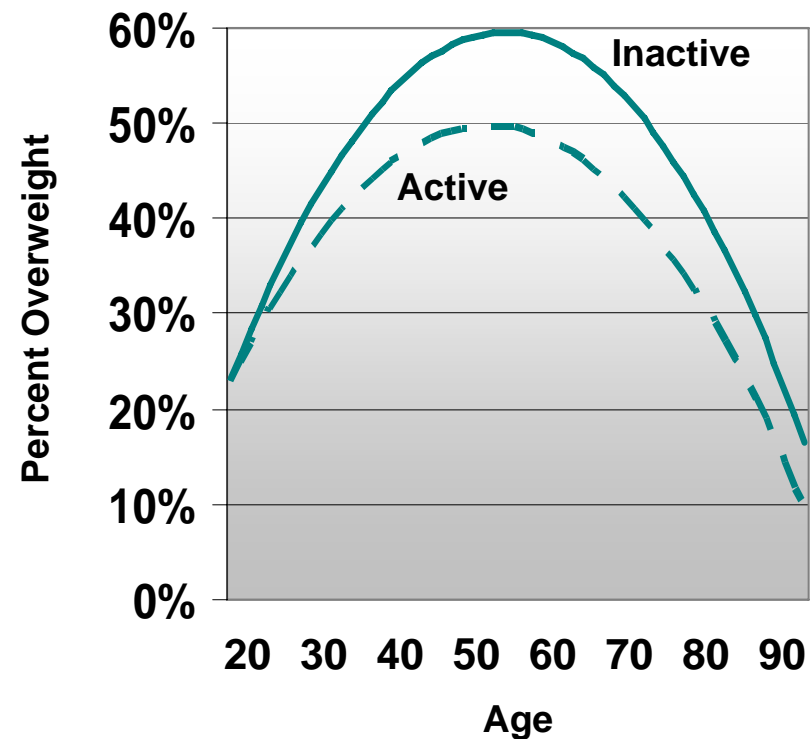
EXAMPLE - PHYSICAL ACTIVITY AND OBESITY ARE NOT INDEPENDENT

Any intervention targeting physical activity or obesity should take into account the association between these two behaviors. The population health forecasting model explicitly enables users to explore the joint distribution and the joint impact on health outcomes

People with healthy BMI have higher levels of Physical Activity:



People with low levels of Physical Activity (<8 METhrs/wk) are more likely to be overweight:



EXAMPLE – MODELLING THE IMPACT OF OBESITY ON MEDICAL EXPENDITURES (CONTINUED)

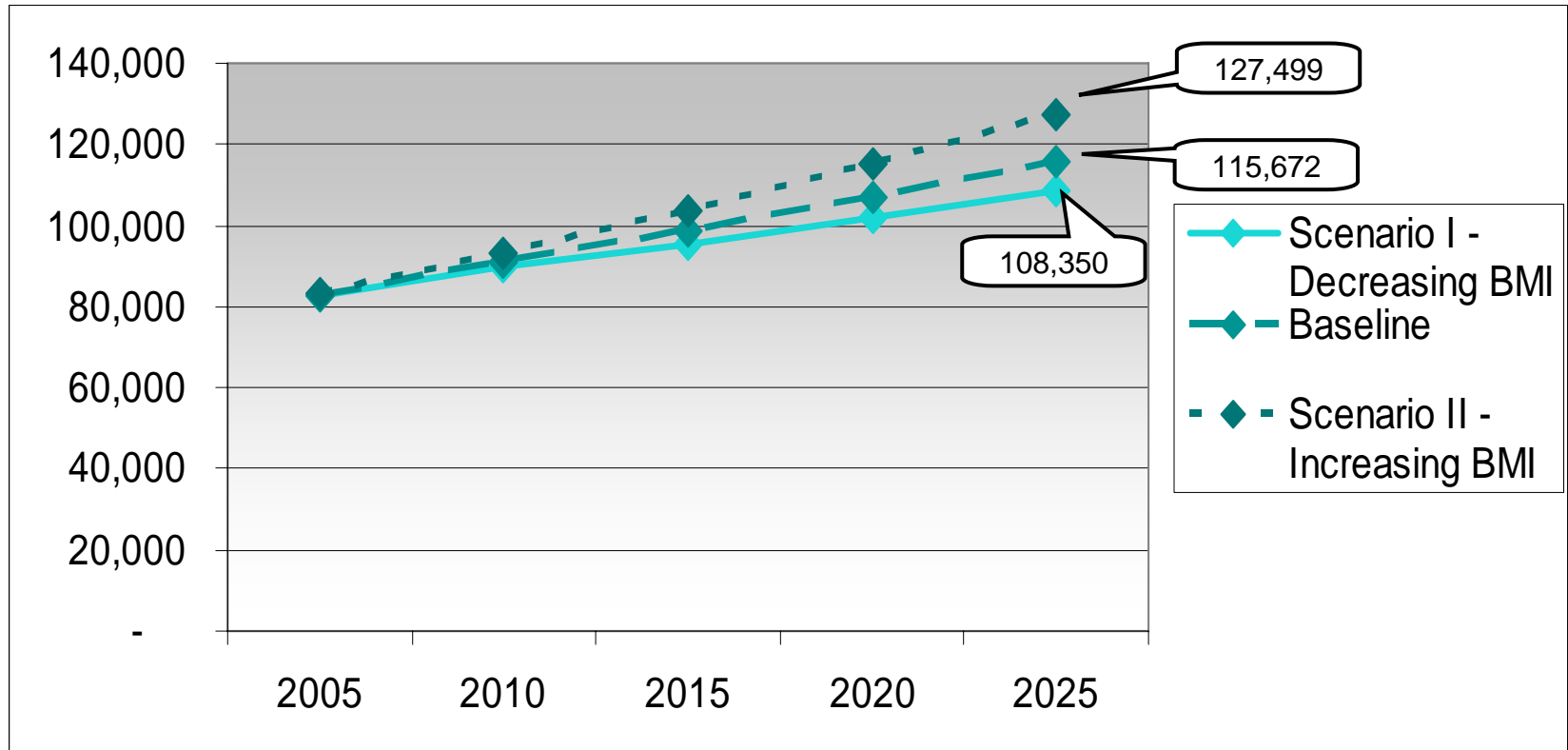
Medical Expenditures associated with Obesity and Physical Activity

- Direct Personal Medical Expenditures associated with Obesity and Physical Activity are estimated using NHIS data linked with data from the Medical Expenditure Panel Survey 1998-2005
- Medical expenditures are significantly higher for Obese people (BMI>30) among the under 65 population, and significantly higher for Overweight and Obese people (BMI>25) among the over 65 population.
- Medical expenditures are significantly lower for people over 65 with recommended levels of Physical Activity (>16 METhrs/wk)
- The simulation model allows researchers to analyze expenditures as BMI and PA levels change for each individual from year to year, thus enabling analysis of lifetime medical expenditures

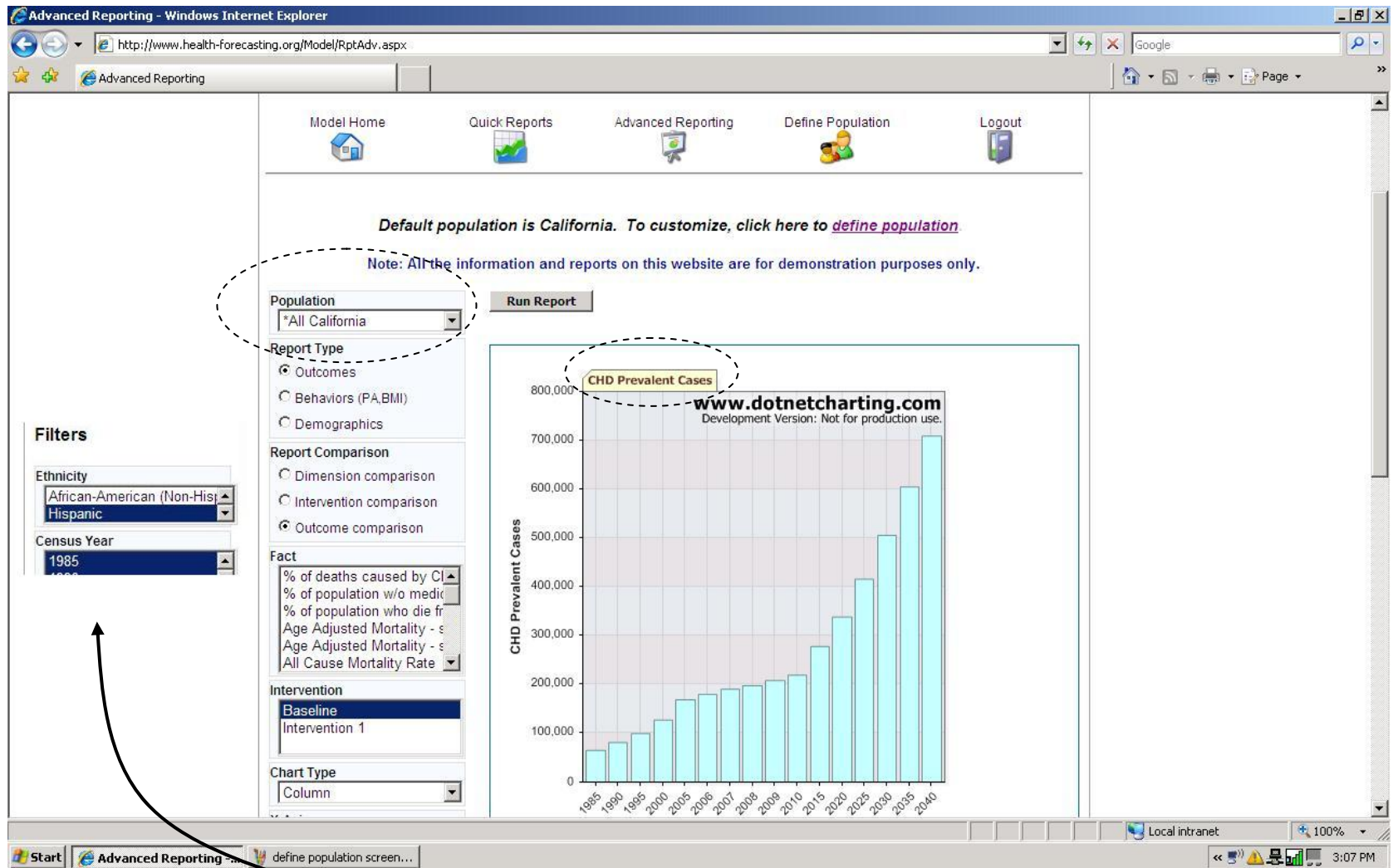
EXAMPLE - FURTHER INCREASES IN BMI COULD COST CALIFORNIANS AN ADDITIONAL \$12 BILLION IN DIRECT PERSONAL MEDICAL EXPENDITURES ANNUALLY BY 2025

Total direct personal medical expenditures*, age 18+ (2003 \$000,000)

Direct personal medical expenditures for the non-institutionalized population make up about 50-55% of total medical expenditures as defined by the National Health Accounts



USER FRIENDLY INTERFACE – FORECAST OUTCOMES FOR SPECIFIC POPULATIONS



USER FRIENDLY INTERFACE – COMPARE OUTCOMES ACROSS DIMENSIONS

