



PARDEE RAND GRADUATE SCHOOL

Estimating the Costs of Childhood Obesity Over the Lifecycle

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Outline

- Background
- Conceptual Model and Components (3)
- Preliminary Findings
- Sensitivity Analyses and Conclusions

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Obesity is a Population-Wide Concern

- Weight gain has increased across *all* major population subgroups
 - Racial/ethnic groups, educational attainment, age
- Among elementary school-aged children in the US:
 - ~ 1 out of every 5 is obese (Ogden, 2008)
 - Higher incidence among Black females and Hispanic males
- Lifestyle and environment play key roles
 - Diet
 - Physical activity



The Associated Costs are Twofold

- Current costs
 - Psychosocial (Dietz, 1998)
 - Heightened disease risk
 - Asthma, diabetes, hypertension
 - Hospital visits (Hemph, 2007; Wang & Dietz, 2002)

- Future costs → *policy concern*
 - Irreversibility
 - Disease burden
 - Heart disease, type 2 diabetes, hypertension, depression, stroke, and osteoarthritis
 - Health care costs

Cost Estimates Can Inform Resource Allocation

- Environmental interventions
 - Location (school or home)
 - Alter choices regarding diet and physical activity
 - Restrict or expand choice set (junk food bans)
 - Increase accessibility (community-school partnerships)
 - Provide information (BMI report card)

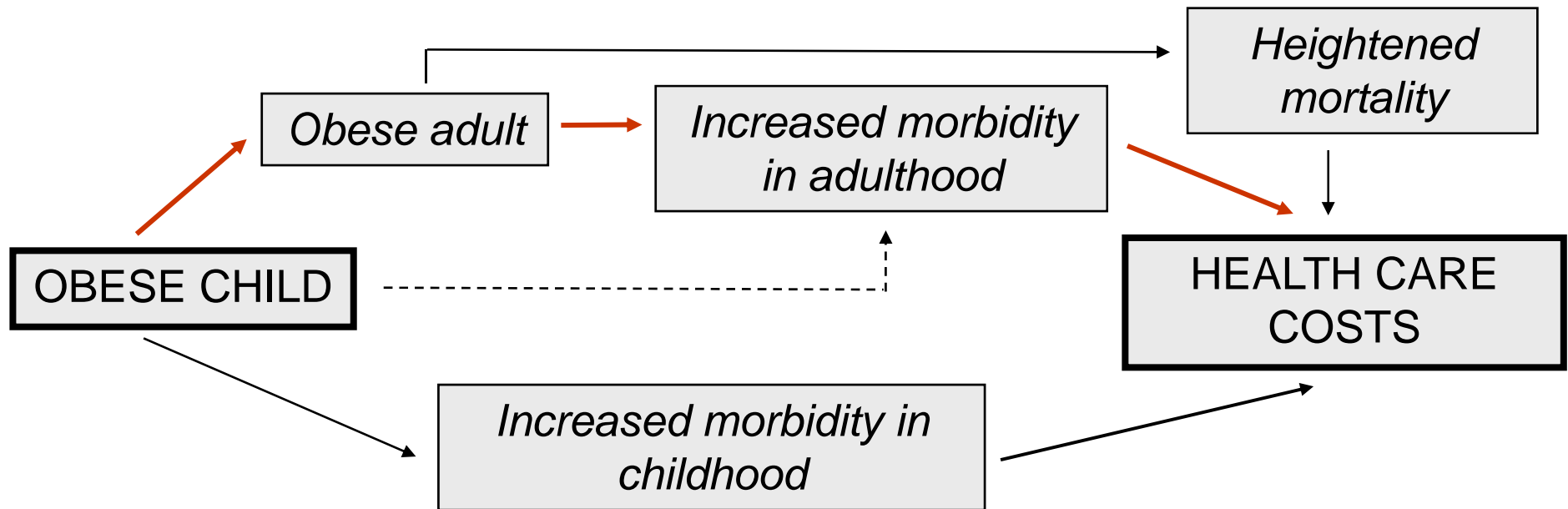
- Approaches to evaluation
 - Return on investment
 - Cost-effectiveness
 - Disease prevention programs particularly difficult
 - Costs incurred upfront
 - Morbidity reductions accrue later (Cawley, 2007)

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Objectives and Conceptual Model

- Translate obesity burden among elementary school population ages 6-11 to lifetime health care costs
- What are the additional lifetime health care costs an obese child will incur relative to a lean child?



Overview of Simulation Model

- Three components
 - A. Project cohort until death (**life table**)
 - B. Tracking of childhood obesity to adult obesity (**epidemiology studies**)
 - C. Additional health care costs of being obese relative to being lean (**economics studies**)
- Obtaining lit review estimates (B. and C.)
 - Lowest common denominator used to make estimates comparable
 - More confidence given to estimates based on a larger set of studies

Overview of Simulation Model (cont'd)

- Incorporating lit review estimates into model
 - Triangular distribution used for B. and C.
 - Minimum, maximum and “best guess” estimates
 - Estimates by age for C

- Population subgroups
 - Overall
 - Gender
 - Race (White, Black and Other)

- Monte Carlo simulation
 - Three components pulled together
 - Simulation run 10,000 times for each estimate

Obesity Definitions

- BMI is metric for both adults and children
- Alternative measures include skinfold and body fat %
- For adults:
 - Obese: $BMI \geq 30$
 - Overweight: $BMI \geq 25$ and $BMI < 30$
 - Lean: $BMI < 25$
- For children:
 - CDC and IOTF
 - Age- and gender-specific percentiles
 - Obese: $BMI \geq 95^{\text{th}}$ percentile
 - Overweight: 85^{th} percentile $\leq BMI \leq 95^{\text{th}}$ percentile
 - Lean: $BMI < 85^{\text{th}}$ percentile

Key Assumptions for Initial Model

- CDC definitions of obesity based on BMI are valid
 - Lean (Underweight and normal), overweight and obese
- Mortality risk the same for obese and lean individuals
- Obese adults remain obese until death
- Costs associated with obesity are the same in 2008 as in the future

Component 1-3: Projection of the Base Sample

1-3: Population: 6-11 Year Olds in 2003

			Obese, % **	
		Population (mil)*	CDC	IOTF
Boys:	White	19.2	18.5	12.1
	Black	3.9	18.6	14.3
	Other	1.9	15.5	12.7
	Total	25.0	18.3	12.5
Girls:	White	18.2	15.4	13.4
	Black	3.8	23.7	20.8
	Other	1.9	6.0	3.1
	Total	23.9	16.0	13.7

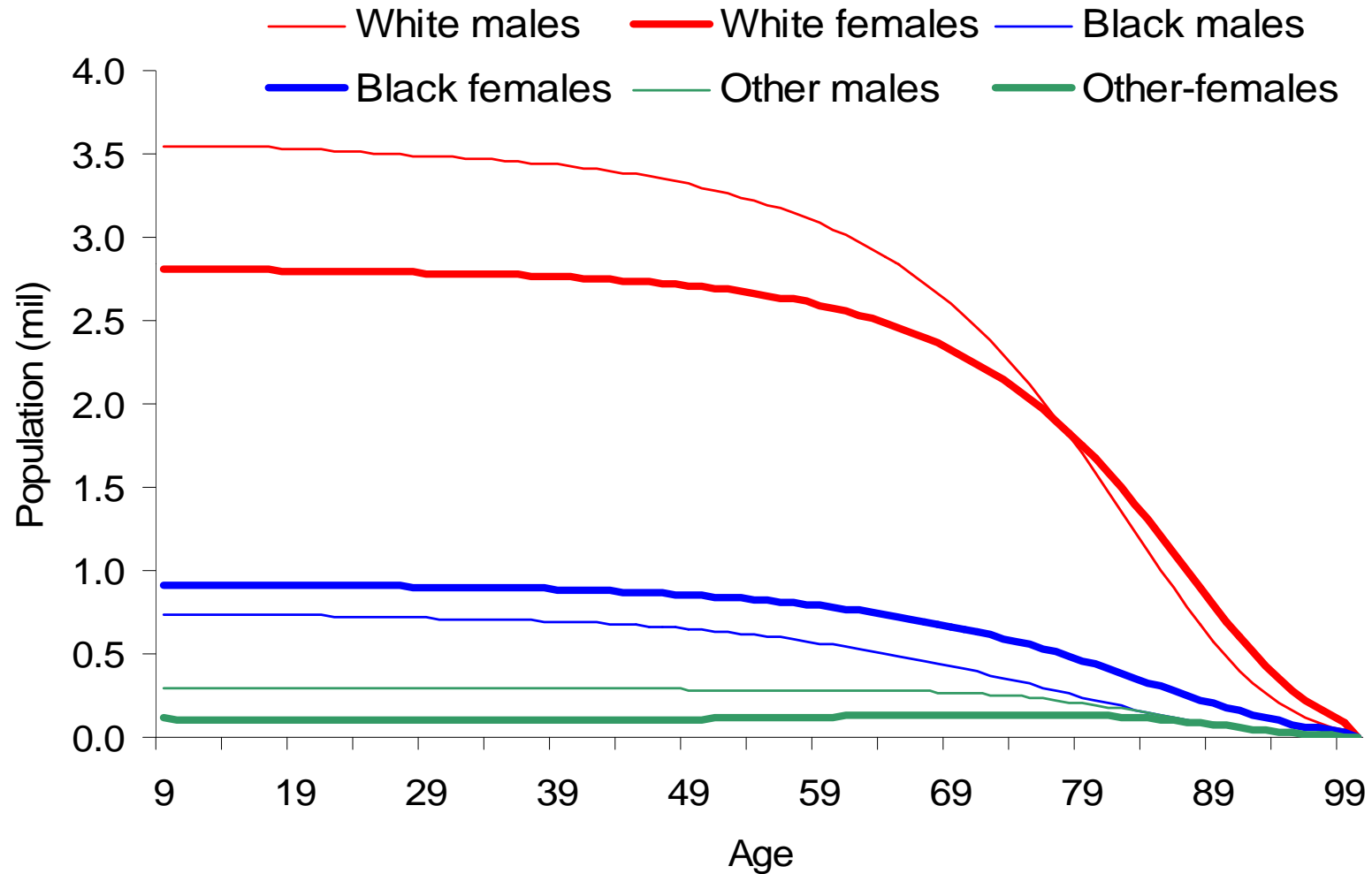
* Census 2008 projections. White includes Hispanics.

** Estimated from NHANES 2001-2006; height and weight are measured.

1-3: Life Table

- Used life table for 9 year olds in 2003
 - Mortality rates are age, gender and race-specific
 - Accounts for historical obesity levels
- Rates applied separately to obese and lean sub-groups
- Everyone dies by age 100

1-3: Projection of Obese Children (CDC)



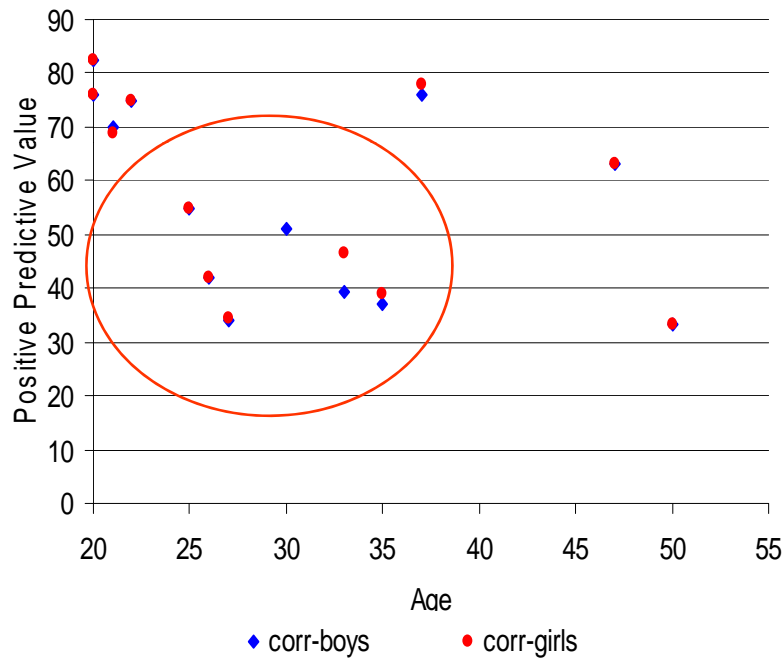
Component 2-3: Tracking of Childhood Obesity to Adult Obesity

2-3: Methodology

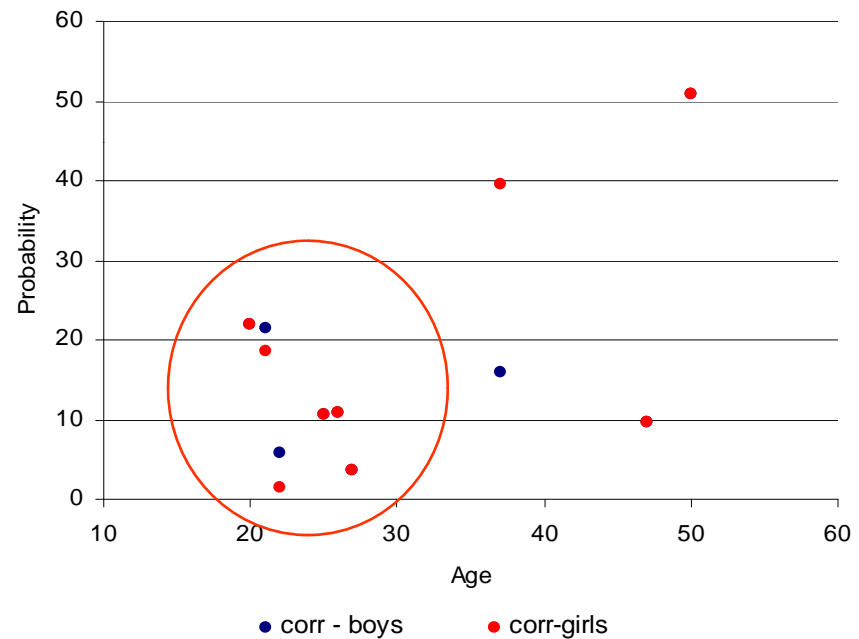
- Reviewed prospective epidemiological studies of obesity trajectory
(Bogalusa, AGAHLS, Harvard Growth Study, Berkeley Study)
- Collected estimates for two parameters
 - Probability of being obese as an adult (age 30) given obese as a child $\rightarrow P(\text{Ob}_A | \text{Ob}_C)$
 - Probability of being obese as an adult (age 30) given lean as a child $\rightarrow P(\text{Ob}_A | \text{not Ob}_C)$
- Obesity does not entail substantially higher costs until age 30
(Finkelstein, 2006; Wee, 2005)

2-3: Estimates from Tracking Studies

$P(O_A | O_C)$:



$P(O_A | \text{not } O_C)$:



2-3: Tracking Inputs for the Model

$P(O_A | O_C)$:

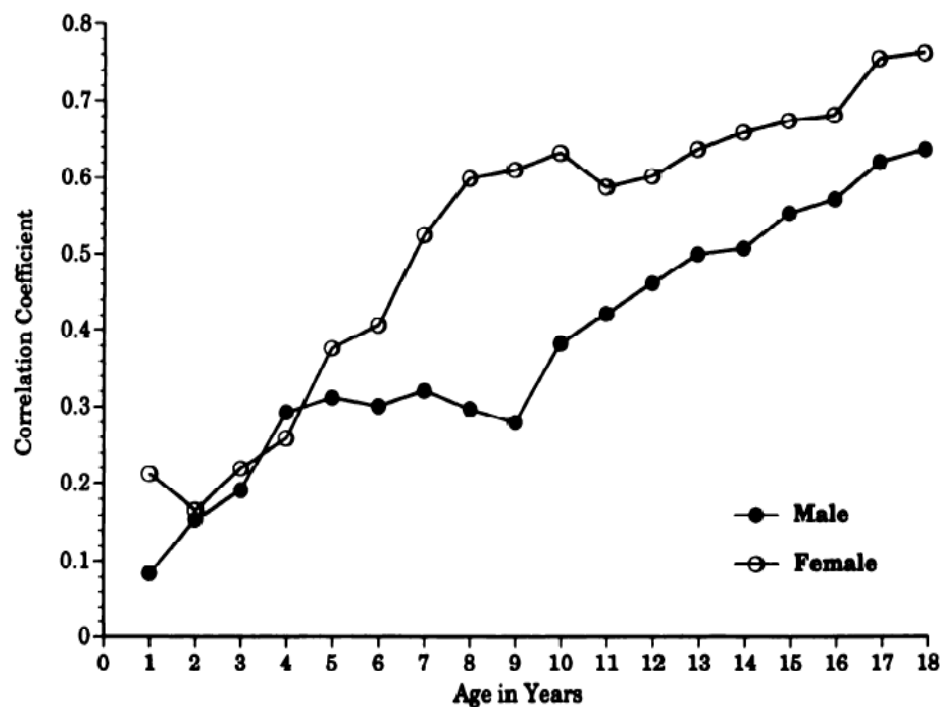
	Low	High	“Best Guess”	# Studies	<i>Simulated Value</i>
Boys	34%	76%	56%	11/13	61.2%
Girls	34%	78%	57%	11/13	62.3%

$P(O_A | \text{not } O_C)$:

	Low	High	“Best Guess”	# Studies	<i>Simulated Value</i>
Boys	4%	22%	13%	8/13	8.5%
Girls	2%	40%	15%	8/13	9.6%

2-3: Considerations to Incorporate

- Translating correlations to probabilities
 - Assume obesity distributions are normal and simulate
 - Estimate probabilities
- Linear trajectory from age 9 to age 30 assumed



(from Guo et al, 1994)

Component 3-3: Health Care Cost Estimates by Age

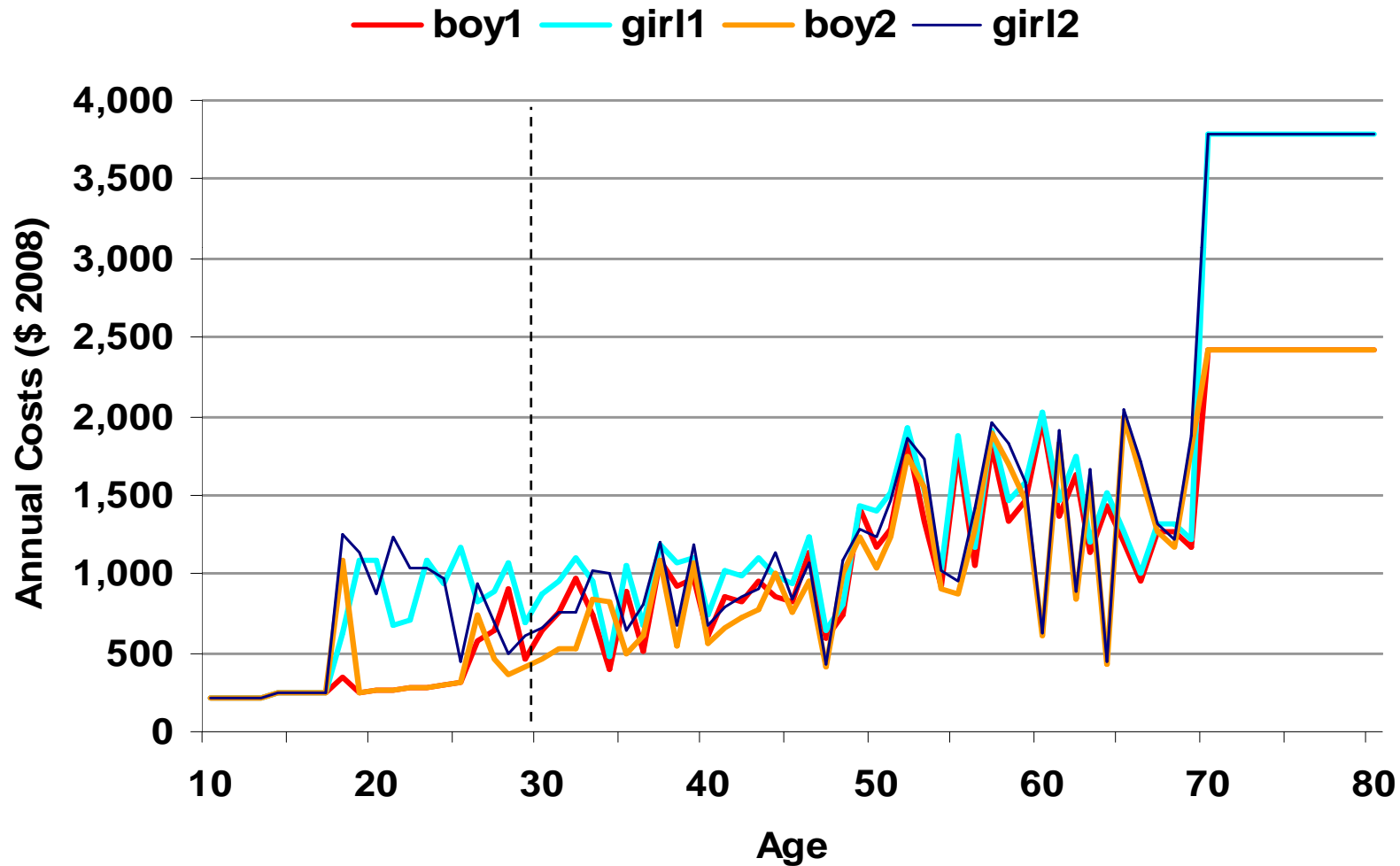
3-3. Methodology

- 14 studies with per-capita annual costs
 - Patient level costs, nationally-representative, less representative (Tsai, working paper)
 - Attributable risk studies not included
 - Medical Expenditures Panel Survey (MEPS)
- Major differences include:
 - Disease adjustment and/or prescription drugs
 - Cross-sectional or prospective design
- Adjusted to \$ 2008 with medical CPI
- Lifetime costs discounted at 3%

3-3: Cost Estimates Obtained

- Collected estimates by gender and race
- Average across studies used for ages 9-14 and 70+
 - Few studies or prospective design
 - Gender differences for 70+ (Wee, 2005)
- Triangular distribution for ages 14-70
 - Low, high and “best guess”
 - Estimates from Eric Finkelstein used as “best guess” for overall and race and gender
 - Cost estimates randomly drawn from distribution for each age
- Lifetime costs are costs for each age summed over lifespan

3-3. Additional HC Costs Incurred by Obese Children



3-3: Considerations to Incorporate

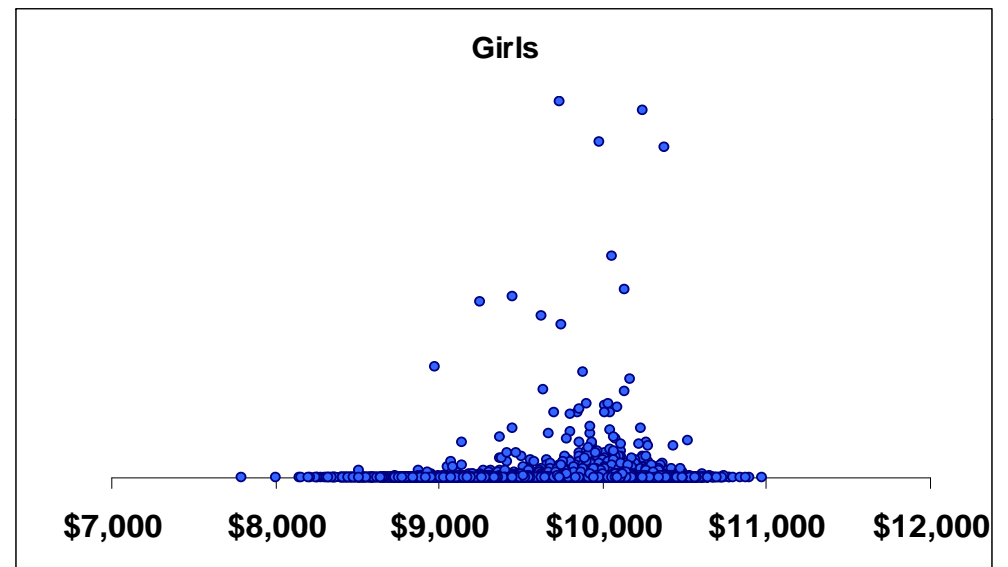
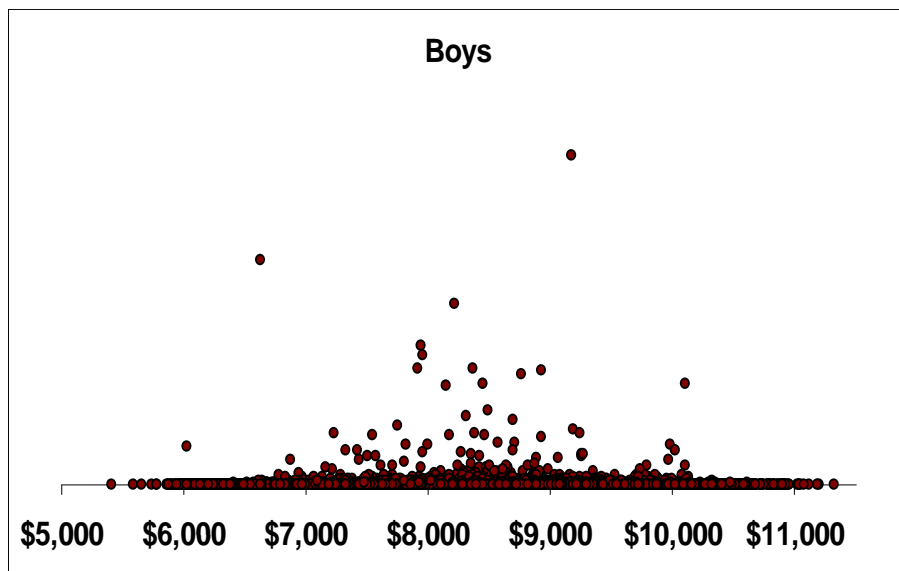
- Correlation of costs over time for an individual
 - Assumed to be 0 conditional on obesity status
 - Between 0 and 1 is more realistic
 - Perhaps age-dependent
- Model costs of overweight separately from obesity
- May draw in QALY/DALY literature

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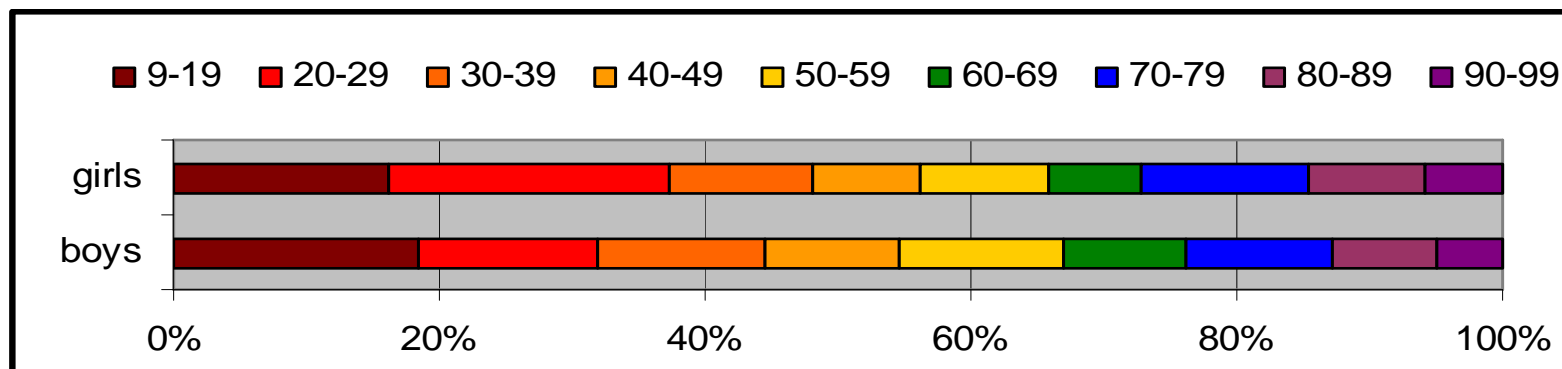
Depiction of Simulated Results

Additional health care costs incurred by an obese child from age 30 until death:



Obese Children Face Higher Lifetime HC Costs

		Lifetime Costs (\$)	St Dev
Ages 30+			
	Boys	\$8,399	\$1,017
	Girls	\$9,812	\$433
All Ages			
	Boys	\$12,047	\$1,178
	Girls	\$15,639	\$596



Overall Burden

- If obese children ages 6-11 were lean, we could expect savings of ~\$115 billion
- An obese girl incurs 3.5 times more in lifetime costs than a lean girl
- An obese boy incurs 4.9 times more than a lean boy

	Cost Burden (\$ mil)	Population (mil)	
		Obese	Lean
Boys	55,156	4.6	20.5
Girls	59,562	3.8	20.1

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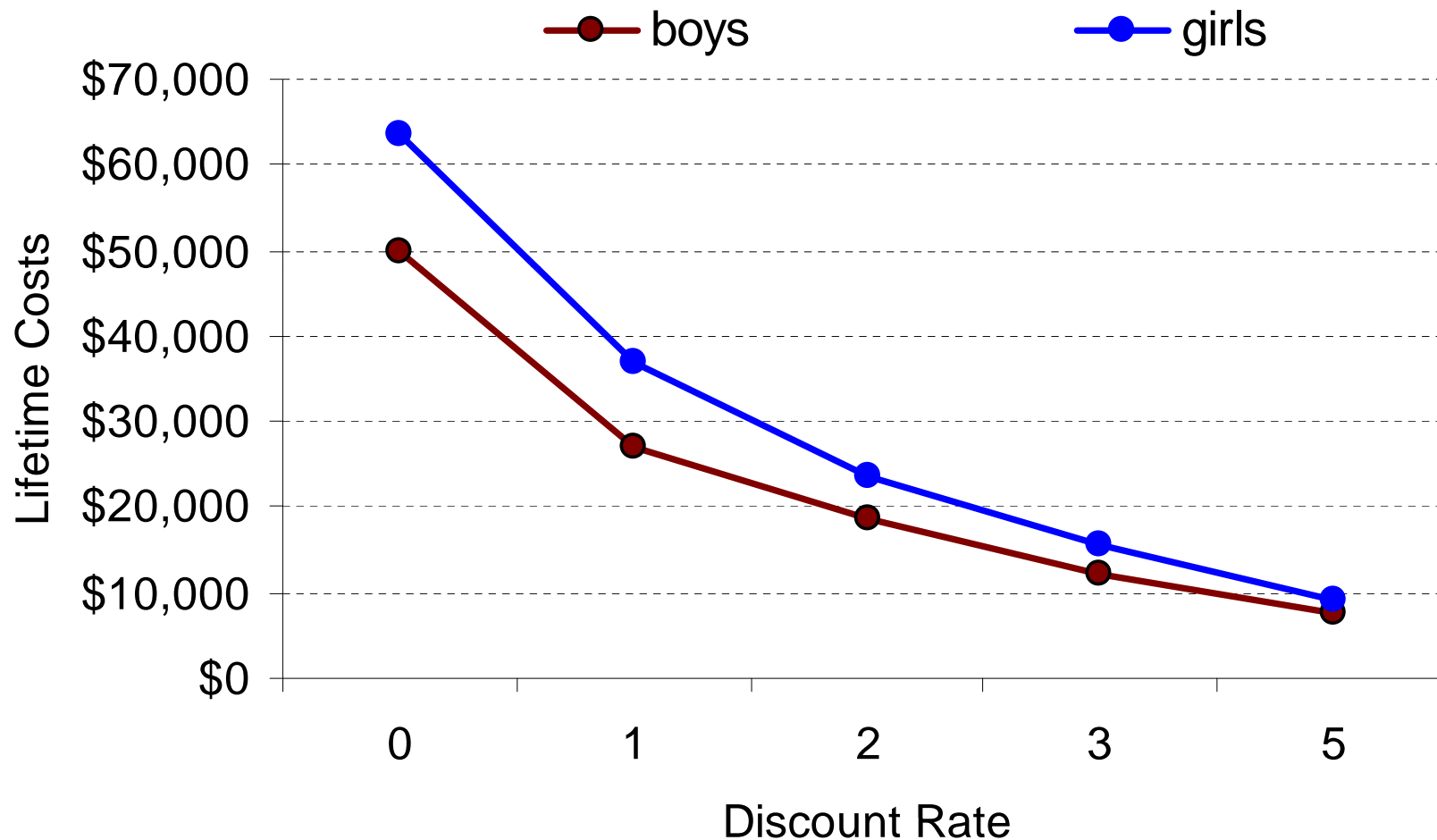
#1: Increased Mortality Risk for Obese has Little Impact

- Increased mortality risk for obese
 - 2% and 5% increased risk for ages 30 and 65
 - Positive selection for elderly who are obese

$$\text{Decline, \$} = \text{Obese}_{\text{baseline}} - \text{Obese}_{\text{increased risk}}$$

		Decline in Costs (\$):	
	Avg Mortality Risk	2% higher	5% higher
Boys	0.006	569	568
Girls	0.004	771	769

#2: Results are Sensitive to the Discount Rate



#3: Results do not Change Substantially using IOTF Definition

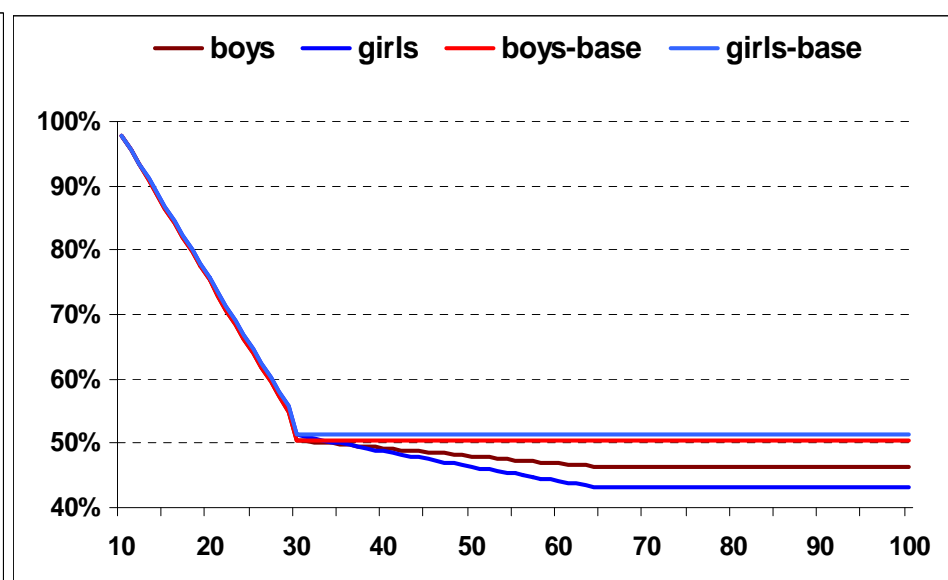
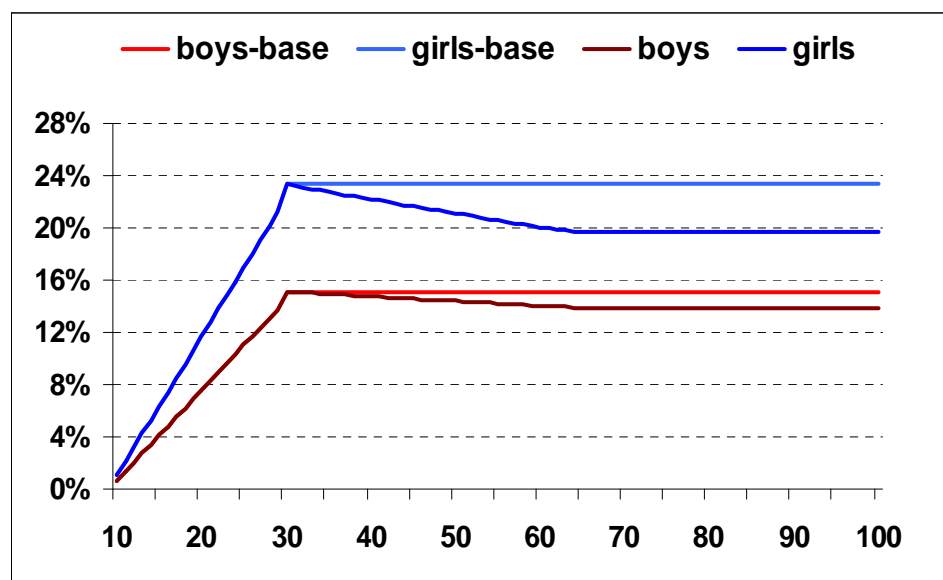
- IOTF and CDC definitions compared in one study (Gordon-Larsen, 2004):
- Tracking estimates stronger with IOTF:

	$P(\text{Ob}_A \text{Ob}_C)$	$P(\text{Ob}_A \text{not Ob}_C)$
IOTF	82.4	12.5
CDC	76.3	11.1

- Lifetime costs with IOTF definition are 6.2% higher
- Lower obesity prevalence using IOTF definition (12.5% vs 13.7%) results in 4% lower burden

#4: Adult Obesity is Not an Absorbing Condition

- Obese adults can become normal weight between ages 30 and 65
 - $P(O_{t+1}) = x\% * P(O_t)$
 - When $x=1.0$ for girls and 0.25 for boys:
 - Obesity declines by 5-10% for obese children and 1-3% for lean children
 - Lifetime costs are 2-3% lower for boys and 6-7% for girls



Summary

- An obese child incurs \$12,000-\$16,000 in additional lifetime costs
 - Average annual HC spending is \$8,000 in 2008
 - Equivalent to ~1.5 years for girls and ~2 years for boys
- Small changes may have a sizeable impact
 - 1% decline in obesity prevalence would result in lifetime savings of ~\$1.2 billion
 - Environmental interventions targeting small decreases may be worthwhile
- Results sensitive to discount rate
- Unaccounted costs include quality of life, mental health, education/labor market

Questions/Comments?

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