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Measurement Concepts and Introduction to Problem Solving

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Objectives

- After listening to, viewing, and studying the lecture materials in this course, you will be able to do the following:
  - Describe sources of vaccine coverage, target disease, and cost data
  - Explain and apply standard immunization program measurement concepts
  - Distinguish alternative theories and methodological approaches to problem solving

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Section A

Immunization Program Data: Disease Incidence, Vaccine Coverage, Program Costs

Main Sources of EPI Target Disease Data

United States

U.S. Centers for Disease Control and Prevention (CDC)

↑

State immunization programs

↑

All vaccine providers

Developing world

World Health Organization (Geneva)

↑

WHO Regional Offices

↑

National ministries of health

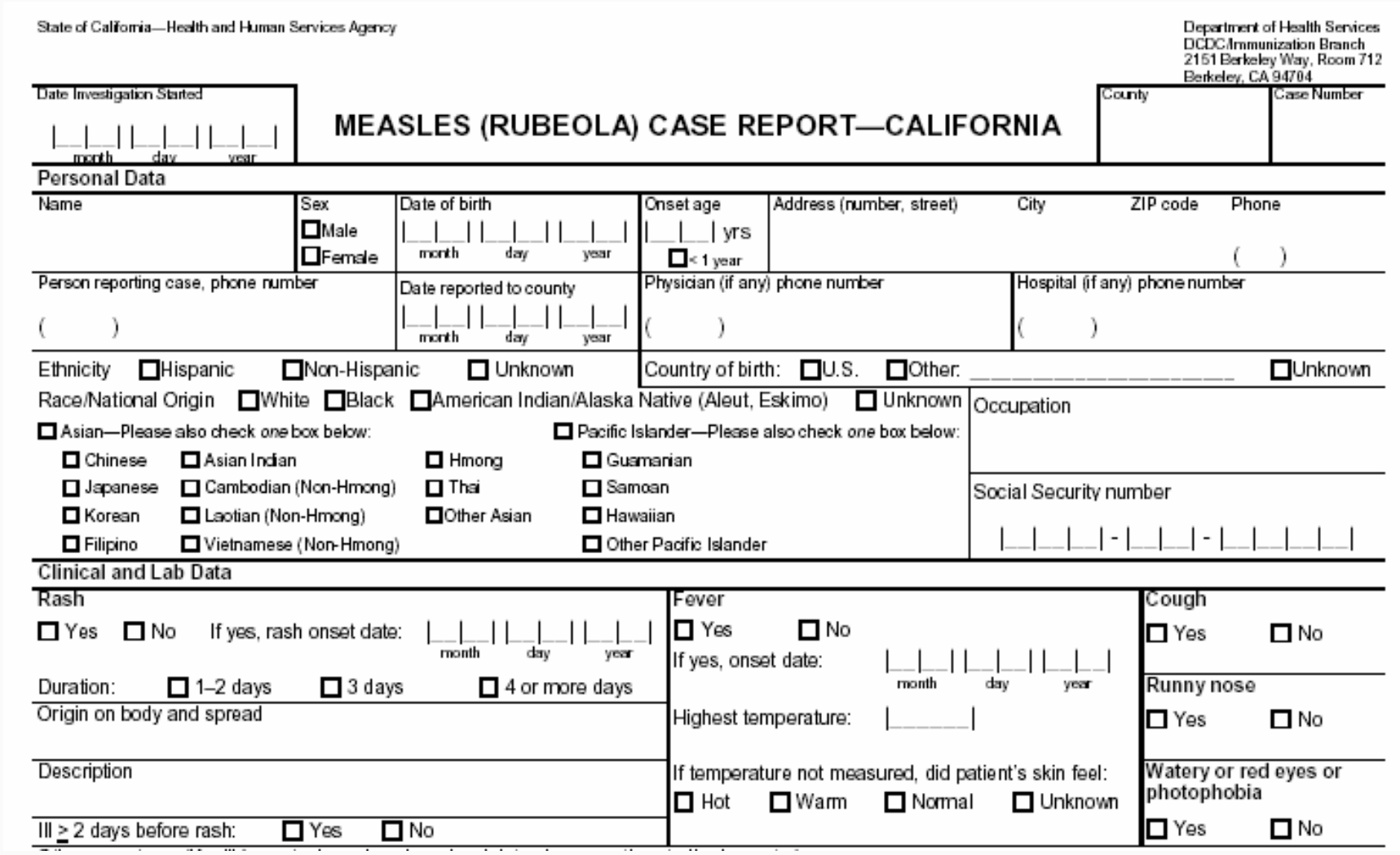
↑

All vaccine providers

Hallmarks of the U.S. Disease-Reporting System

- Decentralized, comprehensive
- Redundant state and federal capabilities
- Fax and online reporting
- Prompt outbreak investigation, feedback (MMWR)

Excerpt of CA Measles-Reporting Form



State of California—Health and Human Services Agency

Department of Health Services
DCDC/Immunization Branch
2151 Berkeley Way, Room 712
Berkeley, CA 94704

Date Investigation Started |__|__| |__|__| |__|__|
month day year

MEASLES (RUBEOLA) CASE REPORT—CALIFORNIA

County | Case Number

Personal Data

Name | Sex ☐Male ☐Female | Date of birth |__|__| |__|__| |__|__| month day year | Onset age |__|__| yrs ☐< 1 year | Address (number, street) City ZIP code Phone ( )

Person reporting case, phone number ( ) | Date reported to county |__|__| |__|__| |__|__| month day year | Physician (if any) phone number ( ) | Hospital (if any) phone number ( )

Ethnicity ☐Hispanic ☐Non-Hispanic ☐ Unknown | Country of birth: ☐U.S. ☐Other: _____ ☐Unknown

Race/National Origin ☐White ☐Black ☐American Indian/Alaska Native (Aleut, Eskimo) ☐ Unknown

☐ Asian—Please also check *one* box below:
☐ Chinese ☐ Asian Indian ☐ Hmong
☐ Japanese ☐ Cambodian (Non-Hmong) ☐ Thai
☐ Korean ☐ Laotian (Non-Hmong) ☐Other Asian
☐ Filipino ☐ Vietnamese (Non-Hmong)

☐ Pacific Islander—Please also check *one* box below:
☐ Guamanian
☐ Samoan
☐ Hawaiian
☐ Other Pacific Islander

Occupation

Social Security number |__|__|__| - |__|__| - |__|__|__|__|

Clinical and Lab Data

Rash
☐ Yes ☐ No If yes, rash onset date: |__|__| |__|__| |__|__| month day year
Duration: ☐ 1–2 days ☐ 3 days ☐ 4 or more days
Origin on body and spread
Description
Ill ≥ 2 days before rash: ☐ Yes ☐ No

Fever
☐ Yes ☐ No
If yes, onset date: |__|__| |__|__| |__|__| month day year
Highest temperature: |_____|
If temperature not measured, did patient's skin feel:
☐ Hot ☐ Warm ☐ Normal ☐ Unknown

Cough
☐ Yes ☐ No

Runny nose
☐ Yes ☐ No

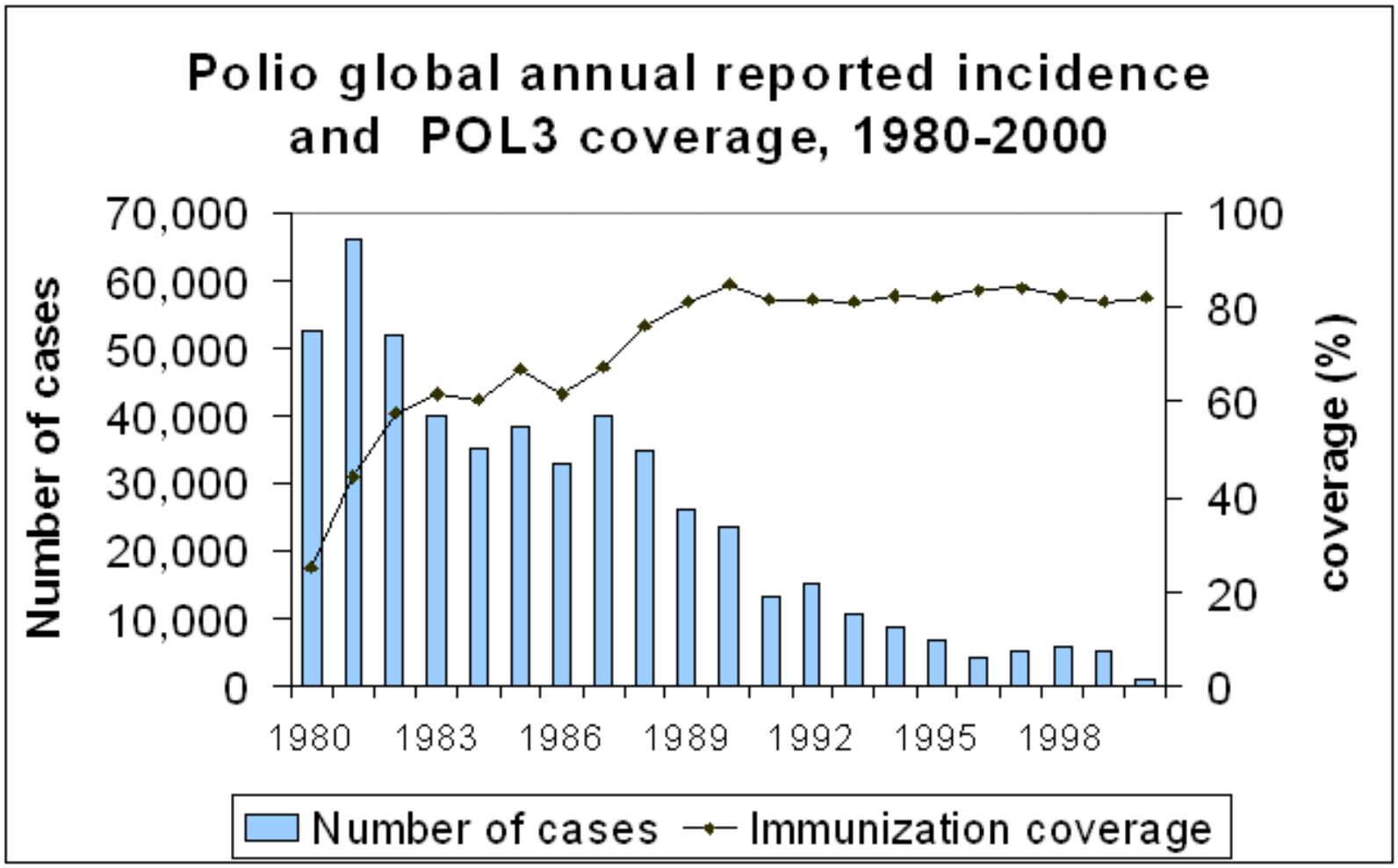
Watery or red eyes or photophobia
☐ Yes ☐ No

Hallmarks of Global Disease Reporting System

- Historically incomplete, delayed in many countries
- Exceptions: smallpox, polio, measles (active surveillance + outbreak investigation)
- Steady improvements in recent years

WHO Vaccine-Preventable Diseases Monitoring System

- Includes the following indicators
  - Coverage rate time series by vaccine
  - Annual numbers of cases EPI target diseases
  - Proportion of districts reporting
  - DPT3 dropout rates
- http://www.who.int/vaccines-surveillance/intro.html


Polio global annual reported incidence and POL3 coverage, 1980-2000
Number of cases
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
100
80
60
40
20
0
coverage (%)
1980
1983
1986
1989
1992
1995
1998
Number of cases
Immunization coverage

Main Sources of Vaccine Coverage Data

- United States
  - National Immunization Survey: 1994–present
  - National Health and Nutrition Examination Survey (NHANES): 1960–present
  - State registries
- Developing world
  - World fertility surveys (1972–84, 60 LDCs)
  - Demographic and health surveys (1984–present, ~200 done so far in over 70 countries)
  - Ministries of health, UN statistics

United States National Immunization Survey

- Surveys 78 Immunization Action Plan areas
- Produces annualized coverage estimates for 10 antigens
- Identifies particular high-risk groups
- Telephone survey + provider record check
- Santoli et al (1999) used 1997 NIS to estimate proportion of vaccinations given through Vaccines for Children Program
- Using 1999 NIS data, Luman et al (2001) showed that 75% of incompletely immunized children were only one visit away from completing their immunization schedules

Sources of Immunization-Cost Data

- Administrative record reviews
- Vaccine manufacturers
- Living Standards Measurement Surveys (World Bank, selected LDCs)
- Other surveys

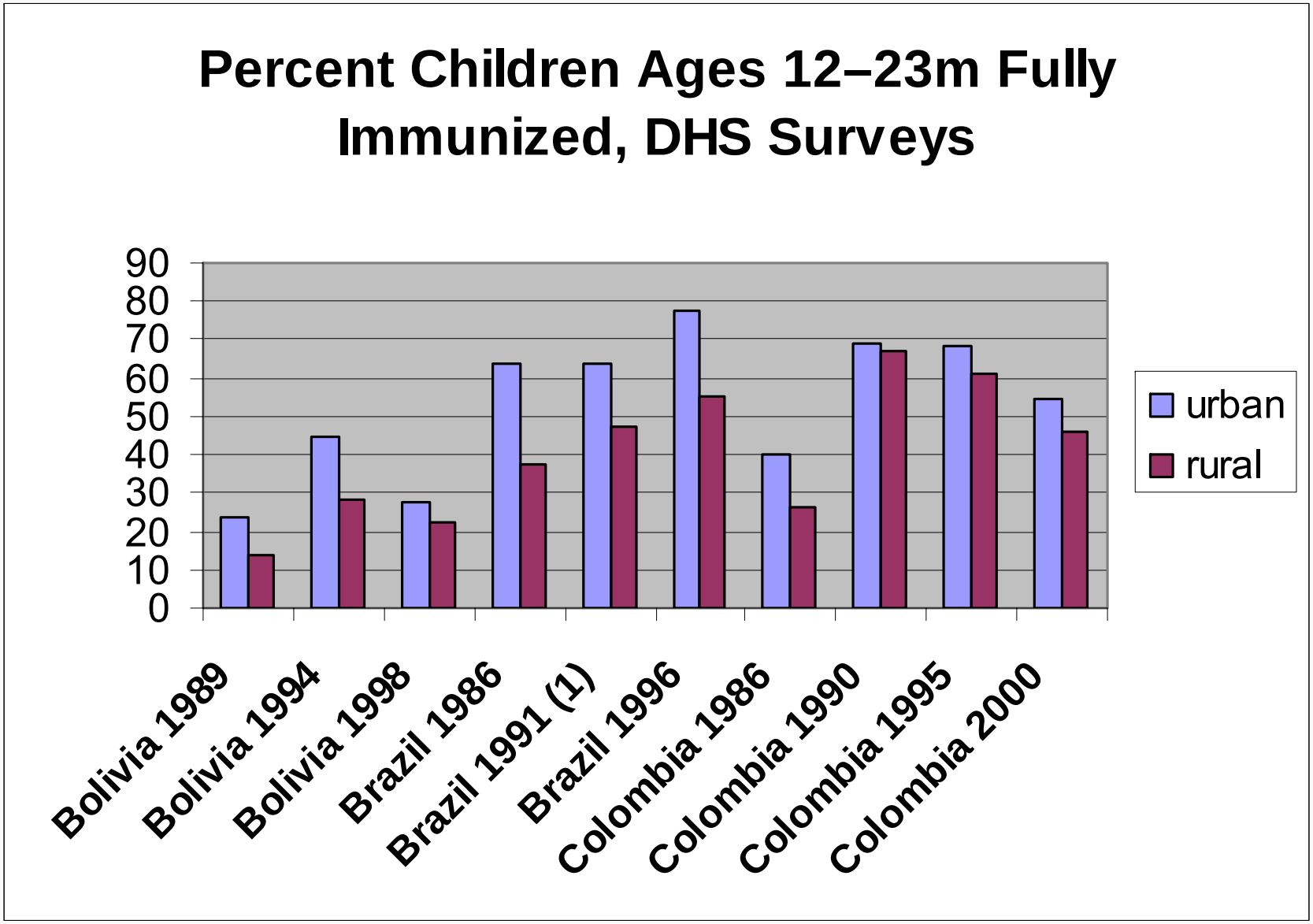
Immunization Costs

- United States
  - Lieu et al (2000) computed the costs of streptococcus pneumonia in a cohort of U.S. children
  - Result: routine immunization against the disease would save $760m/year
- Developing world
  - San Sebastian et al (2001) compared hospital-based to community health worker-based delivery strategies in one region of Ecuador
  - Result: CHWs immunized children more cheaply than hospitals

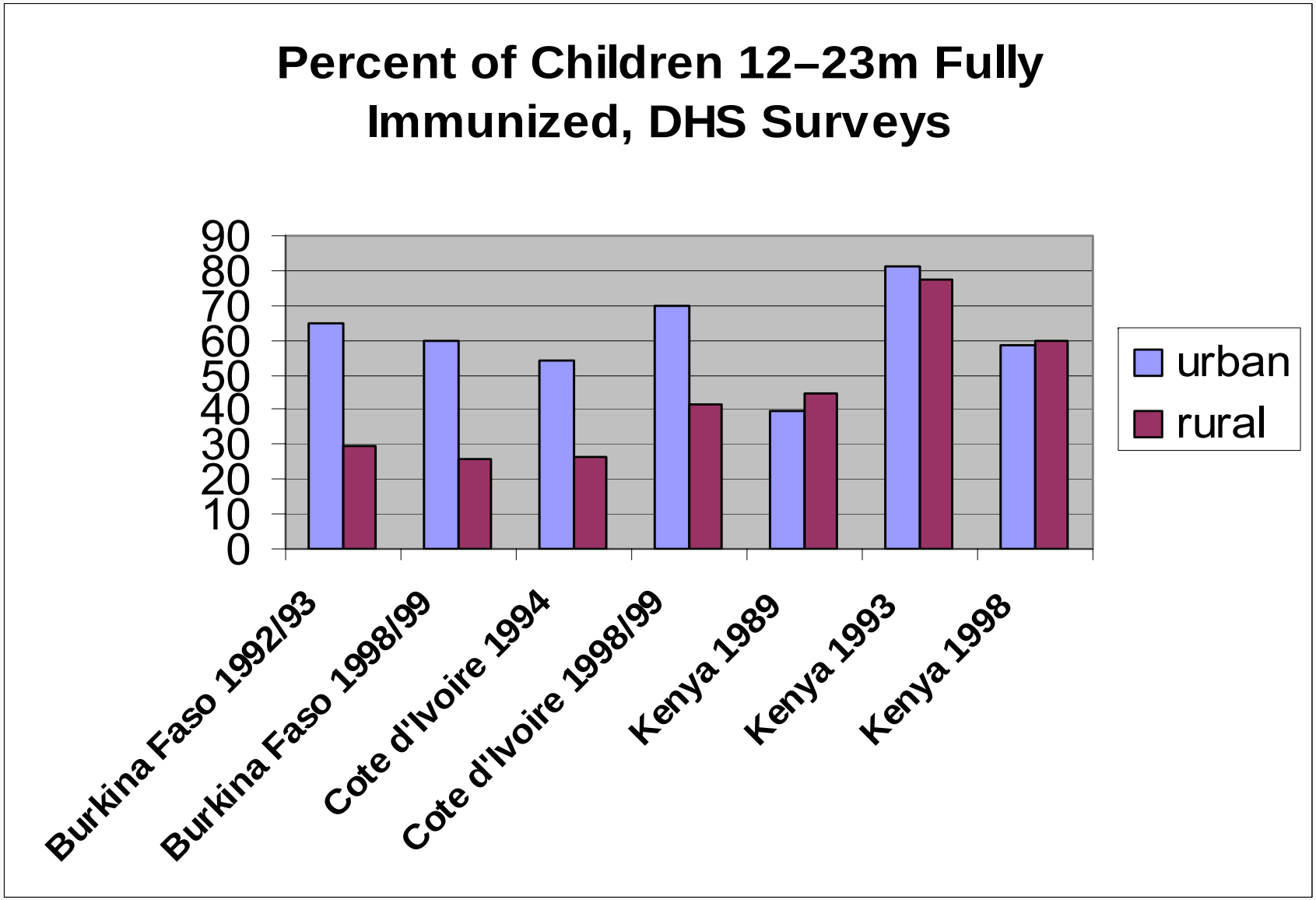
Two Key Macro EPI Measures

- Equity: does the program reach all groups?
- Sustainability: can high performance be maintained?

Equity and Sustainability: Three Latin American Countries



Equity and Sustainability: Three African Countries



Some Key Micro-Level Measures

- Efficiency, affordability, cost-effectiveness
- Access (cost, convenience)
- Community demand
- Quality of services

Generating Local Immunization Data

- Surveys can retrieve data from three sources
  - Vaccination cards
  - Parental recall
  - Medical and administrative records
- The veracity of the data varies by context

Local Data

- United States
  - Bolton et al (1998) compared vaccination card, parental recall, and medical records data for a cohort of 525 Baltimore children
  - Results: parents overestimated and the cards underestimated immunization status
- Developing world
  - Onta et al (1998) studied administrative EPI data from Nepal
  - Results: district health offices, peripheral health workers routinely inflate vaccination reports

Continued

Local Data

- Later in the course, we will learn more about several methods to generate local data, including:
  - Cluster sample surveys
  - Lot quality assurance
  - Provider databases (CASA Program)

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Section B

A Problem-Solving Paradigm

Problem Solving "Paradigm:"

- This is but one approach; use what works for you!
  - Define problem
  - Measure its magnitude
  - Conceptualize its determinants
  - Strategize interventions
  - Implement and evaluate

First Step in Problem-Solving: Define the Problem

- Someone identifies a problem and calls for a solution
- Who selects it and how it is chosen affect both the intervention and its resources
- Why the concern arises and how the problem is defined frame the choice of strategy

Vaccination

- "…an expression of trust between patient and provider [that is] strongly shaped by the management practices of [health care] organizations" (Gilson, in press)

Continued

Vaccination

- "…an expression of trust between patient and provider [that is] strongly shaped by the management practices of [health care] organizations" (Gilson, in press)
- "A health input parents choose conditional on their resources and competing wants" (Victor Fuchs, 1996)

Continued

Vaccination

- "…an expression of trust between patient and provider [that is] strongly shaped by the management practices of [health care] organizations" (Gilson, in press)
- "A health input parents choose conditional on their resources and competing wants" (Victor Fuchs, 1996)
- "Basic health services, including essential immunization, are a human right" (WHO 2001)

Continued

Vaccination

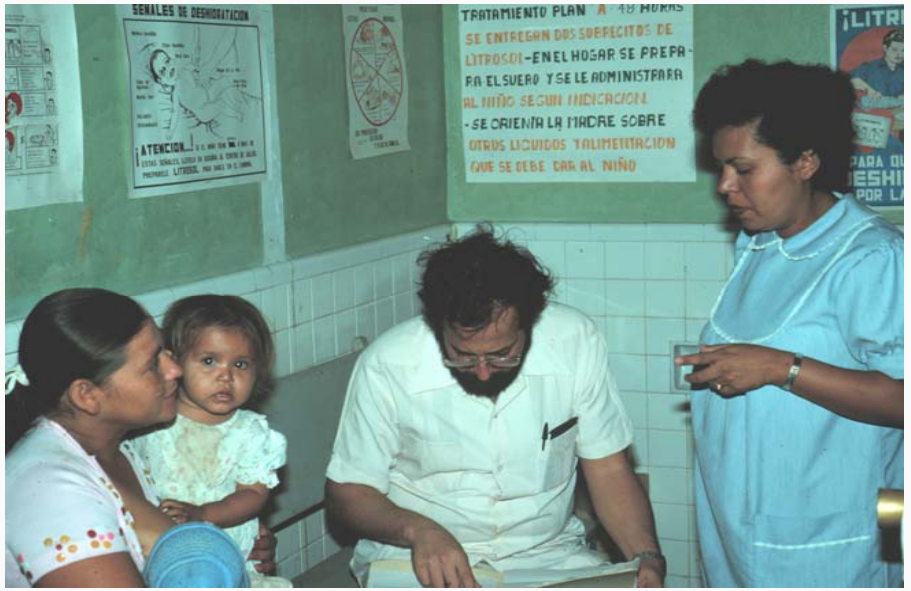
- Which statement is correct?
- All of them, for different reasons
- There are many ways to frame a problem

Alternative Problem Frames

- Our children are unimmunized because:
  - Funding has been cut (political)
  - Parents don't care (moral)
  - Health workers don't do their job (organizational)
  - Disease risk is minimal (epidemiologic)

The Frame Sets the Parameters for the Solution

- **Management frame**
  - *Problem*: low immunization utilization
  - *Solution*: improve quality of services



- **Economistic frame**
  - *Problem*: parents not willing to pay
  - *Solution*: reduce vaccination costs

Continued

Alternative Frames

- **Sociological frame**
  - *Problem*: vaccine coverage low in some communities
  - *Solution*: mobilize target communities

Problem Definition

- Few problems can be conceptualized in purely logical, factual terms
- Problem definition always entails practical value-judgments
- Each frame strives to be logical but invariably imposes its particular parameters (theoretical boundaries) and value judgments

Continued

Problem Definition

- The fact that immunizing children is problematized across disciplines and cultures points to an underlying value judgment that it is important
- Given the above, a robust problem-solving approach should be:
  - Reflexive, making value judgments explicit
  - Evidence-based
- In this course, we will use materials drawn from three frames of reference:
  - Epidemiological
  - Economistic
  - Sociological

Epidemiological Concepts

Individual

- Exposure
- Case
- Risk factors
- Participation

Population

- Endemicity
- Prevalence, incidence
- Contextual factors
- Coverage

Step Two: Measure the Magnitude of the Problem

- Defining problems using different frames
  - Taps different dimensions
  - Reveals different measurement approaches
  - Can lead to more robust solutions

Epidemiologic EPI Measures

- $\frac{\text{No. cases EPI target disease x}}{\text{No. inhabitants}}$
- % communities with ≥ 80% children 12–23m fully immunized
- $\frac{\text{No. households with child 12–23m fully immunized}}{\text{No. households with child age 12–23m}}$
- % health facilities reporting AFP cases weekly

Economic Concepts

- Rationality
- Heterogeneous preferences
- Marginal utility
- Substitutability
- Markets: supply-demand equilibria

Economic EPI Measures

- Efficiency
  - $/child vaccinated
- Cost-effectiveness

$$\frac{\text{\$/child 12–23m fully immunized, strategy 1}}{\text{\$/child 12–23m fully immunized, strategy 2}}$$

- Viability
  - $ collected/$ spent on EPI

Continued

Economic EPI Measures

- Equity

$$\frac{\%\ \text{lowest income quartile fully immunized}}{\%\ \text{highest income quartile fully immunized}}$$

- Cost-benefit

$$\frac{\$/\text{immunization against disease x}}{\$/\text{case EPI target disease x}}$$

Sociological Concepts

Individual

- Attributes: Ascribed, attained
- Beliefs: Self-efficacy,
- Perceived vulnerability
- Behaviors
- Reference groups, social networks

Group-level

- Social structure: strata, heterogeneity, inequality
- Institutions, norms
- Collective action
- Communities

Sociological EPI Measures

- % communities with local health committees meeting at least quarterly
- Whether local health committee controls local health resources
- No. volunteer-days contributed for local vaccination activities
- No. consecutive years community has ≥ 80% children 12–23 months fully immunized

Note That Some Concepts Are Operationalized Differently

- Example: sustainability
  - Epidemiologic: program maintains high coverage
  - Economic: program is self-financing
  - Sociological: community reproduces vaccination behaviors, norms

Low-Income Countries and Routine Vaccines: Financing

Low-Income Countries Financing 25% or More of Routine EPI Vaccines*							
Country	% Financed	Country	% Financed	Country	% Financed	Country	% Financed
Burkina Faso**	100	Nepal	53	Tanzania	10	Congo	0
Chad**	100	Uganda	50	Zambia	10	Eritrea	0
Ghana	100	Mongolia	40	Armenia	7	Guinea-Bissau	0
Honduras	100	Turkmenistan	36	C. Afr. Rep.	4	Lao PDR	0
Mali**	100	Gambia	30	Kenya	3	Liberia	0
Nicaragua	100	Moldava, Rep.	29	Sierra Leone	3	Mauritania	0
Nigeria	100	Cameroon	27	Burundi	2	Mozambique	0
Pakistan	100	Guinea	25	Malawi	2	Myanmar	0
Senegal**	100	Haiti	25	Afghanistan	0	Rwanda	0
India	98	Lesotho	25	Angola	0	Somalia	0
Côte d'Ivoire**	95	Benin	15	Azerbaijan	0	Tajikistan	0
Niger**	80	Ethiopia	15	Bhutan	0		
Togo	80	Madagascar	10	Bosnia/Herz.	0		
Viet Nam	73	Sudan	10	Cambodia	0		

* The routine vaccines of the expanded programme of immunization (EPI) are diphtheria, measles, pertussis, polio, tuberculosis, and tetanus. Yellow fever is part of EPI coverage in countries at risk in Africa and South America. "Low-income country" in this list represents GNP per capita of $785 or less.
** These countries have benefited from grants from the European Union.

Sources for both lists: Vaccine finance: UNICEF; income levels: World Bank

Step Three: Conceptualize Problem Determinants

- Once framed, a problem is analyzed to identify and conceptualize its determinants
- This process necessarily entails two steps:
  - Theorizing
  - Making causal inferences

Definition

- *Theory —* "A particular set of propositions, postulates and assumptions devised to explain some set of facts or phenomena"

Examples of Relevant Theories

- Epidemiology
  - Germ theory
  - Epidemic models
- Economics
  - Free market/ consumer choice
  - Human capital model
- Sociology
  - Symbolic interactionism
  - Organizational behavior
  - Collective action

Theories

- A range of theories can be invoked to solve vaccination program problems, and they generally do not overlap
- What the theories do have in common is the notion of causality
  - For every problem (effect) there must be a cause (which hopefully can be mitigated)

Four Conditions for Causal Inference

1. Association: cause, effect (X,Y) are correlated
2. Time order: cause X must precede effect Y
3. Nonspuriousness: X, not Z, is the true cause
4. Mechanism: X theoretically linked to Y

Causal Inference

- In practice, identifying a particular cause of immunization program problems is difficult
  - The problems have multiple causes
  - Many causes are unobservable
- As a result, most empirical research fails to meet all causal inference criteria
- The methodologically strongest are experiments or quasi-experiments that randomize subjects and compare the outcomes of treatment, control groups
- Problem: most programs are full-coverage, so exposure cannot be controlled

Next Lecture

- In the next lecture, we will learn more about how problem-solving interventions are designed, implemented, and evaluated

Summary

Continued

Summary

- High-quality immunization data are increasingly accessible
- Immunization problems can be framed and measured from several disciplinary perspectives
- Theories rarely overlap and causal inferences are rare in problem solving