Family Health Outcomes Project

TREND ANALYSIS

November 16, 2005
San Francisco, CA

Jointly sponsored by
California Department of Health Services, Maternal and Child Health Branch,
Perinatal Advisory Council: Leadership, Advocacy, and Consultation (PAC/LAC),
and Family Health Outcomes Project, UCSF

Family Health Outcomes Project
UCSF Family & Community Medicine

TREND ANALYSIS

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Family Health Outcomes Project

UCSF Family & Community Medicine

TODAY'S AGENDA

Trend Analysis

By the end of the training, participants should have introductory skills needed for trend analysis. At the end of the training, the participant will be able to:

1. Describe, analyze and interpret a trend
2. Interpret data from the new FHOP MCAH indicator spreadsheets
3. Identify trend results within and across jurisdictions

9:30 am	**Coffee and Registration**
10:00 am	**Welcome and Introductions** *Geraldine Oliva, MD, MPH*
10:15 am	**Session 1.** **Trend Analysis for Local Public Health Surveillance:** **Basic Concepts and Added Value** *Geraldine Oliva, MD, MPH*
11:30 pm	**Session 2.** **Title V Indicators: The FHOP Databooks** *Linda Remy, PhD*
12:00 pm	**Lunch**
1:00 pm	**Title V Indicators: The FHOP Databooks (Continued)** *Linda Remy, PhD*
2:00 pm	**Session 3.** **Working in Small Groups**
3:30 pm	**Wrap-Up and Conclusions**

Trend Analysis for Local Public Health Surveillance: Basic Concepts and Added Value

Geraldine Oliva M.D., MPH
UCSF Family Health Outcomes Project
November 16, 2005

Today's Agenda

- Overview of current policies and thinking that generate an impetus for trend analysis
- Review basic analytical and statistical concepts used in trend analysis
- Review new indicator databook methods and utility
- Practice interpreting databook spreadsheets from counties and preparing an analysis

Today's Training Objectives

By the end of this training, participants should be able to:

- Describe why trend analysis is important
- Articulate the definitions of terms used in trend analysis
- Articulate the basic analytic methods that are used for a variety of situations
- Evaluate longitudinal trends in county-level MCAH indicators
- Interpret health disparity trends for different age and race/ethnic groups

Fiscal and Policy Changes Affecting MCAH

- National budget deficits are resulting in cuts for basic social and health services for poor families
- The state Title V Block Grant funds will be reduced as of July 2005
- Some of the use of local funds as matching funds for public health nursing functions are being challenged

New Expectations from Federal Funders

- The CDC has begun a major initiative on using evidence based prevention strategies
- This requires that state and local governments either use an evidence based model or have an evaluation that provides new evidence on the program's cost and effectiveness
- Federal agencies are interested in program impact on fewer people rather than typical descriptive epidemiology for monitoring of health indicators in the entire population

New Emphases at California DHHS

- Increasing focus on planning at the local level
- Increased focus on local solutions
- Explosion of programs using GIS to examine local health issues

Challenges for Local Health Jurisdictions

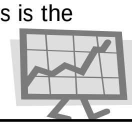
- Determine where to allocate reduced resources
- Monitor results of program cuts
- Advocate for local resources to sustain threatened programs
- Advocate at state level for general fund monies to sustain programs

Analytic Implications

- A longitudinal perspective is required at the local level:
  - To assess the impact of changes in policy and funding among different populations
  - To assess the impact of new programs as they are implemented among different populations
  - To assess the impact as more or fewer clients are served over time
  - To assess the impact of an identified risk or outcome

Statistical Implications

- To observe changes over time at the local level techniques such as time series analysis or forecasting may be used
- Time series is also used when examining the impact of a risk factor on an outcome e.g. Insurance status and access indicators
- Trend analysis can also be used to simultaneously control for the overall trends in two measures where the focus is the association of the two factors rather than the trend itself



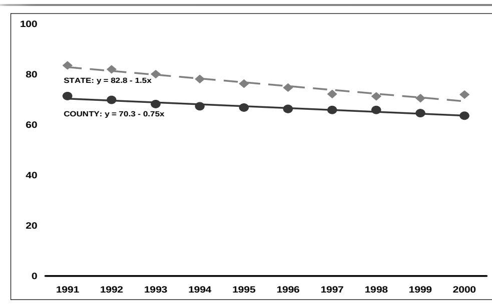
Added Value of Trend Analysis

- The pattern of change in an indicator over time e.g. gradual change, spikes or curves, can provide information on the impact of exposure, new technology or policy changes
- Can provide comparison of trends among small geographic areas and regions
- Can provide comparisons of patterns among different population subgroups
- Can assist in making future projections

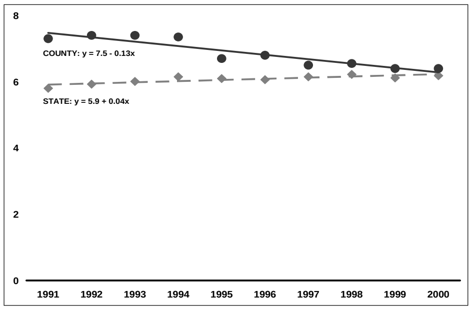
Definition of Terms for Regression Analysis for Trends

- Slope – the average rate of change over time where:
  - ❖ zero = flat
  - ❖ (+) = increasing trend
  - ❖ (-) = downward trend
- Intercept – the rate at the start of the study period i.e. where the line intercepts the x axis

Slope: Fertility Rate per 1,000 Women 15 to 44 – 1991-2000



Change in the Intercept: %LBW newborns (< 2,500 gms. 1991-2000



Definition of Terms for Regression Analysis for Trends

- P-value- the likelihood that model results are statistically significant: used both for significance of trend of an indicator and differences with comparison groups
- Standard Error - the Confidence Interval around the slope and intercept

Factors Impacting Analysis

- Sample size and the number of time periods being examined
- Presence of outliers
- Availability of numerators and denominators over time
- Confounding-changes over time in factors related to the indicator of interest

Small Numbers and Data Points

- For large sample sizes at the state, federal and large county level simple linear plots describing changes are treated as error free
- For the usual county, city or district the problem of unstable rates due to small numbers requires tests of statistical significance and other statistical techniques
- In looking at the individuals impacted by a particular program or policy the same small numbers problems occur

Sample size issues

- Minimum number for stable rate may require statistical techniques such as aggregating or averaging years
- Many years of data may be required in order to obtain at least 3 usable data points needed for a trend analysis
- One size does not fit all: approach differs between one jurisdiction and another and between on indicator and another

Sample Size Issues: Raw Data

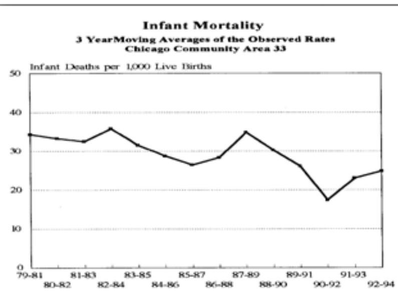
Infant Mortality Rates
Chicago Community Area 33 1979-1994

	Deaths	Births	Rate / 1,000	95% CI*
1979	8	213	37.6	11.6-63.6
1980	7	220	31.8	8.2-55.4
1981	6	179	33.5	6.7-60.3
1982	7	202	34.7	9.0-60.4
1983	5	172	29.1	3.6-54.6
1984	8	184	43.5	13.4-73.6
1985	4	183	21.9	0.5-43.3
1986	4	189	21.2	0.4-42.0
1987	7	194	36.1	9.4-62.8
1988	5	181	27.6	3.4-51.8
1989	9	227	39.6	13.7-65.5
1990	6	252	23.8	4.8-42.8
1991	4	247	16.2	0.3-32.1
1992	3	246	12.2	0.0-26.0
1993	10	244	41.0	15.6-66.4
1994	6	275	21.8	4.3-39.3

Sample Size Issues: Plot of Data

Small #s Methods: Data Aggregation

Small #s Methods: Data Averaging

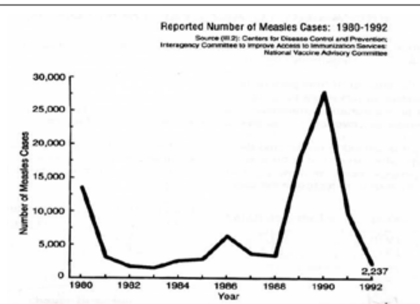


Small #s Methods: Regression Techniques

Presence of Outliers

- This can be the result of real events or a statistical problem
  - When looking at communicable disease there may be years with spikes due to a new flu strain
  - When small numbers are used to generate rates a spike may not reflect a real change
  - In an area with a relatively small population, missing or inaccurate data may cause spikes that are the result of problems at the data collection level

Trend study 3



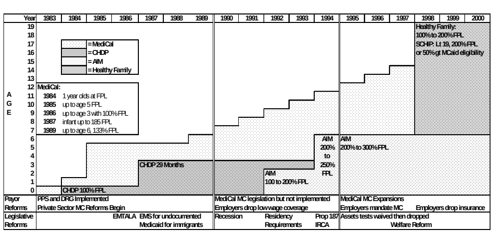
Availability of Numerators and Denominators

- For numerators this occurs where data come from surveys only done periodically e.g. CHIS
- Denominator issues:
  - Between census years we have to arrive at estimates by vendors using multiple data sets to make projections
  - Geographic boundaries may change e.g ZIP codes appear and disappear
  - Intercensile samples for race/ethnic subgroups are often too small to generate reliable rates

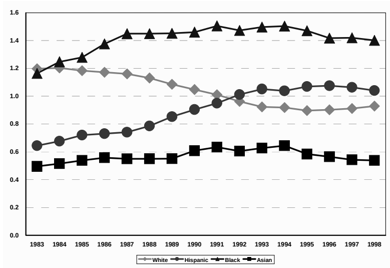
Changes Over Time in Confounding Factors

- Policies affecting access to care can impact rates of service utilization e.g. first trimester prenatal care, teen pregnancy
- Socio-demographic changes in the population of a small area may be a main determinant of changes in an indicator
- Technological advances may drastically change outcomes e.g. better survival of pre-term infants

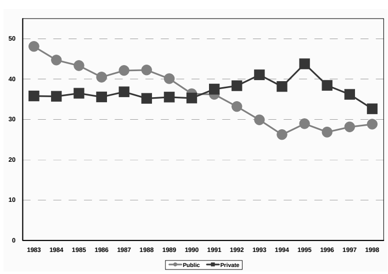
Monitoring the Impact of Policy Changes



Likelihood of Hospital Admission by Race/Ethnicity



ACS Rate/10,000 for Payor



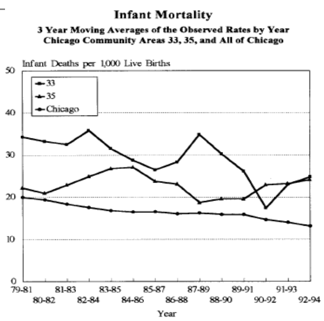
Selecting an Appropriate Statistical Strategy

- Define the purpose and context of the analysis i.e. comparison groups or dates of specific events or policy changes
- Are there enough cases to do a trend analysis i.e. should I manipulate data to do a trend or should I use case studies
- “Eyeball” both a data table and a simple plot of actual numbers or rates
  - Is it a straight line
  - Are there erratic sharp spikes
  - Are there bends or curves

Define Purpose/Affected Groups/Time Period

- What is needed for routine monitoring?
- What is needed for program evaluation?
- Are we interested in differences in outcomes for small areas?
- What programs or policies may impact the outcome in question?

Eyeball the Data

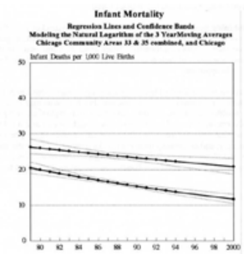


Benefits of Using Regression Approach to Trend Analysis

- Considers information in the series of counts or rates to generate a complementary series of predicted counts or rates
- Stabilizes rates even without other transformations
- Produces a confidence band around a set of predicted values that will be narrower than that for counts or rates
- Allows the inclusion of other variables in the model

Benefit of Regression: Example Without Regression

Benefit of Regression: Example With Regression



Types of Trends

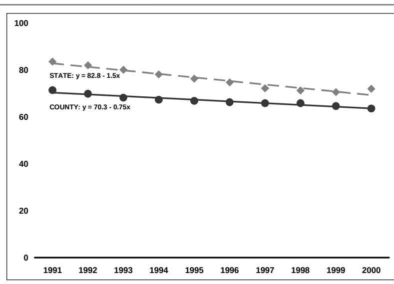
- Simple Linear Trends – Is there a change in the slope and is it significant?
- Change in intercept: What could it mean?
- Complex trends: What do they show and what are the pitfalls?

Example: Simple Linear Trend

County Fertility Rate per 1,000 Women Age 15 to 44 - - 1991 to 2000

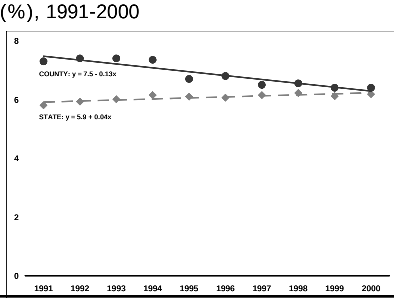
Year		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Rate	State	83.5	82.0	80.1	78.1	76.3	74.7	72.2	71.2	70.5	71.9
	County	71.4	69.9	68.2	67.3	66.8	66.3	65.8	65.8	64.6	63.6
County 95% CI	Lower CI	68.2	66.8	65.2	64.3	63.9	63.4	62.9	62.9	61.8	60.8
	Upper CI	74.5	72.9	71.2	70.3	69.7	69.2	68.7	68.7	67.4	66.3

Fertility Rate per 1,000 Women 15 to 44 - 1991 to 2000



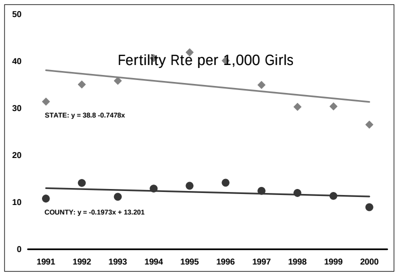
A Change in the Intercept

Newborn birthweight less than 2,500 grams (%), 1991-2000



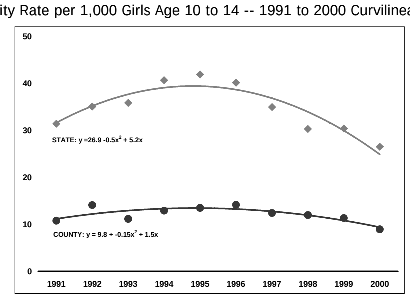
Complex Trends - Curvilinear Trends: Assessing the Fit

Fertility Rate per 1,000 Girls



Complex Trends - Curvilinear Trends: Assessing the Fit

Fertility Rate per 1,000 Girls Age 10 to 14 -- 1991 to 2000 Curvilinear



Help is on the way !!

- FHOP is producing trend templates for use with any data that produce the statistics you need
- EXCEL can generate trend charts
- FHOP is doing this for MCAH required indicators where there is adequate data
- Technical assistance is available

HERE’S LINDA

Title 5 Indicators: The FHOP Databooks

Linda L. Remy, PhD
UCSF Family Health Outcomes Project
November 16, 2005

The FHOP Databook Scientific Team

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The FHOP Databook Technical Support Team

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Revised Databooks

FHOP Databooks now focus on:

- Longitudinal outcome trends
- Region and population disparities

County MCAH staff roles change :

- From data managers
- To program analysts
- Focus on planning, intervention, outcome

Databook Content

- **Data**: 12 years of numerator and denominator data by race/ethnicity for each indicator for the jurisdiction and state
- **Definitions**: Some databooks have additional information as to how definitions were operationalized.
- **Data Quality**: Data quality issues that may impact reliability of indicator results
- **Rates**: N years of rates and confidence intervals, by race/ethnicity, incorporating small numbers guidelines modified for trends
- **Graphs**: N-year trend graphs comparing local jurisdiction and state trends, by race/ethnicity, with trend tests for significance

Data Quality Tab

- Data quality concerns
  - Missing
  - Out-of-range
  - In-range but incorrect
- Each indicator has its own data quality issues
- The data quality tab highlights key errors
  - For the county
  - The county contribution to all errors
  - The county contribution to total state errors
- High data quality problems = unreliable rates

APNCU Data Quality

	Total Births		Age 15 to 44		Missing		
Local	Number	Percent	Number	Percent	Number	Area %	Miss %
State	540,827	100.00	538,864	100.00	17,747	3.3	100.00
1 Alameda	21,574	3.99	21,498	3.99	432	2.0	2.43
2 Alpine	14	0.00	14	0.00	0	0.0	0.00
3 Amador	299	0.06	298	0.06	2	0.7	0.01
4 Butte	2,382	0.44	2,374	0.44	11	0.5	0.06
5 Calaveras	323	0.06	321	0.06	1	0.3	0.01
6 Colusa	330	0.06	330	0.06	1	0.3	0.01
7 Contra Costa	13,210	2.44	13,165	2.44	151	1.1	0.85
8 Del Norte	299	0.06	299	0.06	1	0.3	0.01
9 El Dorado	1,751	0.32	1,747	0.32	8	0.5	0.05
10 Fresno	15,401	2.85	15,335	2.85	74	0.5	0.42
11 Glenn	431	0.08	430	0.08	12	2.8	0.07
12 Humboldt	1,444	0.27	1,440	0.27	28	1.9	0.16
13 Imperial	2,908	0.54	2,901	0.54	264	9.1	1.49
14 Inyo	198	0.04	198	0.04	1	0.5	0.01
15 Kern	12,888	2.38	12,850	2.38	3,323	25.8	18.72
16 Kings	2,365	0.44	2,353	0.44	8	0.3	0.05

Rates Tab

- Definitions, Risk Factors, Sources, Analyses
- Minimum number of events by race/ethnicity
  - N >= 10 every year — present as given
  - < 10 in any year — six 2-year periods
  - < 10 in any 2-year period — four 3-year periods
  - Still too few — declare not big enough
- Rates by race/ethnicity
  - Divide number of events by appropriate denominator
  - Multiply the result times the appropriate "Rate Per" factor (e.g. rate per 1000 births, etc.)
- Confidence interval
  - Wilson score without continuity correction

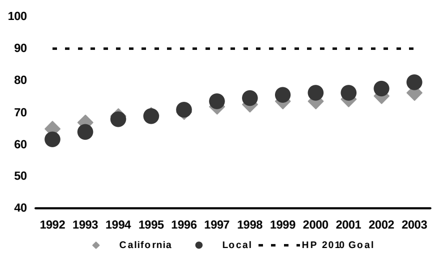
APNCU Rates Tab

ASIAN POPULATION								
	California				Local			
Year	Births	Rate	Lower C.L.	Upper C.L.	Births	Rate	Lower C.L.	Upper C.L.
1992-1994	124,454	72.0	71.8	72.2	20	87.0	67.9	95.5
1995-1997	125,473	73.8	73.6	74.0	23	85.2	67.5	94.1
1998-2000	133,042	76.1	75.9	76.3	35	74.5	60.5	84.7
2001-2003	146,709	77.2	77.0	77.3	35	100.0	60.5	84.7

Graphs Tab

- Display rates over the calculated period
  - State and local jurisdiction
  - HP 2010 goal if applicable
- Statistical tests
  - Linear trend regression
  - If 12 years, non-linear trend (2 years, 3 bends)
  - Test for difference between state and local
- Join Point shareware
  - Developed by National Cancer Institute

APNCU Graph

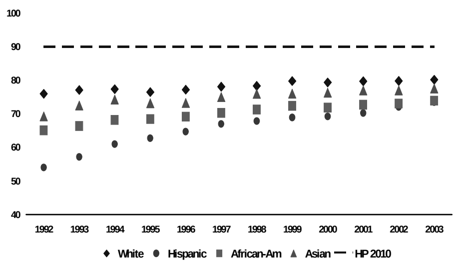


APNCU Trend Test

Trend Regression Results								
		Intercept		Slope				
Level	Date Range	Est.	Std. Err	Est.	Std. Err	P-Value	Sig?
State	1992-2003	66.12	0.39	0.95	0.06	0.000	Yes
Local	1992-2003	63.53	0.74	1.55	0.12	0.000	Yes
	Different?					0.000	Yes
Non-Linear							
State	1992-1994	64.79	0.41	2.04	0.58	0.010	Yes
	1994-2003	67.24	0.43	0.81	0.06	0.000	Yes
Local	No bends						

Exploring Population Disparities

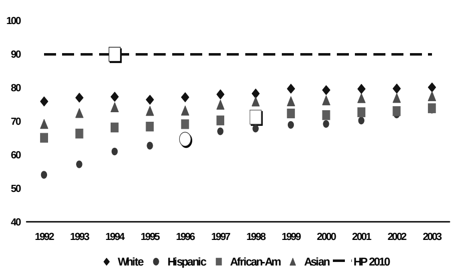
California APNCU by Race / Ethnicity



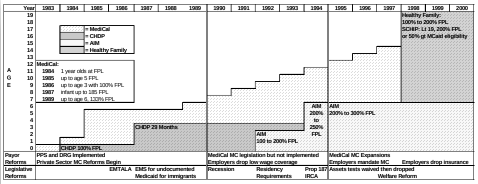
State APNCU Trend Test

Level	Date Range	Intercept Est.	Intercept Std. Err	Slope Est.	Slope Std. Err	P-Value	Sig?
Overall	1992-1994	64.79	0.41	2.04	0.58	0.010	Yes
	1994-2003	67.24	0.43	0.81	0.06	0.000	Yes
White	1992-2003	76.15	0.25	0.38	0.04	0.000	Yes
Hispanic	1992-1996	54.43	0.41	2.76	0.23	0.000	Yes
	1996-2003	61.15	0.87	1.08	0.11	0.000	Yes
African-Am	1992-1998	65.40	0.29	1.00	0.10	0.000	Yes
	1998-2003	68.66	1.39	0.45	0.15	0.021	Yes
Asian	1992-2003	71.33	0.53	0.62	0.08	0.000	Yes

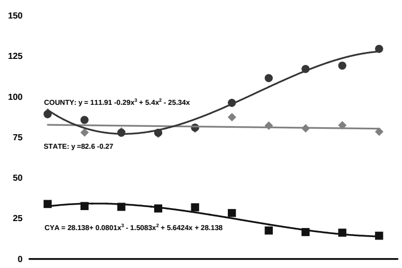
State APNCU Trend Test



Revisiting Public Policy



Conflicting policies?



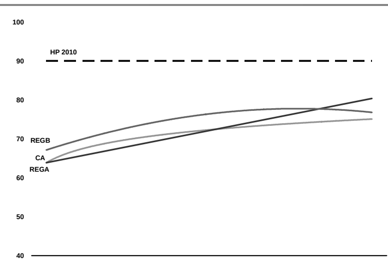
Exploring Regional Disparities

MCAH Perinatal Regions

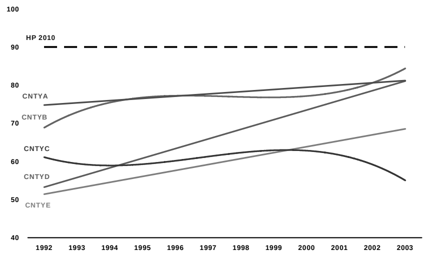
- Single counties with large percent of births (LA, San Diego, Orange)
- Contiguous regions grouped to have sufficient sample size
- Consistent with existing intergovernmental regions (ABAG)
- Share similar socioeconomic, environmental, or MCAH factors
- Approved by Programs and Policy Section and the MIHA Advisory Group

Recommended Grouping

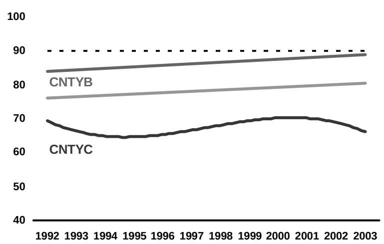
California APNCU Inter-regional Comparison



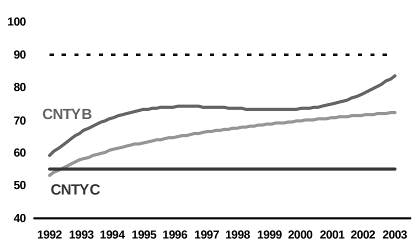
APNCU Region A Disparities



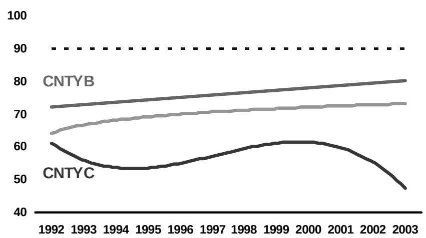
APNCU Region A Disparities White



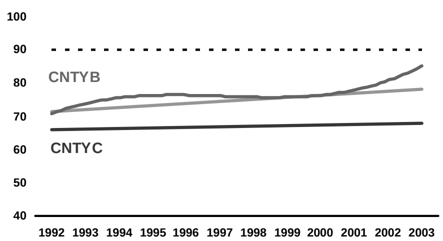
APNCU Region A Disparities Hispanic



APNCU Region A Disparities African-American



APNCU Region A Disparities Asian



Conclusion

- The Databooks incorporate relevant decision rules about
  - Data quality
  - Calculating rates and confidence intervals
  - Statistical tests for linear and non-linear trends
- Local jurisdictions will need
  - Less training about how to calculate indicators
  - More training about how to interpret indicators
- The Databooks facilitate analysis of trends in
  - Race/ethnic disparities
  - Regional disparities

For more information

CONTACT:
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Email: lremy@well.com

Kotelchuck Index. In 2003, 538,864 births were recorded to women age 15 to 44. Statewide, 17,747 birth certificate records (3.3%) were missing one or more data elements needed to calculate the Kotelchuck Index. At the county level, an average of 2.1% of birth records (0.8% median) were missing one or more elements of the Kotelchuck Index.

Implications. Study this table carefully. If more than 0.8% (the county-level median) of your area's birth certificates were missing one or more data elements needed to calculate the Kotelchuck Index, rates will be increasingly inaccurate. Further research may be needed to find out how your area can improve its data quality. Until this is resolved, be increasingly skeptical of Kotelchuck Adequacy of Prenatal Care rates as the Area percent missing increases.

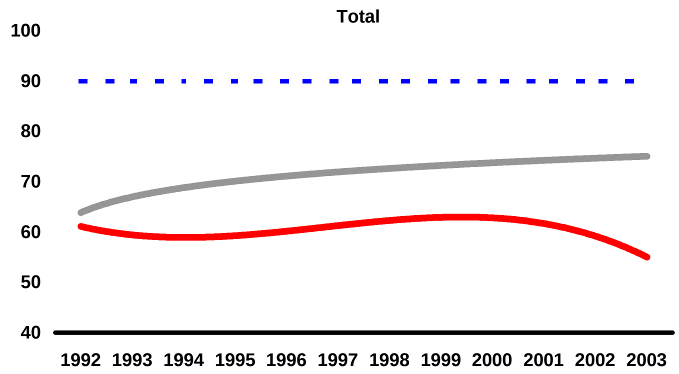
	Total Births		Age 15 to 44		Missing		
Local	Number	Percent	Number	Percent	Number	Area %	Miss %
State	540,827	100.00	538,864	100.00	17,747	3.3	100.00
1 Alameda	21,574	3.99	21,498	3.99	432	2.0	2.43
2 Alpine	14	0.00	14	0.00	0	0.0	0.00
3 Amador	299	0.06	298	0.06	2	0.7	0.01
4 Butte	2,382	0.44	2,374	0.44	11	0.5	0.06
5 Calaveras	323	0.06	321	0.06	1	0.3	0.01
6 Colusa	330	0.06	330	0.06	1	0.3	0.01
7 Contra Costa	13,210	2.44	13,165	2.44	151	1.1	0.85
8 Del Norte	299	0.06	299	0.06	1	0.3	0.01
9 El Dorado	1,751	0.32	1,747	0.32	8	0.5	0.05
10 Fresno	15,401	2.85	15,335	2.85	74	0.5	0.42
11 Glenn	431	0.08	430	0.08	12	2.8	0.07
12 Humboldt	1,444	0.27	1,440	0.27	28	1.9	0.16
13 Imperial	2,908	0.54	2,901	0.54	264	9.1	1.49
14 Inyo	198	0.04	198	0.04	1	0.5	0.01
15 Kern	12,888	2.38	12,850	2.38	3,323	25.8	18.72
16 Kings	2,365	0.44	2,353	0.44	8	0.3	0.05
17 Lake	684	0.13	681	0.13	8	1.2	0.05
18 Lassen	300	0.06	299	0.06	2	0.7	0.01
19 Los Angeles	152,192	28.14	151,597	28.13	6,171	4.1	34.77
20 Madera	2,291	0.42	2,280	0.42	23	1.0	0.13
21 Marin	2,830	0.52	2,805	0.52	4	0.1	0.02
22 Mariposa	135	0.02	134	0.02	4	3.0	0.02
23 Mendocino	1,102	0.20	1,097	0.20	14	1.3	0.08
24 Merced	4,278	0.79	4,261	0.79	273	6.4	1.54
25 Modoc	89	0.02	89	0.02	3	3.4	0.02
26 Mono	139	0.03	139	0.03	0	0.0	0.00
27 Monterey	7,423	1.37	7,395	1.37	1,158	15.6	6.53
28 Napa	1,676	0.31	1,669	0.31	30	1.8	0.17
29 Nevada	821	0.15	818	0.15	3	0.4	0.02
30 Orange	45,366	8.39	45,206	8.39	161	0.4	0.91
31 Placer	3,639	0.67	3,626	0.67	9	0.2	0.05
32 Plumas	180	0.03	180	0.03	1	0.6	0.01

	Total Births		Age 15 to 44		Missing		
Local	Number	Percent	Number	Percent	Number	Area %	Miss %
State	540,827	100.00	538,864	100.00	17,747	3.3	100.00
33 Riverside	28,028	5.18	27,942	5.19	525	1.9	2.96
34 Sacramento	20,424	3.78	20,345	3.78	66	0.3	0.37
35 San Benito	869	0.16	867	0.16	7	0.8	0.04
36 San Bernardino	30,824	5.70	30,732	5.70	1,215	3.9	6.85
37 San Diego	45,368	8.39	45,218	8.39	1,565	3.4	8.82
38 San Francisco	8,659	1.60	8,614	1.60	72	0.8	0.41
39 San Joaquin	10,455	1.93	10,412	1.93	217	2.1	1.22
40 San Luis Obispo	2,620	0.48	2,612	0.48	41	1.6	0.23
41 San Mateo	10,179	1.88	10,135	1.88	44	0.4	0.25
42 Santa Barbara	5,800	1.07	5,772	1.07	38	0.7	0.21
43 Santa Clara	26,997	4.99	26,917	5.00	1,076	4.0	6.06
44 Santa Cruz	3,453	0.64	3,440	0.64	31	0.9	0.17
45 Shasta	2,060	0.38	2,054	0.38	18	0.9	0.10
46 Sierra	30	0.01	30	0.01	0	0.0	0.00
47 Siskiyou	493	0.09	491	0.09	5	1.0	0.03
48 Solano	5,818	1.08	5,803	1.08	111	1.9	0.63
49 Sonoma	5,843	1.08	5,829	1.08	16	0.3	0.09
50 Stanislaus	8,022	1.48	7,994	1.48	402	5.0	2.27
51 Sutter	1,352	0.25	1,350	0.25	0	0.0	0.00
52 Tehama	758	0.14	757	0.14	4	0.5	0.02
53 Trinity	105	0.02	105	0.02	1	1.0	0.01
54 Tulare	7,602	1.41	7,570	1.40	37	0.5	0.21
55 Tuolumne	468	0.09	465	0.09	1	0.2	0.01
56 Ventura	12,008	2.22	11,968	2.22	53	0.4	0.30
57 Yolo	2,434	0.45	2,422	0.45	20	0.8	0.11
58 Yuba	1,196	0.22	1,191	0.22	1	0.1	0.01

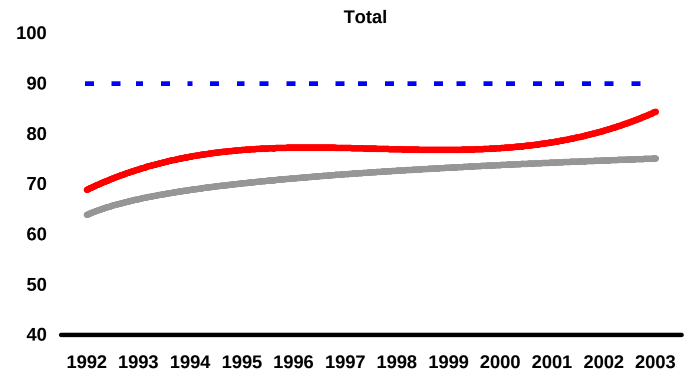
Adequacy of Prenatal Care

CROSS-COUNTY COMPARISON

County C



County B



County C — Trend Regression Results

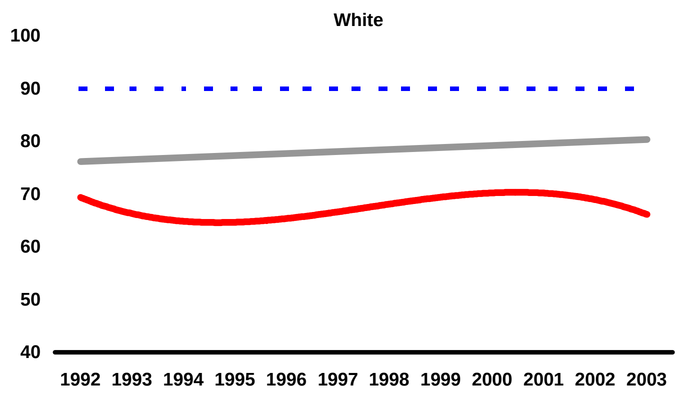
Level	Date Range	Intercept Est.	Intercept Std. Err	Slope Est.	Slope Std. Err	P-Value	Sig?
State	1992-2003	66.12	0.39	0.95	0.06	0.000	Yes
Local	1992-2003	60.77	1.44	-0.11	0.22	0.636	No
	Different?					0.000	Yes
Non-Linear							
State	1992-1994	64.79	0.41	2.04	0.58	0.010	Yes
	1994-2003	67.24	0.43	0.81	0.06	0.000	Yes
Local	1992-1996	60.62	1.08	-0.53	0.58	0.412	No
	1996-1999	49.51	10.85	2.24	1.96	0.317	No
	1999-2003	81.64	5.66	-2.35	0.59	0.016	Yes

County B — Trend Regression Results

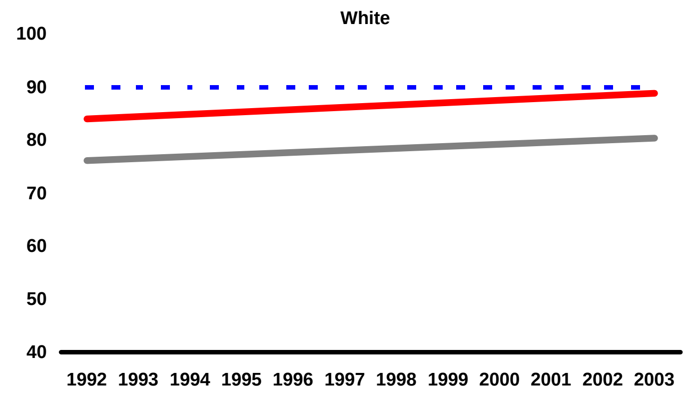
Level	Date Range	Intercept Est.	Intercept Std. Err	Slope Est.	Slope Std. Err	P-Value	Sig?
State	1992-2003	66.12	0.39	0.95	0.06	0.000	Yes
Local	1992-2003	71.67	1.07	0.94	0.17	0.000	Yes
	Different?					0.930	No
Non-Linear							
State	1992-1994	64.79	0.41	2.04	0.58	0.010	Yes
	1994-2003	67.24	0.43	0.81	0.06	0.000	Yes
Local	1992-1995	69.06	0.66	3.11	0.54	0.004	Yes
	1995-1998	81.56	5.34	-1.05	1.18	0.422	No
	1998-2003	66.22	2.54	1.50	0.28	0.006	Yes

Adequacy of Prenatal Care
CROSS-COUNTY COMPARISON

County C



County B



County C — Trend Regression Results

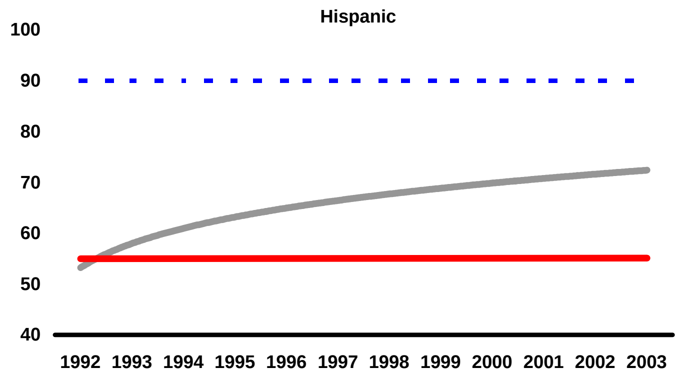
Level	Date Range	Intercept Est.	Intercept Std. Err	Slope Est.	Slope Std. Err	P-Value	Sig?
State	1992-2003	76.15	0.25	0.38	0.04	0.000	Yes
Local	1992-2003	66.30	1.30	0.21	0.21	0.349	No
	Different?					0.420	No
Non-Linear							
State	No bends						
Local	1992-1996	68.71	0.72	-1.43	0.39	0.022	Yes
	1996-1999	51.32	7.67	2.91	1.39	0.104	No
	1999-2003	80.46	4.46	-1.25	0.46	0.055	No

County B — Trend Regression Results

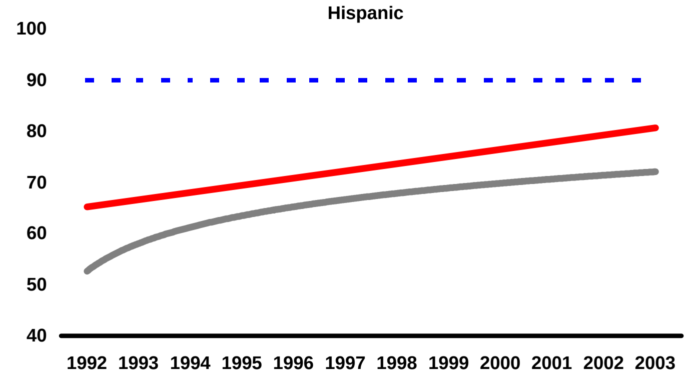
Level	Date Range	Intercept Est.	Intercept Std. Err	Slope Est.	Slope Std. Err	P-Value	Sig?
State	1992-2003	76.15	0.25	0.38	0.04	0.000	Yes
Local	1992-2003	83.87	0.33	0.46	0.06	0.000	Yes
	Different?					0.268	No
Non-Linear							
State	No bends						
Local	No bends						

Adequacy of Prenatal Care
CROSS-COUNTY COMPARISON

County C



County B



Trend Regression Results (County C)

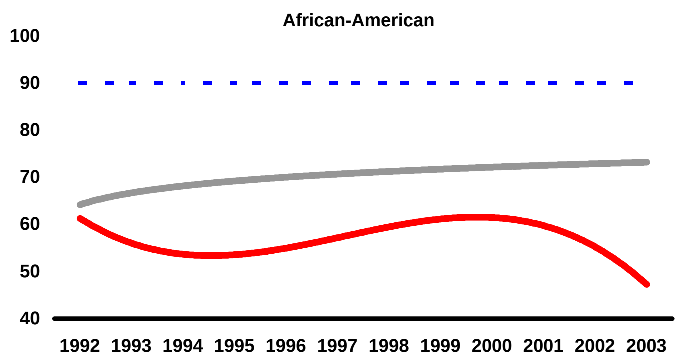
Level	Date Range	Intercept Est.	Intercept Std. Err	Slope Est.	Slope Std. Err	Slope P-Value	Sig?
State	1992-2003	56.61	0.82	1.64	0.13	0.000	Yes
Local	1992-2003	55.05	1.88	-0.06	0.28	0.843	No
	Different?					0.000	Yes
Non-Linear							
State	1992-1996	54.43	0.41	2.76	0.23	0.000	Yes
	1996-2003	61.15	0.87	1.08	0.11	0.000	Yes
Local	No bends						

Trend Regression Results (County B)

Level	Date Range	Intercept Est.	Intercept Std. Err	Slope Est.	Slope Std. Err	Slope P-Value	Sig?
State	1992-2003	56.61	0.82	1.64	0.13	0.000	Yes
Local	1992-2003	64.67	1.89	1.48	0.30	0.001	Yes
	Different?					0.623	No
Non-Linear							
State	1992-1996	54.43	0.41	2.76	0.23	0.000	Yes
	1996-2003	61.15	0.87	1.08	0.11	0.000	Yes
Local	No bends						

Adequacy of Prenatal Care
CROSS-COUNTY COMPARISON

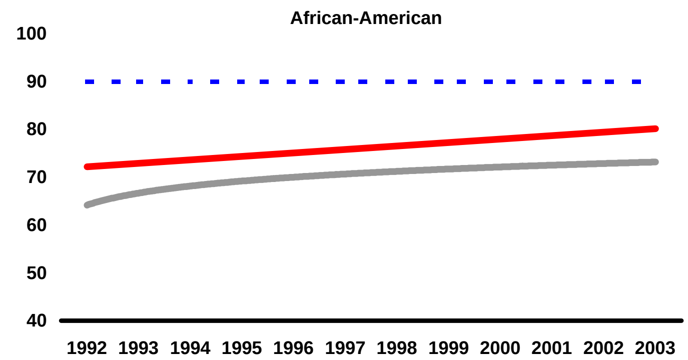
County C



Trend Regression Results

Level	Date Range	Intercept Est.	Intercept Std. Err	Slope Est.	Slope Std. Err	P-Value	Sig?
State	1992-2003	65.92	0.32	0.78	0.05	0.000	Yes
Local	1992-2003	57.66	2.77	-0.27	0.43	0.550	No
	Different?					0.016	Yes
Non-Linear							
State	1992-1998	65.40	0.29	1.00	0.10	0.000	Yes
	1998-2003	68.66	1.39	0.45	0.15	0.021	Yes
Local	1992-1996	59.76	2.00	-2.22	1.09	0.111	No
	1996-1999	31.26	19.54	4.91	3.57	0.241	No
	1999-2003	94.81	10.83	-4.17	1.12	0.020	Yes

County B

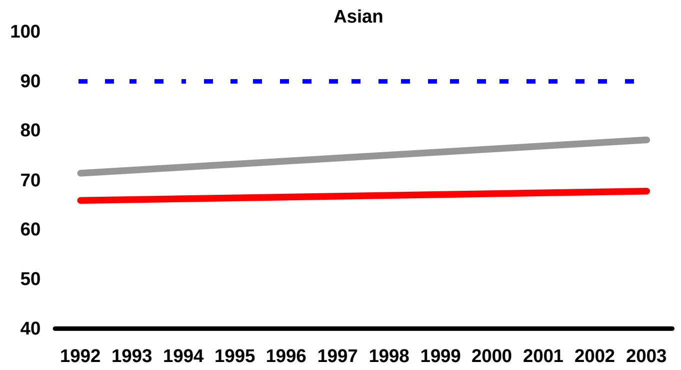


Trend Regression Results

Level	Date Range	Intercept Est.	Intercept Std. Err	Slope Est.	Slope Std. Err	P-Value	Sig?
State	1992-2003	65.92	0.32	0.78	0.05	0.000	Yes
Local	1992-2003	72.02	0.73	0.75	0.12	0.000	Yes
	Different?					0.827	No
Non-Linear							
State	1992-1998	65.40	0.29	1.00	0.10	0.000	Yes
	1998-2003	68.66	1.39	0.45	0.15	0.021	Yes
Local	No bends						

Adequacy of Prenatal Care
CROSS-COUNTY COMPARISON

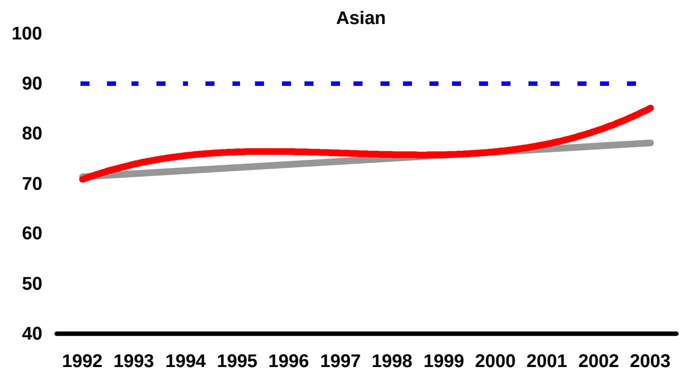
County C



Trend Regression Results

Level	Date Range	Intercept Est.	Intercept Std. Err	Slope Est.	Slope Std. Err	P-Value	Sig?
State	1992-2003	71.33	0.53	0.62	0.08	0.000	Yes
Local	1992-2003	65.88	1.49	0.15	0.22	0.522	No
	Different?					0.051	No
Non-Linear							
State	No bends						
Local	No bends						

County B



Trend Regression Results

Level	Date Range	Intercept Est.	Intercept Std. Err	Slope Est.	Slope Std. Err	P-Value	Sig?
State	1992-2003	71.33	0.53	0.62	0.08	0.000	Yes
Local	1992-2003	72.16	1.39	0.82	0.23	0.005	Yes
	Different?					0.406	No
Non-Linear							
State	No bends						
Local	1992-1994	69.67	1.08	4.33	1.59	0.053	No
	1994-1998	80.82	3.69	-1.24	0.91	0.242	No
	1998-2003	60.83	4.04	2.09	0.45	0.010	Yes

Description	Race/ Ethnicity	NUMERATOR											
		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Prenatal Care Started 1st Trimester	Total	7,548	7,484	7,408	7,362	7,196	6,894	6,702	6,919	7,071	7,007	7,006	7,259
	1 White	2,355	2,150	1,923	1,641	1,605	1,522	1,546	1,511	1,455	1,424	1,363	1,415
	2 Black	1,262	1,299	1,325	1,248	1,164	1,150	1,103	1,079	1,094	1,005	938	935
	3 Hispanic	2,729	2,950	3,101	3,450	3,442	3,280	3,193	3,461	3,596	3,661	3,746	3,987
	4 Asian	1,179	1,064	1,040	1,004	965	918	849	856	906	904	948	905
	5 AmIndian	23	21	19	19	20	24	11	12	20	13	11	17
Prenatal Care Started 3rd Trimester/None	Total	609	535	492	352	331	410	397	293	298	320	171	144
	1 White	77	82	88	50	50	42	57	30	24	24	25	21
	2 Black	99	112	109	94	58	81	64	57	46	50	19	28
	3 Hispanic	360	276	237	156	185	235	214	158	185	212	104	83
	4 Asian	72	64	57	48	37	51	61	47	43	34	23	12
	5 AmIndian	1	1	1	4	1	1	1	1	0	0	0	0
Adequacy of PNC Inadequate	Total	2,014	1,730	1,456	1,106	1,038	1,158	1,120	918	878	792	583	448
	1 White	229	243	206	154	129	126	139	101	76	67	66	49
	2 Black	310	334	288	236	176	206	170	164	153	135	87	85
	3 Hispanic	1,191	914	787	541	590	634	623	503	522	477	350	234
	4 Asian	277	232	169	170	140	188	183	149	124	112	80	80
	5 AmIndian	7	7	6	5	3	4	5	1	3	1	0	0
Adequacy of PNC Average	Total	1,318	1,028	782	706	776	705	724	662	755	731	775	624
	1 White	215	163	112	91	71	80	92	96	94	101	102	100
	2 Black	189	180	125	113	121	106	119	113	120	114	104	100
	3 Hispanic	693	534	433	409	490	420	409	360	430	436	468	346
	4 Asian	213	150	111	89	94	97	104	92	108	78	101	76
	5 AmIndian	8	1	1	4	0	2	0	1	3	2	0	2
Adequacy of PNC Adequate	Total	3,730	2,956	2,464	2,455	2,275	2,139	2,503	2,652	3,131	3,409	3,148	3,596
	1 White	1,123	702	537	451	423	410	513	538	640	782	673	760
	2 Black	547	439	374	355	323	345	335	413	470	434	420	445
	3 Hispanic	1,491	1,362	1,226	1,313	1,214	1,108	1,351	1,371	1,615	1,748	1,638	1,951
	4 Asian	559	446	324	330	311	268	300	324	398	439	410	430
	5 AmIndian	10	7	3	6	4	8	4	6	8	6	7	10
Adequacy of PNC Adequate Plus	Total	3,657	4,504	4,939	4,769	4,646	4,565	3,978	3,915	3,422	3,084	3,223	3,160
	1 White	1,156	1,398	1,356	1,175	1,169	1,089	1,002	908	741	569	603	585
	2 Black	713	824	953	874	812	801	722	621	559	490	451	413
	3 Hispanic	1,179	1,636	1,896	2,042	1,997	2,006	1,718	1,884	1,666	1,571	1,687	1,706
	4 Asian	601	631	718	665	652	655	528	496	447	447	478	449
	5 AmIndian	8	15	16	13	16	14	8	6	9	7	4	7
Adequacy of Prenatal Care Utilization Index (Kotelchuck)	Total	7,387	7,460	7,403	7,224	6,921	6,704	6,481	6,567	6,553	6,493	6,371	6,756
	1 White	2,279	2,100	1,893	1,626	1,592	1,499	1,515	1,446	1,381	1,351	1,276	1,345
	2 Black	1,260	1,263	1,327	1,229	1,135	1,146	1,057	1,034	1,029	924	871	858
	3 Hispanic	2,670	2,998	3,122	3,355	3,211	3,114	3,069	3,255	3,281	3,319	3,325	3,657
	4 Asian	1,160	1,077	1,042	995	963	923	828	820	845	886	888	879
	5 AmIndian	18	22	19	19	20	22	12	12	17	13	11	17

Description	Race/ Ethnicity	DENOMINATOR 1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Prenatal Care Started 1st Trimester	Total	10,785	10,314	9,759	9,214	8,944	8,725	7,978	8,336	8,360	8,175	7,864	7,978
	1 White	2,730	2,517	2,224	1,897	1,811	1,724	1,510	1,667	1,569	1,535	1,466	1,510
	2 Black	1,774	1,798	1,764	1,604	1,472	1,481	1,059	1,333	1,323	1,188	1,074	1,059
	3 Hispanic	4,586	4,496	4,404	4,395	4,420	4,264	4,356	4,252	4,357	4,354	4,238	4,356
	4 Asian	1,662	1,472	1,341	1,290	1,217	1,226	1,034	1,070	1,086	1,082	1,075	1,034
	5 AmIndian	33	31	26	28	24	30	19	14	25	16	11	19
Prenatal Care Started 3rd Trimester/None	Total	10,785	10,314	9,759	9,214	8,944	8,725	7,978	8,336	8,360	8,175	7,864	7,978
	1 White	2,730	2,517	2,224	1,897	1,811	1,724	1,510	1,667	1,569	1,535	1,466	1,510
	2 Black	1,774	1,798	1,764	1,604	1,472	1,481	1,059	1,333	1,323	1,188	1,074	1,059
	3 Hispanic	4,586	4,496	4,404	4,395	4,420	4,264	4,356	4,252	4,357	4,354	4,238	4,356
	4 Asian	1,662	1,472	1,341	1,290	1,217	1,226	1,034	1,070	1,086	1,082	1,075	1,034
	5 AmIndian	33	31	26	28	24	30	19	14	25	16	11	19
Adequacy of PNC Inadequate	Total	10,755	10,290	9,746	9,231	9,031	8,788	8,532	8,512	8,447	8,216	7,918	8,035
	1 White	2,729	2,511	2,222	1,894	1,831	1,728	1,765	1,670	1,572	1,535	1,456	1,508
	2 Black	1,768	1,792	1,768	1,610	1,490	1,495	1,384	1,354	1,338	1,191	1,082	1,071
	3 Hispanic	4,567	4,488	4,397	4,399	4,448	4,301	4,229	4,372	4,411	4,383	4,286	4,379
	4 Asian	1,658	1,469	1,333	1,300	1,238	1,233	1,136	1,102	1,101	1,090	1,083	1,058
	5 AmIndian	33	30	26	28	24	31	18	14	25	17	11	19
Adequacy of PNC Average	Total	10,755	10,290	9,746	9,231	9,031	8,788	8,532	8,512	8,447	8,216	7,918	8,035
	1 White	2,729	2,511	2,222	1,894	1,831	1,728	1,765	1,670	1,572	1,535	1,456	1,508
	2 Black	1,768	1,792	1,768	1,610	1,490	1,495	1,384	1,354	1,338	1,191	1,082	1,071
	3 Hispanic	4,567	4,488	4,397	4,399	4,448	4,301	4,229	4,372	4,411	4,383	4,286	4,379
	4 Asian	1,658	1,469	1,333	1,300	1,238	1,233	1,136	1,102	1,101	1,090	1,083	1,058
	5 AmIndian	33	30	26	28	24	31	18	14	25	17	11	19
Adequacy of PNC Adequate	Total	10,755	10,290	9,746	9,231	9,031	8,788	8,532	8,512	8,447	8,216	7,918	8,035
	1 White	2,729	2,511	2,222	1,894	1,831	1,728	1,765	1,670	1,572	1,535	1,456	1,508
	2 Black	1,768	1,792	1,768	1,610	1,490	1,495	1,384	1,354	1,338	1,191	1,082	1,071
	3 Hispanic	4,567	4,488	4,397	4,399	4,448	4,301	4,229	4,372	4,411	4,383	4,286	4,379
	4 Asian	1,658	1,469	1,333	1,300	1,238	1,233	1,136	1,102	1,101	1,090	1,083	1,058
	5 AmIndian	33	30	26	28	24	31	18	14	25	17	11	19
Adequacy of PNC Adequate Plus	Total	10,755	10,290	9,746	9,231	9,031	8,788	8,532	8,512	8,447	8,216	7,918	8,035
	1 White	2,729	2,511	2,222	1,894	1,831	1,728	1,765	1,670	1,572	1,535	1,456	1,508
	2 Black	1,768	1,792	1,768	1,610	1,490	1,495	1,384	1,354	1,338	1,191	1,082	1,071
	3 Hispanic	4,567	4,488	4,397	4,399	4,448	4,301	4,229	4,372	4,411	4,383	4,286	4,379
	4 Asian	1,658	1,469	1,333	1,300	1,238	1,233	1,136	1,102	1,101	1,090	1,083	1,058
	5 AmIndian	33	30	26	28	24	31	18	14	25	17	11	19
Adequacy of Prenatal Care Utilization Index (Kotelchuck)	Total	10,755	10,290	9,746	9,231	9,031	8,788	8,532	8,512	8,447	8,216	7,918	8,035
	1 White	2,729	2,511	2,222	1,894	1,831	1,728	1,765	1,670	1,572	1,535	1,456	1,508
	2 Black	1,768	1,792	1,768	1,610	1,490	1,495	1,384	1,354	1,338	1,191	1,082	1,071
	3 Hispanic	4,567	4,488	4,397	4,399	4,448	4,301	4,229	4,372	4,411	4,383	4,286	4,379
	4 Asian	1,658	1,469	1,333	1,300	1,238	1,233	1,136	1,102	1,101	1,090	1,083	1,058
	5 AmIndian	33	30	26	28	24	31	18	14	25	17	11	19

Family Health Outcomes Project

UCSF Family & Community Medicine

PARTICIPANT'S GUIDE

Trend Analysis

LEARNING OBJECTIVES

By the end of the afternoon session, participants will be able to:

1. Describe, analyze and interpret a trend
2. Interpret data from the new FHOP MCAH indicator spreadsheets
3. Identify trend results within and across jurisdictions

Following the presentations, you will break into small groups. Using the information gained during the morning and afternoon sessions, you will complete a preliminary analysis of an indicator for your health jurisdiction.

Step 1: Review Where You Are in the Process and Determine Next Steps. - 5 Minutes
To understand the impact of the population size on trend test results, each group must contain at least two counties. At least one county must have a larger population with the others midsize or small. People from the same county must sit in different groups.

The facilitator will review the steps involved in Trend Analysis and ask the group to determine its course of action for the next hour and thirty minutes. Assign a timekeeper for each activity.

Step 2: Review the Definition Tab - 5 Minutes
When is a Definition Tab in a Databook? Review and understand the difference between the general definition (on the Rates Tab) and the operational definition used to calculate the indicator. Who needs to pay attention to the variable name columns?

Step 3: Review the Data Quality Tab - 10 Minutes
Compare and discuss data quality differences across jurisdictions. Identify those that do and do not appear to have data quality problems for the indicator. Identify steps jurisdictions might take to improve data quality?

Where does your jurisdiction fall in this spectrum? Does your interpretation of this indicator need to take data quality into consideration?

Step 4: Review the Rates Tab - 20 Minutes
Review the indicator definitions to be sure you understand what is being measured. If necessary and one is included in the file, revisit the Data Definitions Tab.

Next look at the rates for your jurisdiction. Notice the number of years shown. Did your community have enough cases to calculate 12-year rates, or are there fewer years? Do the various race/ethnic groups have different rate groupings? Do the rates seem to be going up or down, or is there not a clear pattern? Do you see consistent similarities or differences across the race/ethnic groups?

Now look at the state rates. Notice that they are grouped into the same intervals as your jurisdiction for each race/ethnic group. Does the state rate seem to be going up or down or is there no clear pattern? Do you see consistent similarities or differences across race/ethnic groups at the state level?

Next check confidence intervals to see if your annual rates were higher or lower than the state rates. If your rates seem to be higher than the state, look at your lower confidence intervals. If rates seem to be lower, look at the upper confidence intervals.

Are the confidence interval bounds above or below the state rate? In one or multiple years? Over time, have confidence intervals tended to be above or below the state? For a few years at the start or end of the period? Throughout the period? Are the similarities or differences consistent across the race/ethnic groups?

How would you interpret your pattern of rates relative to the state?

Step 5: Review the Graph Tab - 20 Minutes
Before beginning this section, let's do a review. Under what conditions will trend tests be conducted? Under what conditions are non-linear tests conducted? Did your jurisdiction meet the criteria for a linear or non-linear trend test for any race/ethnic group?

The graphs portions of this tab visually plot the longitudinal pattern of data from the Rates Tab, for each race/ethnic group. Identify the line for your jurisdiction and for the state. Does this plot include a Healthy People 2010 Goal? Compare your jurisdiction and the state rates to the goal. Does your community seem to be moving toward or away from the National Goal, or making no progress? How is the state doing? Are you going in the same direction as the state or in a different direction? Do you see the same general pattern for all race/ethnic plots or does the pattern differ?

Now, to find if trend patterns are statistically significant, let's start with the linear trend test. What has been the average rate of change over the period (the trend, the slope) for your jurisdiction and the state? Is the trend statistically significant for your jurisdiction? For the state? Is your trend similar to or different from the state?

What does the intercept tell us? How is this related to the rates on the Rates Tab?

Next look at the non-linear trend tests. If you or the state has a non-linear trend, where are the break points (change in the slope, bends, splines, join points, and perhaps intercept)? Are they at the same time for the county and the state, or do they break at different intervals? Are different race/ethnic groups affected at different periods? In the same or different ways?

Why might this happen? Did a major policy shift occur at these times in your community or the state? Did your jurisdiction undergo a sudden population change? Was there a change in eligibility requirements? In medical technology? Hospital access?

Step 6: Summarize results of the analysis for your jurisdiction - 10 Minutes.
Make a bulleted list identifying key elements of your jurisdiction's longitudinal performance. Summarize key findings from the Rates and Graph tabs, including race/ethnic differences and similarities. In summarizing performance, complexity unfortunately trumps simplicity.

- Refer to the Rate Tab to evaluate statistical differences in rates.
- Refer to the Graph Tab to evaluate statistical differences in trends.
- If local rates equal state rates (Rate Tab) and local slopes equal state slopes (Graph Tab) for all race/ethnic groups, the local area is performing the same as the state, and you describe the state performance since that is your "best guess" as to how your jurisdiction is doing.
- If local race/ethnic trends are significantly different from state trends, describe race-ethnic differences. If any race/ethnic group has higher rates than others (compare the intercepts and slopes), identify the differences. Otherwise, use the total trend.
- If local trends are statistically similar to state trends, describe the state trends since that is the "best guess."
- If local trends are different from state trends, describe the state trend and the local trend.
- Statistically significant bends must be described instead of linear trends.
- If your jurisdiction has a potential data quality problem, identify how you would modify your interpretation to take this into consideration. Also identify potential steps your jurisdiction might be able to take to improve the situation.

Step 7: Prepare a 5-7 Minute Presentation - 10 Minutes.
Make a bulleted list of points summarizing conclusions for each county in the group. Focus here on cross-jurisdictional trends, similarities and differences. Select a representative speaker and be prepared to present these points and your group's conclusions.

Family Health Outcomes Project

UCSF Family & Community Medicine

Do We Have a Linear Trend?

A Beginner's Approach to Analysis of Trends in Community Health Indicators

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TABLE OF CONTENTS

TABLES AND FIGURES

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INTRODUCTION

Monitoring trends in community health status is an important public health function. Statewide trends may differ from local trends. Monitoring trends also is of value in assessing the impact of public health interventions. It is important that program staff distinguish between significant differences in a number or rate from year to year, and significant trends over 5 or more years. However, few public health managers have the analytic expertise to determine whether a trend may be occurring and, if so, whether it is statistically significant. These guidelines are intended to help program staff and epidemiologists from local health jurisdictions make such determinations. This is NOT intended to teach program managers to do trend analysis. It may help to educate them how to make appropriate trend analysis requests to data analysts or epidemiologists with whom they consult.

Since 1993, the Family Health Outcomes Project (FHOP) has provided training and technical assistance to California's 61 local maternal, adolescent and child health (MCAH) programs. We have helped counties build capacity to use health related data effectively for community health assessment, program planning, and evaluation. Over this period, FHOP has developed written methodologic guidelines for data analysis and a set of automated analytic tools.

To assist local health departments with their data analysis functions, FHOP developed *Guidelines for Statistical Analysis of Public Health Data with Attention to Small Numbers. The Guidelines* describe analytic approaches to address the problem of comparing statistics describing two groups in a given year, or comparing two observations from different years. The *Guidelines* do not discuss approaches to trend analysis.

FHOP also developed a set of Excel Data Templates to provide a tabular overview of a set of key MCAH indicators for a 12 year period and to generate statistical confidence intervals for these data. This enables comparison with state benchmark figures, for which a rate ratio and its confidence interval also are generated. Each template constructs a graph plotting indicator values over time for county data, the state benchmark estimate, and the Healthy People 2010 goals. The graph includes confidence limits for each year of data for the county indicators.

In the past, template users have compared confidence intervals between Point A and Point B. Based upon that comparison, they have made conclusions about whether there had been a significant change in the indicator value between the two time points. Although these differences may be valid, they are inadequate to provide information on *trends*. Consequently, users tend to "eyeball" graphs to see if indicator values appear to be increasing or decreasing without regard to statistical significance. This may cause a problem when analysts present graphs to community groups or decision makers who may be unfamiliar with statistical analysis and then make unwarranted conclusions. Therefore, in response to requests from county MCAH directors, we developed this briefing on linear trend analysis. We suggest that it be used in conjunction with the *Statistical Guidelines* and our Excel Data Templates.

This briefing describes some alternative ways of analyzing trends, and provides guidance for interpreting trend analysis methods. We ask the reader first to become familiar with our *Guidelines for Statistical Analysis* and our *Data Templates*.

All the resources described above are available at our website: http://www.ucsf.edu/fhop/.

We begin with a discussion on how one first approaches trend analysis. Subsequent sections include a number of examples to help the reader understand the issues involved. The Appendices include instructions for using the Trend Templates to calculate trends as well as other statistical information.

HOW TO APPROACH TREND ANALYSIS

Look at the Data. Simplify the picture as much as possible. Look at local data separately from state data. Do not include confidence intervals. Do the data form a generally straight or curved shape? If the shape is generally straight for your jurisdiction **and** for the state (or other comparison), you may use simple trend analysis methods.

If the data curve, simple trend analysis methods may be inappropriate. Using simple trend methods in the face of a complex trend would result in misleading conclusions. If, upon reviewing the data, a complex trend seems likely for either the local jurisdiction or the state, it would be best to obtain help from skilled statisticians.

Context is Essential. Trend data bear on a question at the heart of quantitative thinking: "Compared to what?" Consider what one might conclude by simply drawing a graph of county data with one line connecting county rates for two years. A simple comparison of two widely spaced time points often can miss the true picture. Adding a 2-point comparison with nearby counties, the state, or nation would give a better sense of context, but still may mislead. Nothing can replace examining the data in context, from year to year over an adequate time period. Suspected trends can be confirmed by observing linear patterns. The impact of policy or programs can be suggested by changes in direction and curves at critical times. After visually examining the data, and with sufficient numbers of cases, perhaps as few as three time points would essentially convey a 10-year trend. However, to gain this knowledge, you must start by looking carefully at all the data points, first separately then in context.

Trend Analysis is Time Sensitive. Sometimes 5-year trends (1991-1995 or 1996-2000) or 3-year rolling averages miss the big picture. Consider a county that introduced an intervention to reduce teen pregnancies. In considering whether to do trend analysis, take care to establish the appropriate intervals. It is important to group time periods and intervals so they can end before the program started and have a sufficient interval after the start to assess effectiveness. In establishing intervals, also carefully compare trends with other similar counties, the region, or the state. Note: It is widely accepted in the field of program evaluation that program effects cannot be assessed until at least 6 months after program initiation.

Quantitative Data Displays Must Have Graphical Integrity. The primary motivation for displaying data is to facilitate understanding of complex phenomena. Graphic data displays are critical to conveying unbiased statistical results. Of all methods to analyze and communicate statistical information, well-designed data graphics are usually the simplest and most powerful way to describe, explore, and summarize quantitative data. We strongly recommend that MCAH analysts hone their graphic skills.

A FEW TECHNICAL TERMS

While we wish it were otherwise, we have to introduce a few technical terms to help readers understand what they are seeing. Regression analysis is the usual statistical technique by which a series of observations are "fit" to a trend line. This line may be straight (the simple case, presented here) or may have some other shape (the complex case).

When we are using regression to examine data for a trend, we are trying to calculate the "best" line to describe the fit between our outcome of interest, referred to as the dependent variable (the rate in a given year, typically shown in a trend analysis formula as "Y") and our independent factor or factors whose impact we are assessing ("X"). In trend analysis the independent variable typically is time, in this case expressed as years. In this situation, three basic statistics are most helpful: the intercept, the slope, and the probability (P-value). It also is helpful to understand the difference between the confidence interval (CI) and the standard error (SE). These are described in the immediately following paragraphs.

The slope is the average rate of change over the years being examined. The slope is the most important part of a trend model. It represents the rate at which change occurs over time. Interpreting the slope is straightforward. If the value of the slope is zero, there was no trend. The indicator did not change with time. A graph showing a zero slope has a horizontal line. If the slope has a positive value, the rate is increasing. If it is negative, the rate is decreasing. We interpret the slope to mean that, on average, the rate changed by the slope value each year. The issue is whether the slope value is significantly different from zero, i.e., is the P-value less than or equal to 0.05. If it is, we have a linear trend. If it is not, we must conclude there is no meaningful trend. Example 1 illustrates a simple linear trend.

Complex regression analysis adds more factors and/or different mathematical techniques to the basic formula. However, the basic purpose is the same: to "fit" the "best" line to summarize the data trend. Examples 2 and 3 illustrate situations using different mathematical models.

Finally, the data can reflect a more complex picture with a change (or bend) in the slope, a change in the intercept, or both. Example 4 illustrates a change in the slope.

The intercept is the estimated rate at the start of the period examined. In the regression formula, the intercept typically is shown as a number, without the X following it.

Under certain circumstances, the intercept can change without an accompanying change in the slope. For example, the percent of infants born with low birthweight could drop from one year to the next in the absence of a trend and remain at this lower value. This change could be statistically significant in the absence of a trend. Example 2 illustrates such a situation. The trend is flat from 1992 through 1994, then drops and remains essentially flat through the end of the period. This shows as a statistically significant trend, even though it in fact is due entirely to a drop in the intercept.

The probability value (P-value) reflects the likelihood that the model results are due to chance. Whether the model is simple or complex, the P-value summarizes the statistical results for both the variables in the model and the final model overall. The interested reader should refer to an introductory statistics text to understand how the P-value is calculated. Here, it suffices to say that a P-value less than 0.05 ($P<0.05$) is statistically significant. In the presence of $P<0.05$, you are safe to reject the null hypothesis that there is no trend or there are no differences among the comparisons. If the P-value is greater than 0.05, then you must accept that there is no trend and/or no differences among the comparison groups. In this latter case, you would conclude that the county results are similar to the state results.

Standard Error. Most public health professionals are familiar with the confidence interval (CI), calculated on one year at a time. The CI is useful to help understand if your county rate is different from or similar to the state rate in any given year or compared with **one** other year. However, the CI is not the appropriate statistic to use in trend analysis. In fact, comparing one year to another over a 10-year period without a linear regression analysis could be misleading. Instead, the standard error (SE), or the CI around the slope and intercept is used to determine if the rate is different from its comparison, e.g., the state.

To help readers unfamiliar with regression methods for trend analysis, we developed a Trend Template (shown in Appendix A) which we used to do Example 1, a simple linear trend. The template calculates the basic statistics described above, and includes others that help to get a full understanding of the trend model. This template is inappropriate for curvilinear or any other complex data trend

EXAMPLE 1: A LINEAR TREND, THE SIMPLE CASE

For the 10-year period 1991 to 2000, Table 1 shows the annual state and county fertility rate and the county confidence interval (CI) per 1,000 women age 15 to 44. This shows the state fertility rate dropped from 83.5 to 71.9 per 1,000 women age 15 to 44. During this same period, the county fertility rate dropped from 71.4 to 63.6. Figure 1 also shows that the county upper CI always has been below the state rate. Thus we can conclude that the county fertility rate has been significantly lower than the state rate for at least ten years.

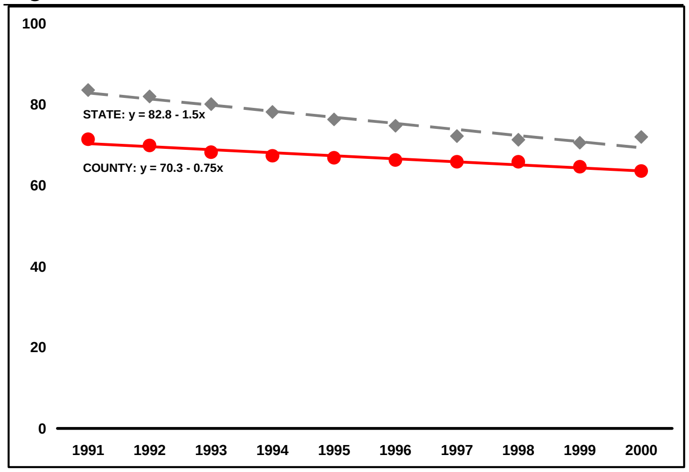
Table 1: County Fertility Rate per 1,000 Women Age 15 to 44 -- 1991 to 2000

Year		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Rate	State	83.5	82.0	80.1	78.1	76.3	74.7	72.2	71.2	70.5	71.9
	County	71.4	69.9	68.2	67.3	66.8	66.3	65.8	65.8	64.6	63.6
County	Lower CI	68.2	66.8	65.2	64.3	63.9	63.4	62.9	62.9	61.8	60.8
95% CI	Upper CI	74.5	72.9	71.2	70.3	69.7	69.2	68.7	68.7	67.4	66.3

At this point, it would be helpful to know two things: First, does the county have a statistically significant linear trend? Second, if it does, is the county trend similar to or different from what is happening at the state level?

Using the Trend Template in Appendix A and the Excel methods described in Appendix B, Figure 1 summarizes the results to answer these questions. Instead of a line connecting the year-to-year rates, we show regression lines for the annual county and state rates. Trend analysis focuses on the standard error rather than the CI. In plotting trends, neither CIs nor standard errors are shown. However, results of the statistical tests are summarized either in the plot or in the accompanying text. Finally, we omitted most horizontal lines and all vertical lines to maximize "white space." These visual aids enhance the ability of viewers to focus on the trends.

Figure 1: Fertility Rate per 1,000 Women
Age 15 to 44 -- 1991 to 2000



First notice that the regression line is slightly above or slightly below the center for most data points. That line represents the "best fit" for the data we have. The regressions tested if the line slope is significantly different from zero. We put the "best fit" formula of each test below its regression line. This does not show the statistical significance of the results.

In the County, the rate in a given year (y) dropped -0.76 (the slope) from the average rate over the 10 years of 70.3 per 1,000 women (the intercept). The trend template indicates that the slope is significantly different from zero (that is, we have a linear trend) at a P-value <0.0000. Since this P-value is less than 0.05, we can answer our first question: Do we have a statistically significant linear trend? The county fertility rate is declining at the statistically significant rate of about -0.75 annually from an intercept rate in 1991 of 71.1 per 1,000 women age 15 to 44.

Now let's answer the second question: Does the county trend differ from the state? We start by testing if the state trend is significantly different from zero. Starting from a rate in 1991 of 82.8 (the intercept) the state rate is decreasing annually about -1.5 per year (the slope), and the trend is statistically significant at P<0.0000. Thus, we have two statistically significant trends, one in the county and another in the state.

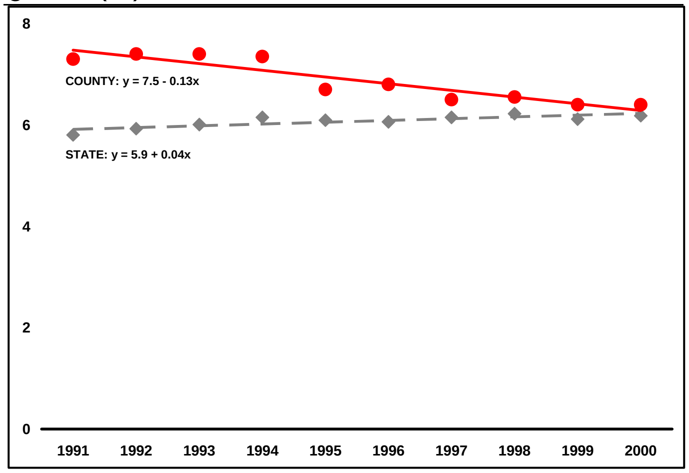
At this point, we can test if the trends are similar. That is, is the difference between the state slope (-1.5) and the county slope (-0.75) statistically significant. The trend template calculated that the difference between these slopes (0.75) has a P-value of 0.0002. This indicates that the state fertility rate is dropping faster than the county fertility rate.

From these analyses, we can conclude the following: The fertility rate for females age 15 to 44 has been declining during the period 1991 to 2000, statewide and in this county. Over this period, the rate of change (the slope) was smaller for the county than the state. The county upper confidence interval (Table 1) was below the state rate in every year, indicating the county rate was lower throughout this period.

EXAMPLE 2: A CHANGE IN THE INTERCEPT

In this example, our county knew for many years that its percent of infants born weighing less than 2,500 grams was higher than the state average. In 1994, they decided to do an outreach program to increase enrollment in WIC programs for low-income women. Figure 2 below compares the percent of infants born who weighed less than 2,500 grams for the county and state for the 10-year period 1991-2000.

Figure 2: Newborn birthweight less than 2,500 grams (%), 1991-2000



Treating the county line as if it was an uninterrupted trend, regression results show that the county average rate at the start of the period (intercept) was 7.5 and the annual rate of change (slope) was -0.13. The trend template calculated a significant trend (P=0.0001). The state regression results indicate the percent of low birthweight infants increased slightly at 0.04 per year from an intercept of 5.9%. Again the trend template indicates the state increase was statistically significant (P = 0.0028), as was the test for the difference of slopes (P<0.0000).

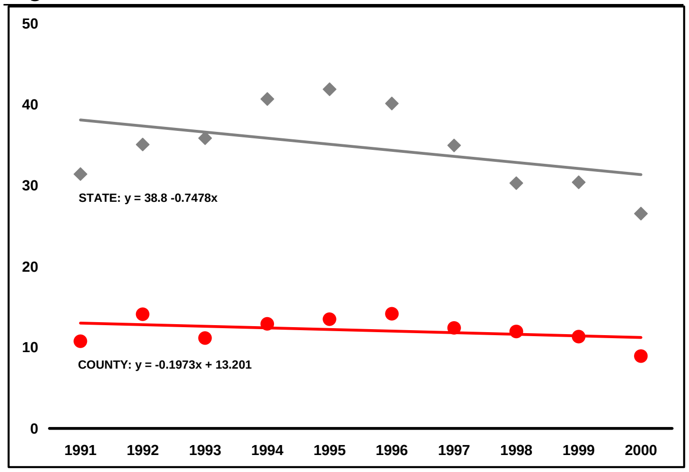
Trend analysis results reflected in the county formula are statistically significant, and highlight the county's accomplishments. By the end of the period, the county CI overlapped the state rate, indicating the WIC intervention was associated with a change in the county percent of low birthweights into the "average" range. However, the state and county are going in opposite directions. If current trends continue at both levels, the county percent of low birth weights will be below the state average in a few years. However, simple linear regression as used in this example probably is not the appropriate test for these data.

Notice how poorly the county line fits the observed data points. In fact, the county rate was stable from 1990 to 1994, dropped near the state rate when the program was implemented, and since 1995 has not been significantly different from the state rate. In this situation, it would be best to speak with a statistician to obtain a test for difference in the intercept.

EXAMPLE 3: CURVILINEAR TRENDS

Next, we examine trends for the fertility rate per 1,000 girls age 10 to 14 between 1991 and 2000. As before, Figure 3A shows the observed data points, regression lines and model results using the linear trend template. Notice that both trend lines slope down, indicating the possibility of a trend for the fertility rate to decrease. However, the linear trend test was statistically non-significant for both the state (p = 0.40) and county (p = 30).

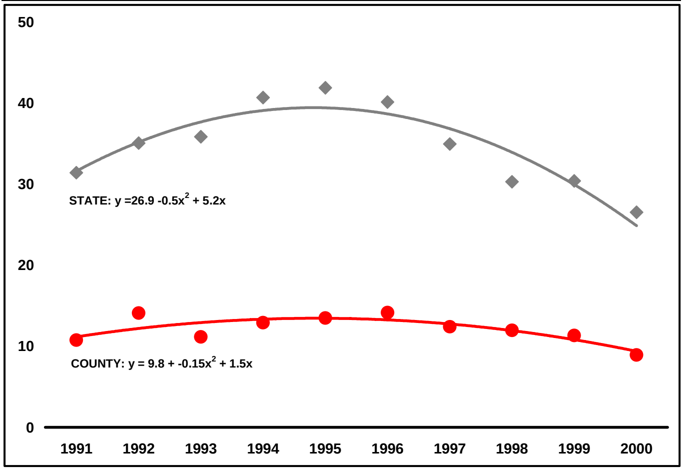
Figure 3A: Fertility Rate per 1,000 Girls Age 10 to 14 -- 1991 to 2000 Linear Trend



If the straight line is a "good fit", the data points would form no particular pattern relative to the line. Some points would be above the line, some below, in a random pattern as in Example 1. If the straight line is a "bad fit", you usually see a clustered rather than a random pattern. The points above the line would cluster near each other; points below the line also would cluster near each other. Sometimes there may be two clusters above or below the line.

As an example, look more closely at the state data points in Figure 3A, relative to the linear trend line. The 1994, 1995, 1996 and 1997 data points are above the line. Data points below the line are in two clusters (years 1991-1993 and 1998-2000). Clearly in this example, you have a clustered, not random, pattern. You would conclude that the linear model is a "bad fit." In this situation we recommend that you obtain a statistical consultation.

Figure 3B: Fertility Rate per 1,000 Girls Age 10 to 14 -- 1991 to 2000 Curvilinear



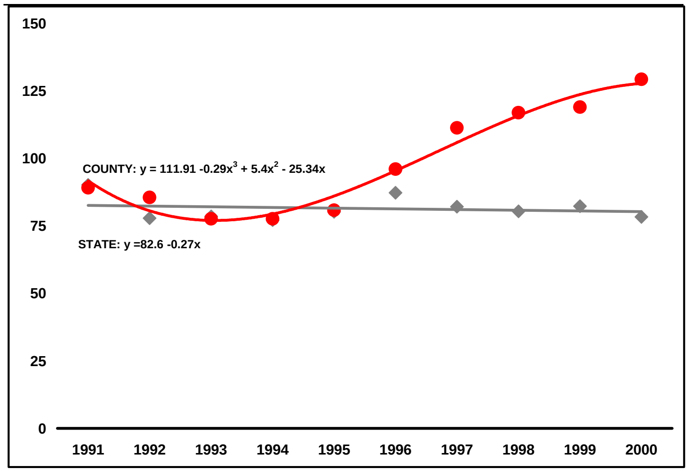
When your data are not explained with the simple linear model, you may find that more complex models fit better. These can be examined using the various alternatives on the "Type" Tab shown in Step 2 of Appendix B. Fitting a "Power" trend line to this data gives you the result shown in Figure 3B. These may make the visual understanding of your data more clear. However, the statistical interpretation of your results becomes more complex and is beyond the scope of this document.

During this 10-year period, both the county and state had what is known as a "polynomial" trend. That is, the best-fitting line is curvilinear, rising through 1995 and declining thereafter. Throughout the period, the county rate was lower, and its curve (-0.15) was flatter than the state curve (-0.5). Based on the R-squared, or the total amount of variance explained by the model (which Excel can give), both curves were statistically significant, when the linear trends were not. When you see this or any other type of complex trend, we recommend statistical consultation to be sure you are interpreting it correctly.

EXAMPLE 4: ANOTHER COMPLEX TREND

In this example we are looking at mental health hospital admissions for adolescents age 15 to 19. Throughout the period, Figure 4 shows the state rate was relatively stable, and at P = 0.6060 (from the template), there was no trend. However, the county rates display as markedly curvilinear and the Excel regression line that appears to best fit the data is a third degree polynomial. Note that this regression result cannot be obtained with the trend template FHOP developed.

Figure 4: Psychiatric Admission Rate per 10,000 Adolescents 15-19 -- 1991 to 2000



If you examine the data points closely, you will see that the county rate was declining through 1994. After 1995, it increased markedly and in a curvilinear pattern. To tease out this complexity, advanced methods are needed that we do not describe in this monograph. However, we identify this situation so you will know that if you see it, you may wish to seek help from a statistician to see if a spline model might fit or if you should use the National Cancer Institute's JoinPoint software to test these data.

SUMMARY

This document introduced a few ways to look at linear trends. We started with the statistical concepts of intercept, slope, and probability. Then we showed a table with observed data points and their associated confidence intervals. These were analyzed using the FHOP data template, to test if the data had a statistically significant linear trend. Next, we showed the observed state and county points and regression lines on the same graph. We identified that a linear trend test was an appropriate method for these data. In the discussion for this section, we gave an example of how to compare and interpret results.

The complex curvilinear trend examples provided a few variations of how these look and how they may be interpreted. We wish to highlight that curvilinear trends occur frequently. Because of their frequency, we urge caution when complex curves present themselves, and recommend readers seek help from qualified statisticians in such circumstances. The only trend a non-statistician should be testing using the FHOP trend template is Example One, which was linear for both the county and state. If you see anything else, get a statistical consultation.

Regression can be a useful exploratory tool to understand trends. Exploratory estimates of the rate of change -- the county's intercept and slope – can be helpful in assessing simple trends. Properly interpreted, the results can provide unbiased estimates of the intercept and slope of the pattern of change.

APPENDIX A: LINEAR TREND TEMPLATE

This shows the results produced by the linear trends template for the analysis of Example 1. The important statistics for purposes of this monograph are highlighted.

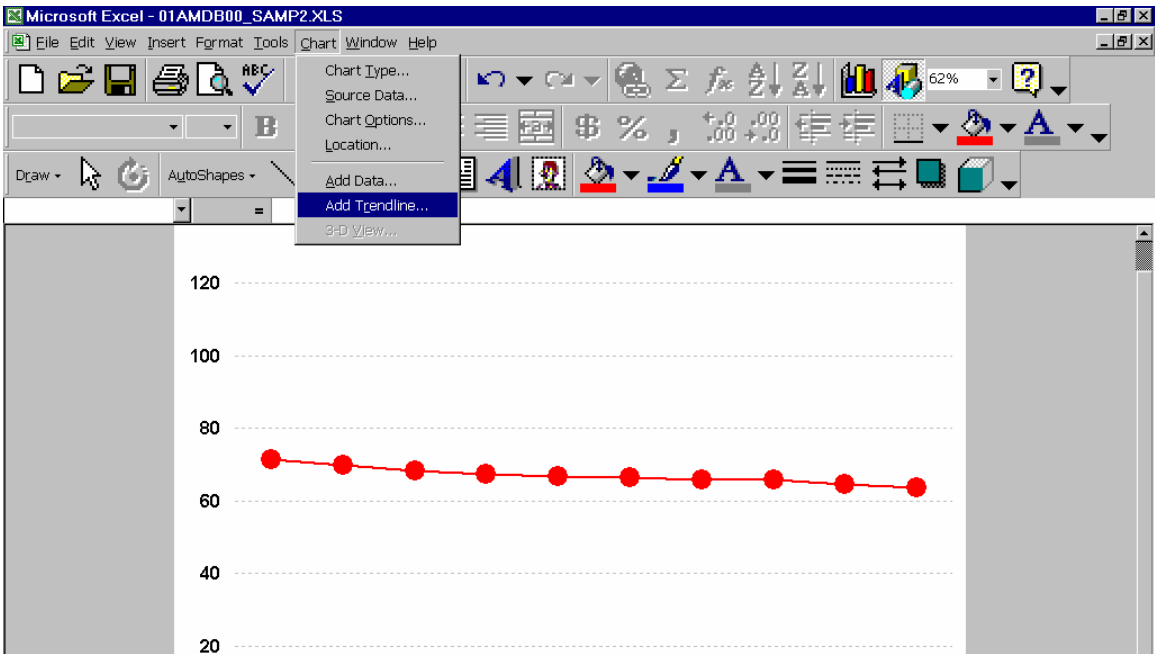
Linear Trend Template Results Example 1

Year	Calendar	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	Start	0	1	2	3	4	5	6	7	8	9
Rate	State	83.5	82.0	80.1	78.1	76.3	74.7	72.2	71.2	70.5	71.9
	County	71.4	69.9	68.2	67.3	66.8	66.3	65.8	65.8	64.6	63.6
County	Lower CI	68.2	66.8	65.2	64.3	63.9	63.4	62.9	62.9	61.8	60.8
95% CI	Upper CI	74.5	72.9	71.2	70.3	69.7	69.2	68.7	68.7	67.4	66.3
		State		County							
		Estimate	Std. Err	Estimate	Std. Err						
Regression	Intercept	82.8	0.7	70.3	0.4						
Statistics	Slope	(1.5)	0.1	(0.8)	0.1						
	R2	0.94		0.93							
	F	118.2		114.9							
	SE v	1.3		0.4							
	DF	8		8							
	SS reg	186.6		46.4							
	SS resid	12.6		3.2							
T-Test H0	T-stat	(10.87)			(10.72)						
Slope = 0	Prob T	0.0000			0.0000						
	Reject	YES			YES						
T-Test H0	Difference	(0.75)									
County Trend	Std Err Diff	0.16									
= State Trend	T-Test	(4.86)									
	Prob T Diff	0.0002									
	Reject	YES									

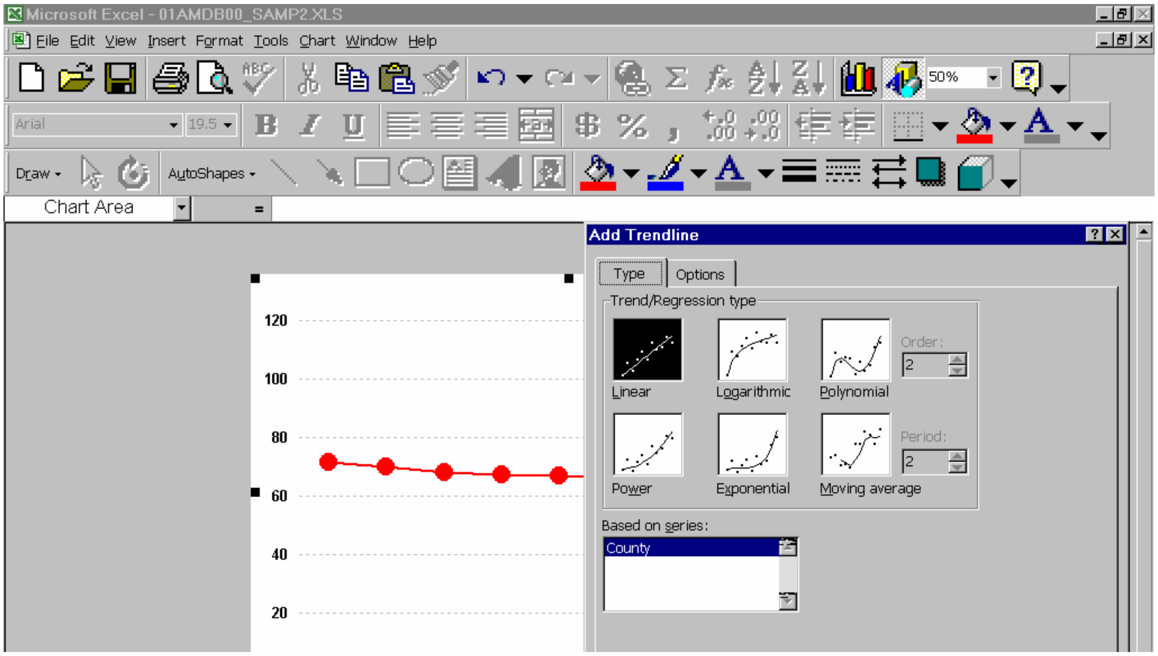
APPENDIX B:
USING EXCEL TO OBTAIN LINEAR TREND RESULTS

This example begins when the reader has data organized into a linear graph. As our example, we use county data in the linear trend template. This and subsequent figures are cropped to focus on the point being made.

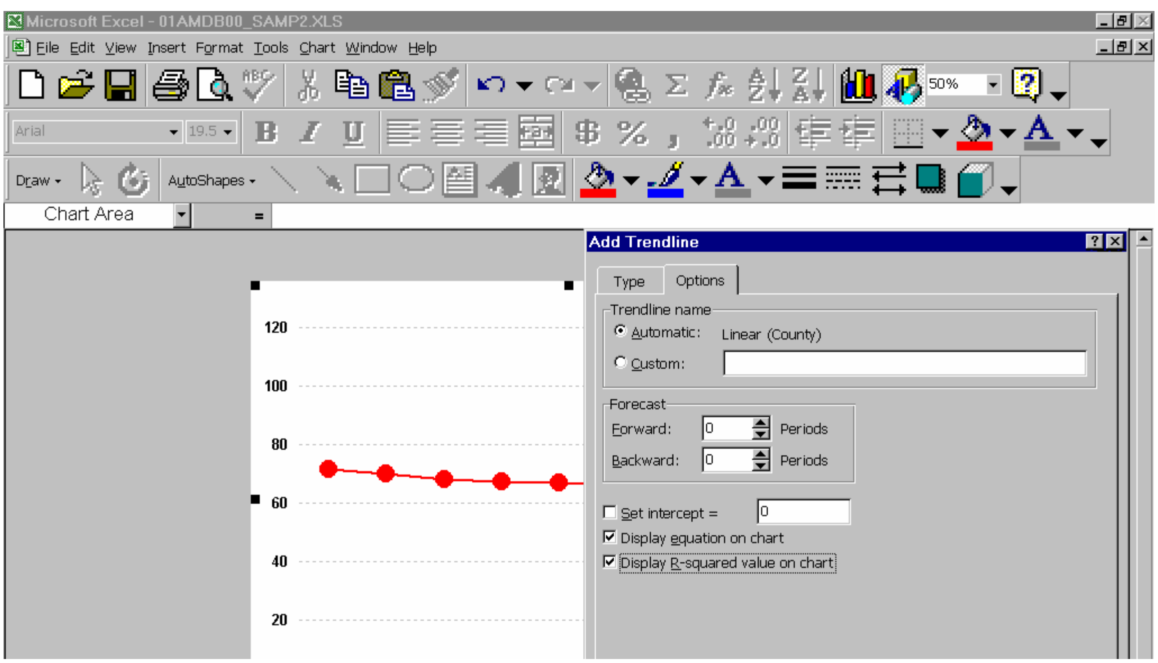
1. Click on chart, then click on Add Trendline



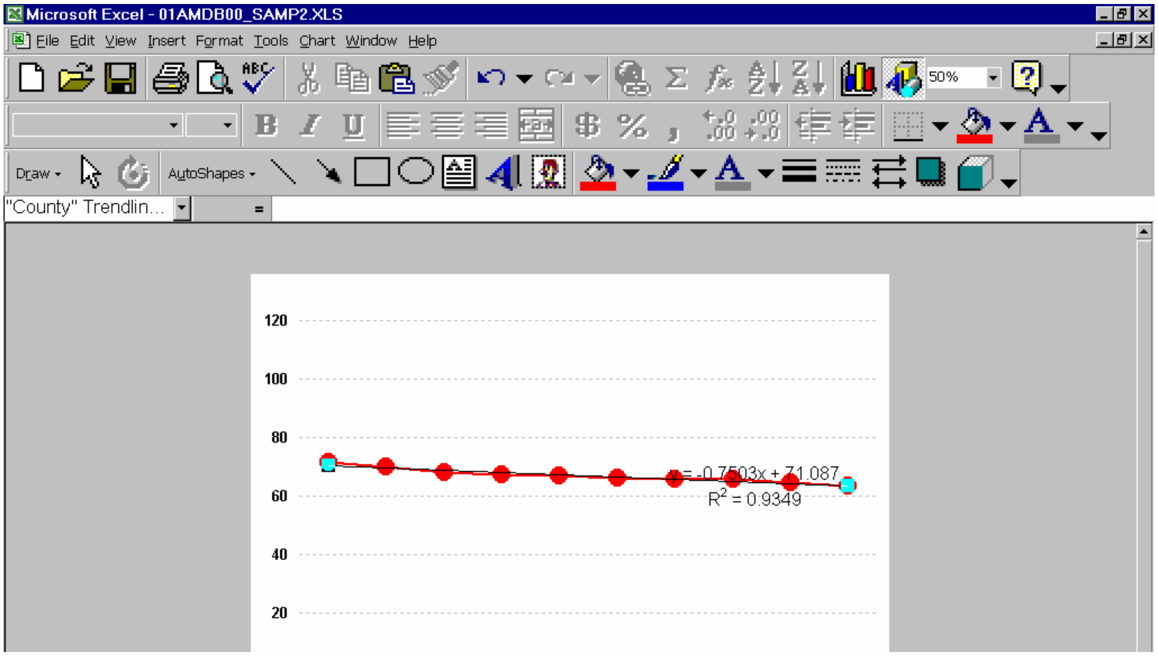
2. Pick the kind of trendline you want to test. In this case, because we think we have a simple linear trend, we picked the first display option. In other examples, we got our best results with other trends, which we tested in turn until we found the "best fitting" model. The "best fitting" model has the highest R^2. If two models have similar R^2, pick the simpler model.



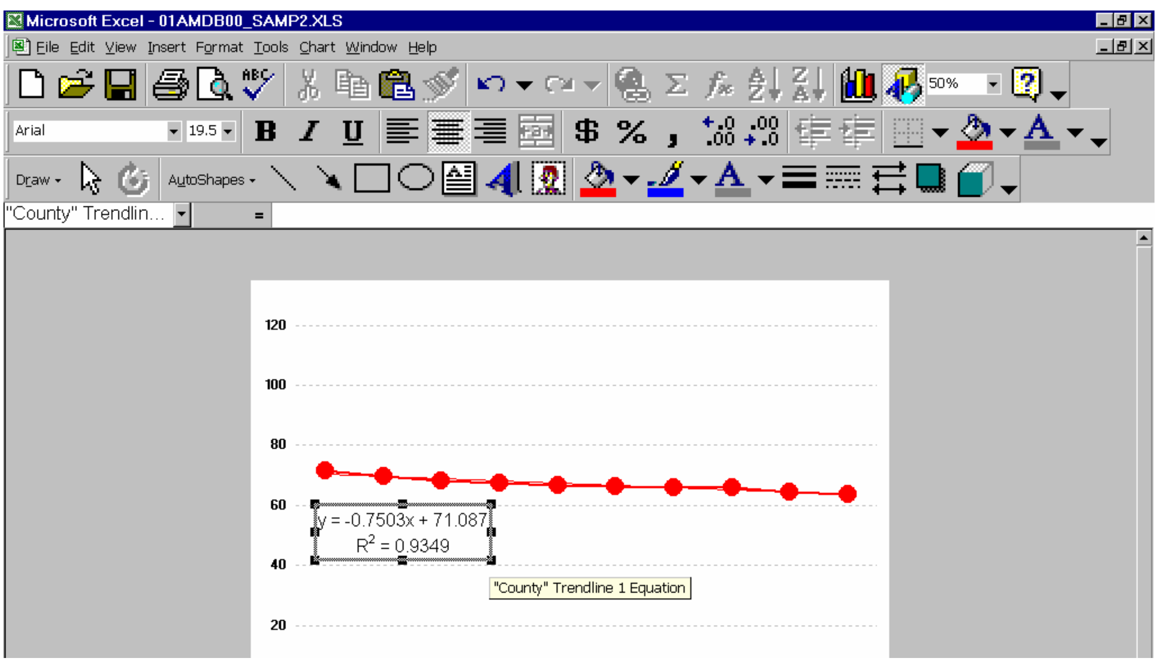
3. Now click on the Options Tab. Select "Automatic" trendline, "Display Equation on Chart" and "Display R-squared value on chart."



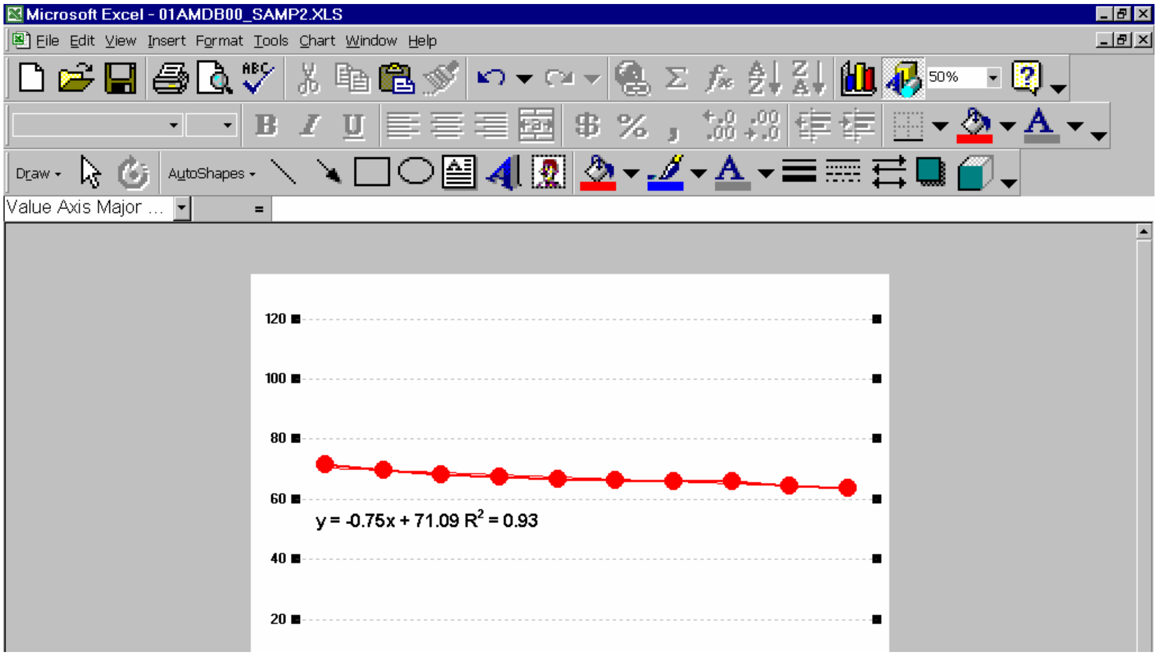
4. This generated a picture with a trendline and the regression results that looks a bit messy. Because the county rate is consistent from year to year, the trendline and the regression results are overlaid on the line connecting the rates. Let's fix this up.



5. In this case, we want to keep the results of the regression, but we do not want it to overlay the graph line. Select the box that contains the equation and move it to the location you want.



6. You can make the equation a bit more readable by reducing the number of digits that show. In general, there is no need to display more than 1 or 2 decimal points. Remember to round figures when you shorten the displays. Also, you can move the R^2 statistic to the same line as the slope and intercept.



APPENDIX C: RESOURCES

Healthy People 2010. Available at: http://www.healthypeople.gov. At this site, you will find the national health goals and objectives.

Tufte ER. The Visual Display of Quantitative Information. Cheshire, CT: Graphics Press. 1983. This is the first in a series of three books Tufte wrote that revolutionized how we think about the presentation of data. http://www.edwardtufte.com/tufte/.

Oreglia A: Public Health Rate Program (PHRATE), Version 1.1. Vital Statistics Section, Center for Health Statistics, California Department of Health Services: May 1993. This public release program Available for $10 enables an analyst to calculate various simple statistics: http://www.dhs.cahwnet.gov/hisp/chs/OHIR/Catalog/DataProductCatalog.htm.

Singer JD and Willett JB. Applied Longitudinal Data Analysis: Modeling Change and Event Occurrence. New York: Oxford University Press, 2003. This excellent book for statisticians describes the theory and shows methods underlying longitudinal data analysis. The authors have released programs written to duplicate examples presented in their book for the following statistical software programs: MPlus, MLWin, HLM, SAS, STATA, SPlus, and SPSS. These programs are at: http://www.ats.ucla.edu/stat/stata/examples/alda/.

Example 4 showed an example where the data were best described using two intersecting straight lines rather than a quadratic or higher-degree polynomial, in order to capture the exact point (also called "bend" or "knot") where the trend changed. This type of model is called a "linear spline model," or a first-degree polynomial (straight lines) model. While a single straight line can be fitted using ordinary least squares models, fitting splines requires special methods.

To do Example 4, FHOP staff used an algorithm contained in a macro we developed using SAS. To obtain a copy, please send email to lremy@fcm.ucsf.edu or lremy@well.com.

JoinPoint Regression Program. The National Cancer Institute offers this easy-to-use statistical freeware to model longitudinal trends using spline methods. After a simple registration procedure, it can be downloaded from: http://srab.cancer.gov/joinpoint/.

NCI has developed other statistical software to analyze complex trends as described at http://srab.cancer.gov/software/text.html. These various freeware packages can be used for a variety of public health trend analysis needs.

The following are some references showing the use and interpretation of splines. PDF versions of these papers can be obtained by sending email to lremy@well.com.

Pollio DE, Spitznagel EL, North CS, Thompson S, Foster DA. Service use over time and achievement of stable housing in a mentally ill homeless population. Psychiatric Services, Dec. 2000, 51(12), 1536-1543. This article shows the use of spline trends with a small sample (n = 55) followed for 24 consecutive months.

Kim S, Kim K. Personal, temporal and spatial characteristics of seriously injured crash-involved seat belt non-users in Hawaii. Accid Anal Prev. 2003 Jan; 35(1):121-30. This study used police crash data over a 10-year period.

MacNab YC. A Bayesian hierarchical model for accident and injury surveillance. Accid Anal Prev. 2003 Jan; 35(1):91-102. This studied trends for motor vehicle accident injuries to boys aged 0-24 between 1987 and 1996 in British Columbia.

Family Health Outcomes Project

UCSF Family & Community Medicine

Title V 5-Year Needs Assessment Indicators

DATABOOK 1992 to 2003

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Funding Provided by the
Maternal Child and Adolescent Health Branch
California Department of Health Services

October 2005

TABLE OF CONTENTS

TABLE OF TABLES AND FIGURES

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TITLE V 5-YEAR NEEDS ASSESSMENT INDICATORS DATABOOK 2005

The 2005 version of the set of Title V Indicator Databooks has changed significantly. The purpose of this document is to provide an overview of the changes and to introduce implications for using the Databooks to inform local monitoring and planning activities.

LAYOUT

The revised databook contains a minimum of four types of tabs: Data, Data Quality, Rates, and Graphs. A few databooks also have a Definition tab.

Data Tabs. As in previous years, the Data Tabs are a 2-tab set of 12 years of local jurisdiction and state data summarizing required and optional indicators. Each Data Tab presents the numerators with the appropriate denominators to calculate rates. Data presented here are the source for calculating Rates and Graphs tab for each indicator.

Definition Tab. A few indicators include a Definitions Tab to provide more specific information as to how they were calculated. These are mainly indicators using a population subset, e.g., births to mothers age 15 to 44, singleton births. In these instances, the total reported will be less than the total for the source data, e.g., all births vs. singleton births. Other indicators require adding cases from multiple data sources, e.g., births and fetal deaths. For these indicators the total number typically reported will be greater than either file independently.

The Data Quality Tab focuses on the last year in the 12-year trend. It identifies key data quality issues that may impact reliability of information used to calculate the indicator. Jurisdictions are advised to review this tab carefully to understand if underlying quality issues affect their data to such an extent that the validity of their local statistics may be compromised. Jurisdictions with proportionally more exclusions may have distorted rates due to the smaller numbers of cases used. In these cases it is difficult to know if the county truly is an outlier for the indicator or if the results are affected by a problem with the underlying data. If data quality appears to be compromised, jurisdictions are urged to be extremely careful in reporting their data.

The Rate Tab incorporates information previously available in the FHOP data templates. This table is preset to print in three pages.

Page 1 defines the indicator and its risk factors. Below this is the rate table for total cases. It may have as many as 12 or as few as no data rows, depending on the number of cases available. Rules for determining the number of rows are in the next section of this document. Below the rate table on page 1, we identify the data sources and additional analyses you might wish to undertake to understand your jurisdiction's performance on the indicator.

Page 2 of the rate table summarizes rates for White Non-Hispanic and Hispanic All-Race, and Page 3 summarizes results for Non-Hispanic African-American and Asian populations. We used the same rules to calculate these tables as we used for the Total table.

The Graph Tab new this year. This summarizes results of trend tests for data on the Rate Tab. As with the Rate Tab, page 1 summarizes results for all data, page 2 for White Non-Hispanic and Hispanic All-Race, and page 3 for Non-Hispanic African American and Asians. Methods for calculating trend statistics are described in Appendix A.

CALCULATING ANNUAL RATES

MINIMUM NUMBER OF EVENTS

If the minimum number of events over all years was greater than or equal to 10 in each year, the 12 years of indicator data was left as given.[1] If the minimum number of events in any period was less than 10, we aggregated the data into six 2-year periods. If the minimum still was less than ten, we aggregated into four 3-year periods. When all four 3-year periods still did not meet the minimum of 10, we declared the number of cases not big enough and did not calculate rates. These are shown on the Rates tab by the phrase "Rates not calculated." Otherwise, the Rates Tab tables show the periods, numerators, rates, and rate confidence intervals.

Given the final level of aggregation for the local data, the same aggregation was performed on the corresponding California data. Then the local and state data were merged for side-by-side presentation in the Rate Tab.

DENOMINATORS

We used two different types of denominators: Annual county-level population estimates from the California Department of Finance (DOF), and counts based on qualifying records from the birth certificates and/or or fetal death certificates.

The DOF one-year age categories were summarized as needed for the indicators that use state population as their denominators. Some indicators use only certain ages in the female population for denominators, others use all population or all population in given age categories.

Some indicators have as their denominator the total number of records in a given category and file, for example from the birth certificates file, the number of women age 15 to 44 delivering a live born infant. Others need refinement: women age 15 to 44 delivering a live born singleton infant. Before deciding if a record meets the minimum qualifying condition(s), our macros check to be sure we are excluding invalid or unlikely cases (age missing, 92 year old mother, 27-month gestational age, 5 gram birthweight). We set aside cases outside allowable ranges and report the frequency on the Data Quality Table described in a later section.

RACE/ETHNICITY

The various data sources we used had different definitions of race/ethnicity over time. After the 2000 Census, the federal government issued bridging guidelines.[2] These recommend that longitudinal investigations use their recommended groupings until sufficient years are available to permit more detailed analyses of the complexities of race and ethnicity.

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1 Note that the minimum numbers we used are smaller than those suggested in FHOP's "Small Numbers Guidelines," because the focus is on longitudinal trends rather than one-year comparisons, and the statistical tests we used are based on counts rather than rates.

2 Provisional Guidance on the Implementation of the 1997 Standards for Federal Data on Race and Ethnicity. Executive Office of the President, Office of Management and Budget, Washington, D.C. 20503. December 15, 2000

California requires state-funded researchers to use Department of Finance (DOF) population estimates.[3] The DOF provides county-level estimates by sex and race/ethnicity, with age in 1-year intervals. Through 1999, race/ethnicity was categorized as White, Black, Hispanic (all races), Asian and Pacific Islander, and American Indian. In the DOF classification, All-race Hispanic was assigned first. The remainder were assigned to White, Black, Asian/Pacific Islander, and American Indian. Groups that did not fit these classifications were assigned to White race/ethnicity.

For 2000 and later, DOF classifies race as White, Black, Hispanic, Asian, Pacific Islander, American Indian, and Multi-race. To make race/ethnic classifications compatible longitudinally, we combined the 2000-and-later race categories as follows. First, we combined Asian with Pacific Islander. Then we broke apart the Multi-race category using the DOF multi-race allocation table, which gives the percentage to allocate to each race, within each county separately.[4] Note that the Hispanic category had no multi-race allocation because the DOF made assignment to this category before assigning to other single- or multi-race categories. Also note that the DOF allocation table was based on the 2000 census, and we use it for years later than 2000 as well, as the DOF guidelines recommend.

We did other bridging reclassifications for records in the birth, death, and fetal death certificates, and for records from the hospital discharge data in order to attain compatability across numerator and denominator sources. This was accomplished using SAS macros. The result is five race/ethnic groups: White, Black, Hispanic All-Race, Asian, American Indian. In calculating total population rates, we include all cases, but we do not calculate rates for American Indians. Their numbers are small and we believe unreliable because of definitional issues.

CALCULATING RATES AND CONFIDENCE INTERVALS

Rates were calculated overall and for each race/ethnic group by dividing the numerator (number of events) by its appropriate denominator (population, births, deaths, etc), and multiplying the result times the appropriate factor (e.g. rate per 1000 births, etc.). The confidence interval for the rate was calculated using the Wilson score without continuity correction.[5 6]

EXAMPLE DATA QUALITY TAB

The Data Quality Tab focuses on the numbers of cases set aside in the last year of the 12-year period for each grouped set of indicators. Table 1 presents an example of a Data Quality Tab. The top part identifies the indicator that has been pre-screened for data quality, in this case the Kotelchuck Index for Adequacy of Prenatal Care. Then it describes the implications in terms of whether a county can rely on the reasonableness of the resulting index.

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3 See: http://www.dof.ca.gov/html/Demograp/DRU_datafiles/DRU_datafiles.htm. Last accessed 26-Jan-2005.

4 See: http://www.dof.ca.gov/html/demograp/MultiraceAllctns2000-2040.htm. Last accessed 17-Mar-2005.

5 Newcombe RG. Two-sided confidence intervals for the single proportion: Comparison of seven methods. Statist. Med. 17, 857-872 (1998). Note that this is a different test than is recommended in FHOP's "Small Numbers Guidelines," which focuses on easy-to-calculate statistics.

6 A copy of the SAS programs we used to calculate rates and confidence intervals is available upon request.

Table 1: Example Kotelchuck Index Data Quality Tab

Kotelchuck Index. In 2003, 538,864 births were recorded to women age 15 to 44. Statewide, 17,747 birth certificate records (3.3%) were missing one or more data elements needed to calculate the Kotelchuck Index. At the county level, an average of 2.1% of birth records (0.8% median) were missing one or more elements of the Kotelchuck Index.

Implications. Study this table carefully. If more than 0.8% (the county-level median) of your area's birth certificates were missing one or more data elements needed to calculate the Kotelchuck Index, rates will be increasingly inaccurate. Further research may be needed to find out how your area can improve its data quality. Until this is resolved, be increasingly skeptical of Kotelchuck Adequacy of Prenatal Care rates as the Area percent missing increases.

	Total Births		Age 15 to 44		Missing		
Local	Number	Percent	Number	Percent	Number	Area %	Miss %
State	540,827	100.00	538,864	100.00	17,747	3.3	100.00
1 Alameda	21,574	3.99	21,498	3.99	432	2.0	2.43
2 Alpine	14	0.00	14	0.00	0	0.0	0.00
3 Amador	299	0.06	298	0.06	2	0.7	0.01
4 Butte	2,382	0.44	2,374	0.44	11	0.5	0.06
5 Calaveras	323	0.06	321	0.06	1	0.3	0.01
6 Colusa	330	0.06	330	0.06	1	0.3	0.01
7 Contra Costa	13,210	2.44	13,165	2.44	151	1.1	0.85
8 Del Norte	299	0.06	299	0.06	1	0.3	0.01
9 El Dorado	1,751	0.32	1,747	0.32	8	0.5	0.05
10 Fresno	15,401	2.85	15,335	2.85	74	0.5	0.42
11 Glenn	431	0.08	430	0.08	12	2.8	0.07
12 Humboldt	1,444	0.27	1,440	0.27	28	1.9	0.16
13 Imperial	2,908	0.54	2,901	0.54	264	9.1	1.49
14 Inyo	198	0.04	198	0.04	1	0.5	0.01
15 Kern	12,888	2.38	12,850	2.38	3,323	25.8	18.72
16 Kings	2,365	0.44	2,353	0.44	8	0.3	0.05
17 Lake	684	0.13	681	0.13	8	1.2	0.05
18 Lassen	300	0.06	299	0.06	2	0.7	0.01
19 Los Angeles	152,192	28.14	151,597	28.13	6,171	4.1	34.77
20 Madera	2,291	0.42	2,280	0.42	23	1.0	0.13
21 Marin	2,830	0.52	2,805	0.52	4	0.1	0.02
22 Mariposa	135	0.02	134	0.02	4	3.0	0.02
23 Mendocino	1,102	0.20	1,097	0.20	14	1.3	0.08
24 Merced	4,278	0.79	4,261	0.79	273	6.4	1.54
25 Modoc	89	0.02	89	0.02	3	3.4	0.02
26 Mono	139	0.03	139	0.03	0	0.0	0.00

Counties with few records set aside can be more comfortable with their results than counties with more records set aside. For example, reviewing the column Missing Area %, Marin County can be relatively certain that their scores on the Kotelchuck Index are reliable. A county with more than 0.8% of their records set aside faces increasing uncertainty about their results.

EXAMPLE RATE TAB

Table 2 is an example of the Rate Tab for one indicator, in this case the number of live births per 1,000 women age 15 to 17. The top section includes definitions of the indicator, numerator, denominator, the Healthy People 2010 Objective, and risk factors associated with this indicator.

Table 2: Fertility Rate Per 1,000 Female Population Age 15 to 17 by Race/Ethnicity

DEFINITION: The number of live births per 1,000 women age 15-17

NUMERATOR: The number of live births to women age 15-17, by place of residence in a calendar year

DENOMINATOR: Population of women age 15-17, by place of residence in a calendar

HP 2010 OBJECTIVE **9-7:** Reduce pregnancies among adolescents to 43 pregnancies per 1,000 (Baseline: 68 per 1,000 in 1996)

RISK FACTORS: Not applicable

TOTAL POPULATION								
	California				Local			
Year	Births	Rate	Lower C.L.	Upper C.L.	Births	Rate	Lower C.L.	Upper C.L.
1992	25,967	43.0	42.5	43.5	850	34.8	32.6	37.2
1993	26,301	42.9	42.4	43.4	814	32.4	30.3	34.7
1994	26,378	42.3	41.8	42.8	733	28.6	26.6	30.7
1995	25,821	40.4	39.9	40.9	784	30.0	28.0	32.1
1996	24,047	36.4	36.0	36.9	694	26.2	24.3	28.2
1997	23,064	33.8	33.4	34.2	669	24.9	23.1	26.8
1998	21,630	31.1	30.6	31.5	660	24.7	22.9	26.6
1999	20,209	28.8	28.4	29.2	601	22.7	21.0	24.6
2000	18,887	26.6	26.2	26.9	577	21.6	19.9	23.4
2001	17,307	23.8	23.5	24.2	514	19.0	17.4	20.7
2002	16,660	22.4	22.0	22.7	414	15.2	13.8	16.7
2003	16,193	21.1	20.8	21.4	426	15.3	13.9	16.8

Sources: **Definition:** http://www.cdc.gov/nchs/datawh/nchsdefs/rates.htm#birth last accessed 18 Apr 05

Numerator: California Center for Health Statistics, Vital Statistics, Births Statistical Master File. To order: http://www.dhs.ca.gov/hisp/chs/OHIR/Catalog/DataCatalog.htm. Last accessed 19 Apr 05.

Denominator: 1990-1999: State of California, Department of Finance, Race/Ethnic Population with Age and Sex Detail 1990-1999. 2000-2050 Projections: State of California, Department of Finance, Race/Ethnic Population with Age and Sex Detail, 2000-2050. Sacramento, CA, May 2004. Both files available at: http://www.dof.ca.gov/html/Demograp/DRU_datafiles/DRU_datafiles.htm. Last accessed 19 Apr 05.

Recommended Tables: ***Can be analyzed using EpiBC:***

Births by mother's race/ethnicity -- Review Fertility Birth Rate Tables
Births by mother's age
Births by geographic area (ZIP code, if available)
Map of distribution of births by geographic area (ZIP code)
Births by parity

Notes: 2000-2050 Multirace/ethnic population projections must be allocated before use. See State of California, Department of Finance, Suggested Allocations of the Multirace Category for Use with Population Projections by Race/Ethnicity for California and It's Counties 2000-2050, Sacramento, California, June 2004. http://www.dof.ca.gov/HTML/DEMOGRAP/MultiraceAllctns2000-2050.htm. Last accessed 19 Apr 05.

C.L. = Confidence Limit = the boundary of the 95% confidence interval.

The Rate Table shows data for the total population in California and the local jurisdiction, over the most recent 12-year period for which data are available, in this case 1992 through 2003. For both California and the jurisdiction, columns indicate the number of events, the rate, and lower and upper confidence limits for that rate.

Below the rate table, we present information on the sources for the definitions of the indicator, the numerator, and the denominator. Recommended tables that can be made using EpiBC (if a birth-certificate indicator) or EpiHosp (if a discharge data indicator) are shown. Finally, we present any notes that we think are important to understand the data presented. On pages 2 and 3 of a given Rate Tab, we show the same rate-based data for the other race/ethnic groups, as described earlier.

Comparing the state and local rates and confidence intervals, from start to end of period, we see that the local rate and its upper confidence intervals are always below the state rate. This allows us to conclude that the local rate was significantly lower than the state throughout the time period. In both cases, we also see that the rates appear to be dropping. This leads us to wonder if the drop in rates is statistically significant. Is the rate of change the same for the jurisdiction and state? That is, do we have a trend, and if so, is it linear or curvilinear? How does the jurisdiction compare with the state?

DISPLAYING AND TESTING TRENDS

If rates are on the Rates Tab, as they are for our example, we display local and state rates over the period on the Graph Tab and summarize the results of statistical linear trend tests. If the data permitted 12 years of rates, as they do here, we also test for non-linear trends.

THE TREND GRAPH

Figure 1 shows the graph made using the rates from Page 1 of the Graph Tab for our example indicator. Depending on the number of events the data allow us to calculate, a given graph might have 12, 6, 4, or no points. Note that the graphs do not include confidence intervals, which would be inappropriate for a trend test. Here, we focus on the rate of change over time rather than within a given period such as a year.

Figure 1: Fertility Rate Trend Per 1,000 Female Population Age 15 to 17

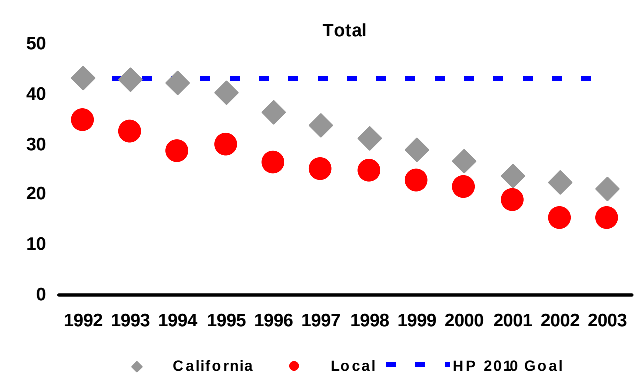

Figure 1 has 12 points, because the number of events was greater than 10 in all years. If the indicator had too few cases, the graph would be empty. Red dots (●) show the local jurisdiction rate and grey diamonds (◆) the state rate. When an indicator has a Healthy People (HP) 2010 performance objective, it is shown with a dashed blue line. For this indicator, the HP 2010 objective is 43 births per 1,000 female population age 15 to 17.

The Rate Table shows that both the state and local jurisdiction were at or below the HP 2010 objective throughout the 12-year period. Thus, the state had a higher rate than the jurisdiction throughout the time. However, visually, it appears that the state declined more rapidly and by 2003 is much closer to the jurisdiction. Let's see if statistical tests confirm our visual conclusion.

TREND TESTS

Table 3 reports the results of statistical tests to evaluate if the trend we see is significant. The first column indicates the test type, i.e., linear (first set) or non-linear (second set) for the state and local jurisdiction. The second column shows the date range tested. In the linear example, the data permit us to test the 12-years from 1992 to 2003. The third major column set shows the intercept statistics, in this case the estimated intercept and its standard error. The intercept is the estimated rate at the start of the period. The fourth major column set shows the slope statistics: slope estimate, standard error, and p-value testing if the slope is equal to zero. The last column tells us if the slope is statistically different from zero.

Table 3. Fertility Rate Trend Regression Results
Per 1,000 Female Population Age 15 to 17

		Intercept		Slope			
Level	Date Range	Est.	Std. Err	Est.	Std. Err	P-Value	Sig?
State	1992-2003	45.17	0.67	-2.27	0.09	0.000	Yes
Local	1992-2003	34.05	0.71	-1.73	0.10	0.000	Yes
	Different?					0.000	Yes
Non-Linear							
State	1992-1994	43.15	0.70	-0.47	0.99	0.658	No
	1994-2001	47.52	0.83	-2.66	0.14	0.000	Yes
	2001-2003	34.82	6.63	-1.25	0.63	0.119	No
Local	No bends						

Readers with a non-statistical background will find it most helpful to focus on the last column. Those who would like a statistical refresher may wish to review the FHOP monograph, "Do We Have a Linear Trend?" It is available on the FHOP website at: http://www.ucsf.edu.

LINEAR TREND TEST

Let's start with the linear trend test, the top part of the table. Looking in the last column, we see "Yes, Yes, Yes." The state trend is statistically significant, the jurisdiction trend is statistically significant, and those trends are significantly different from each other.

For more detailed information, look at the slope estimate section of the table. It shows that the state rate dropped -2.27 per 1,000 population per year (P = 0.000), while the jurisdiction dropped -1.73 per 1,000 population per year (P = 0.000). We tested the hypothesis that the local and state trends were equal, assuming the local and state data were independent and had a normal distribution. In essence we performed a T-test on the slopes. Our third "Yes" indicates that the slopes indeed are significantly different (P = 0.000).

NON-LINEAR TREND TEST

We next evaluated the data to see if the trend had some shape other than linear. Sometimes statistically significant trends will be reported when the data in fact are not linear. In these cases, it would be inaccurate to describe a trend as linear if it has some other shape. Other times, the trend test is non-significant because the data has some other shape. If the series had 12 periods, as in this case, we searched for significant "bends". If there were fewer than 12 points, we wrote "Too few points" to test for significant bends. If there were 12 periods with no significant bends, we wrote "No bends." If bends were found we wrote the periods covering each interval, and display the intercept and slope during those intervals.

Our local jurisdiction did not have a curvilinear trend. Thus it is accurate to characterize its trend as linear. However, the last column indicates the state trend was nonlinear (No, Yes, No). From 1992 to 1994, the rate was essentially flat (P = 0.658). The significant drop in the state rate occurred between 1994 and 2001 (P = 0.000). It was essentially flat from 2001 through 2003 (P = 0.11). Now that you know this, you can look back to Figure 1 and see that this is the case.

Reality is often complex, and complexity trumps simplicity when reporting statistical results. Thus when a statistically significant nonlinear trend exists, the interpretation must reflect the nonlinear trend instead of the linear trend.

In our example, the jurisdiction trend is different from the state trend. When the jurisdiction linear trend is not significantly different from the state linear trend, and the state has a nonlinear trend, the interpretation of the jurisdiction trend should reflect that it was not significantly different from the state nonlinear trend.

CONCLUSION

Because the jurisdiction trend was significantly different from the state trend, we describe results separately. Specifically, the local rate of live births per 1,000 females age 15-17 was significantly below the state rate throughout the period and declined linearly at the statistically significant rate of -1.73 per 1,000 live births. The state rate declined overall during the period at a rate of -2.27 per 1,000 live births, with the state rate of change significantly different from the jurisdiction rate of change. Essentially all of the state's decrease occurred during the period 1994 through 2001, at a rate of -2.66 per 1,000 live births, with no statistically significant changes before or after those years. Both the state and jurisdiction had rates below the Healthy People 2010 Objective for this indicator throughout the period.

APPENDIX A: OTHER STATISTICAL ISSUES

The entire process of creating the Databooks is macro driven using SAS. The process starts by summarizing the indicator data and the appropriate denominator data to the geographic level of interest (state, county, super region (e.g., Bay Area) or sub-region (Berkeley, Long Beach, Pasadena, LA County Service Provider Areas). We calculate rates, feed the numerators and denominators into JoinPoint, bring the results back into SAS, and output the results directly into preformatted Excel template files.

We use JoinPoint to estimate linear trends for the jurisdiction and the state and to test whether the resulting slope for each trend is significantly different from zero.[7] [8] Joinpoint program options we used to calculate trends are: 1) input numerators and denominators, 2) test for bends at whole years, 3) use a minimum of two years between bends and between a bend and either end of the data, 4) test for a maximum of 2 bends, 5) fit a linear (not log-linear) model with uncorrelated errors.

The Statistical Research and Applications Branch (SRAB) of the National Cancer Institute developed JoinPoint as one among a set of new statistical methods and associated software tools for the analysis and reporting of cancer statistics. This group of powerful shareware statistical packages is appropriate for the analysis of any population-based data.[9] In this set of software, JoinPoint was developed explicitly to estimate linear and curvilinear trends.

JoinPoint takes trend data and fits the simplest trend model that the data allow. The user supplies the minimum and maximum number of joinpoints. The program starts with the minimum number of joinpoints (e.g. 0 joinpoints, which is a straight line, or a standard trend test) and then tests whether more joinpoints are statistically significant and must be added to the model (up to that maximum number). This enables the user to test if an apparent change in trend from one period to another is statistically significant. The tests of significance use a Monte Carlo Permutation method. Models may incorporate estimated variation for each point (e.g. when the responses are age adjusted rates) or use a Poisson model of variation. In addition, models may also be linear on the log of the response (e.g. for calculating annual percentage rate change). The software allows viewing one graph for each joinpoint model, from the model with the minimum number of joinpoints to the model with maximum number of joinpoints.

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7 The Joinpoint software program was obtained at: http://srab.cancer.gov/joinpoint/. Last accessed 25 Apr 2005.

8 Kim HJ, Fay MP, Feuer EJ, Midthune DN. Permutation tests for joinpoint regression with applications to cancer rates. Stat Med 2000;19:335-51 (correction: 2001;20:655).

9 See Methods & Software for Population-Based Cancer Statistics: http://srab.cancer.gov/software/. Last accessed 25 Apr 2005.