CHAPTER 10

REGIONAL COMPARISONS OF HIV AND AIDS IN RISK GROUPS

The goal of this chapter is to use the computer simulation model developed in Chapter 7 to analyze HIV transmission and AIDS in risk groups in the four major regions of the United States shown in Figure 10.1. Each region is divided into three to five subregions based on similarities and differences in AIDS incidences in parts of the region. Whenever there are no significant differences in the time trends in AIDS incidences between racial/ethnic (r/e) groups or subregions, AIDS cases in the groups or subregions are aggregated. Thus the first step in each region is to aggregate into as few subpopulations as possible. Aggregation simplifies the simulation process since it leads to fewer populations to fit. Of course, the HIV and AIDS incidences in the groups or subregions which were aggregated could be recovered at any time by using the fraction of cases which occurred in these groups or subregions.

Each aggregated population is fit using the computer simulation model described in Chapter 7. When male and female IVDUs are aggregated, the fit to AIDS incidences in these IVDUs is found and then the model is fit to AIDS incidences in their heterosexual partners; finally, the model is fit to pediatric AIDS incidences in the children of the female IVDUs and the female heterosexual partners. For each of the four regions, the section in this Chapter devoted to the aggregation process is followed by a section on computer simulations of the aggregated groups. Parameter values in the best fitting simulations are compared among subpopulations, subregions and regions at the end of the Chapter. The different parameter values provide a quantitative measure of the differences in time trends in AIDS incidences.

Data have been furnished by Debra Hanson in the Statistics and Data Management Branch, Division of HIV/AIDS, Center for Infectious Diseases, National Centers for Disease Control. She has sent yearly AIDS incidence estimates for all cases and consistent cases through 1990; these are based on reported AIDS incidences through September 1, 1991 which have been adjusted for reporting delays with redistribution of unclassified cases. Recall from Section 5.4 that the consistent cases are those with a diagnosis (definitive or presumptive) of a disease in the pre–1987 case definition. The expansion of AIDS surveillance definition in 1987 increased the number of patients reported with AIDS. The method used in Section 5.4 is also used here to estimate the total consistent cases by adding the modified nonconsistent cases to the consistent cases. All fitting in this chapter uses these total adjusted consistent case estimates. Data were sent for the major risk groups in subregions in the four regions of the United States. The subregions were chosen to reflect similarities and differences in AIDS incidences in the various parts of each region.

The Northeast (NE) region consists of the New England and Mid–Atlantic states. The North Central (NC) region contains the East and West North Central states. The South (S) region has the South Atlantic and the East and West South Central states. The West (W) region contains the Mountain and Pacific states (including Alaska and Hawaii). The data for the regions, risk groups, subregions and r/e groups are often identified by code words according to

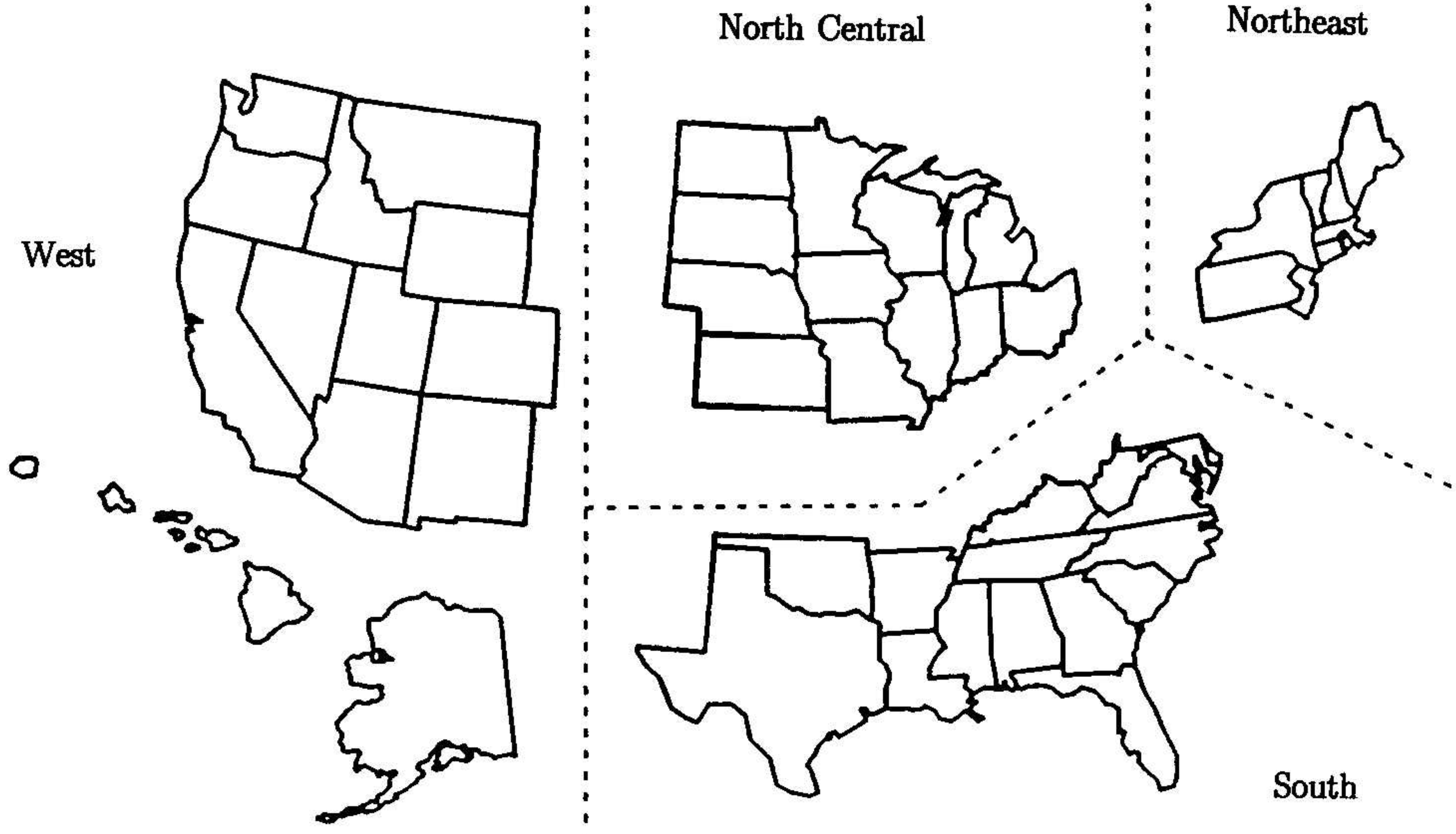

Figure 10.1 The four major regions of the United States.

Table 10.1. Coding scheme for identifying risk groups

First Character(s) (region):
- NE – Northeast
- NC – North Central
- S – South
- W – West

Next Two Characters (risk group):
- 01 or 1M – Homosexual and bisexual men, not using IV drugs
- 03 or 3M – Homosexual and bisexual male IV drug users (IVDU)
- 2M – Male heterosexual IVDU
- 2F – Female IVDU
- 2T – Male heterosexual and female IVDUs
- 5M – Male sex partners of IVDUs
- 5F – Female sex partners of IVDUs
- 5T – Male and female heterosexual partners of IVDUs
- 16 – Perinatal; mother is IVDU
- 17 – Perinatal; mother is sex partner of IVDU
- 12 or CT – Perinatal; mother is IVDU or sex partner of IVDU

Next Character (subregion):
- T – all subregions (total)
- Northeast:
- A – New York City (NYC) MSA (Metropolitan Statistical Area)
- B – New York (minus NYC), New Jersey (minus Philadelphia MSA), Connecticut, Rhode Island
- C – Maine, New Hampshire, Vermont, Massachusetts, Pennsylvania, portion of Philadelphia MSA in New Jersey
- North Central:
- A – Chicago MSA
- B – Detroit MSA
- C – Other MSAs with populations over one million
- D – Other MSAs with populations under one million
- South:
- A – Florida
- B – Texas
- C – Washington,D.C. and Baltimore MSA
- D – Other MSAs with populations over one million including Atlanta, New Orleans, Norfolk, Charlotte and the part of Cincinnati in Kentucky
- E – All other areas in the South region
- West:
- A – San Francisco and Seattle MSAs
- B – Los Angeles, Oakland, Anaheim, Riverside, and San Jose MSAs
- C – All other areas in the West region

Last Character (racial/ethnic group):
- W – White
- B – Black
- H – Hispanic
- T – All racial/ethnic groups (total)

the scheme given in a Table 10.1. For example, NE01AW refers to the Northeast region, homosexual/bisexual men, subregion A (New York City) and the white racial/ethnic category.

10.1. Simplifications Based on Modeling New York City

Chapter 8 on modeling HIV and AIDS in New York City (NYC) has yielded some useful results. The NYC populations of homosexual men and the heterosexual IVDUs were first fit separately. Then the populations of homosexual men, homosexual IVDUs, and heterosexual IVDUs were fit with both linkages through homosexual and needle–sharing partnerships. The interesting result is that the parameter values for the homosexual men and the heterosexual IVDUs are nearly the same as when these populations are fit separately. Thus the homosexual IVDUs do not serve as an important link in which the HIV epidemic in one population feeds or sustains the epidemic in the other population. Hence the homosexual IVDU linkage is not necessary, and can be eliminated. The time trends in AIDS incidence in homosexual IVDUs are similar to that for homosexual men in NYC so that the simulations for homosexual IVDUs would be similar to those for the homosexual men. Based on the NYC modeling experience, the homosexual men are always fit as a separate population in this regional modeling. Since the AIDS incidence in homosexual IVDUs is much smaller and they have incidence patterns similar to homosexual men, they are not fit explicitly. The heterosexual IVDUs are modeled and fit as a separate population. After parameter values are found for simulation of AIDS incidences in IVDUs, the average number PAP of heterosexual partnerships per month is adjusted to fit the AIDS incidence in heterosexual partners and then the fecundity FC is adjusted to fit the perinatal AIDS incidence. Note that only one parameter is varied in order to fit the AIDS data for heterosexual partners and only one parameter is varied to fit the perinatal AIDS data.

In the NYC modeling the value of PAP which gives the best fit is 0.0318 new partners per month, which corresponds to about one new heterosexual partner per IVDU every 2.6 years. Thus the AIDS incidence in heterosexual partners is consistent with very slow partner turnover. In the NYC modeling the value of the fecundity FC which fit the perinatal data is 0.005 births per female per month. This is close to the reported national birth rate since there are about 70 births per 1000 women per year (World Almanac, 1988) which corresponds to about 0.006 births per female per month. The average probability of transmission during birth by women in the infectious stages is 0.22 in the model.

10.2. The Northeast Region: Aggregation of Racial/Ethnic and Risk Groups

It is important to know in each risk group if the trends over time of the AIDS cases in the r/e groups in the three Northeast (NE) subregions are the same or different. Recall that the three r/e groups and three NE subregions are defined in Table 10.1. If the time trends are the same in the r/e groups or in the subregions, then these groups or subregions can be aggregated together and the larger category can be fit in simulation models. If the time trends in AIDS cases are different in r/e groups or subregions, then they cannot be aggregated and must be modeled separately. Aggregation of groups is a distinct advantage in simulation modeling, since fewer

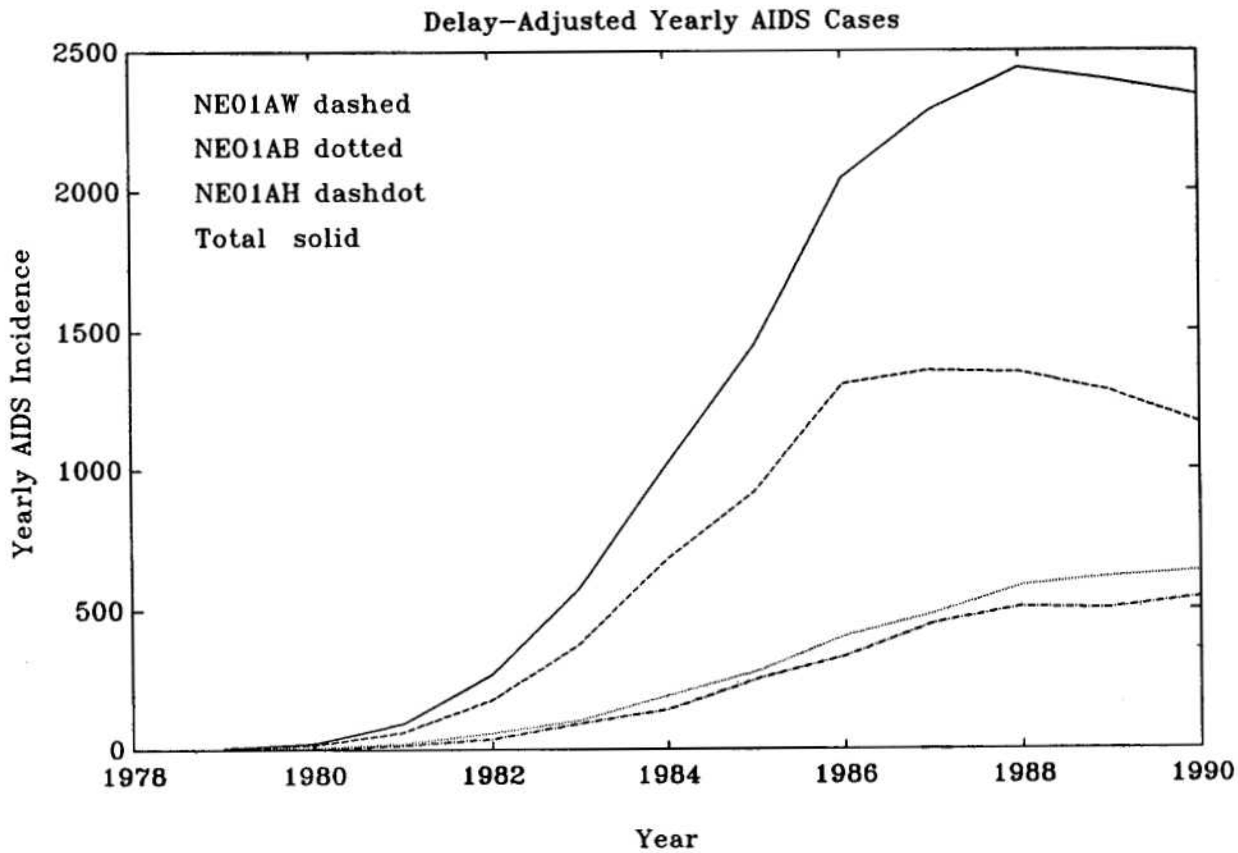

Figure 10.2. AIDS incidence in white, black, and Hispanic homosexual men in NE subregion A (New York City).

groups must be simulated. Of course, the AIDS case incidences in the subgroups which have been aggregated could be recovered at a given time by using the percentages of cases occurring in these subgroups.

First, consider the risk group of homosexual/bisexual males with AIDS case rates in the three r/e groups and the three subregions shown in Figures 10.2 to 10.4. In region A the AIDS cases in all three r/e groups increase steadily until about 1986, after which the AIDS cases continue to increase in blacks and Hispanics, but seem to level off and decrease in whites. Thus in region A (New York City) the time trend in white homosexual males seems to be different from that in black and Hispanic homosexual males. Thus white homosexual/bisexual males should be analyzed separately and should not be aggregated; however, blacks and Hispanics can be aggregated.

For homosexual/bisexual males in regions B and C, the time trends in r/e groups in Figures 10.3 and 10.4 are less clear. Tables giving the r/e percentage distributions each year in each subregion have been printed out, but are not included here. Although there are some differences in 1990, the r/e distributions over time in regions B and C seem to remain reasonably constant. Thus lumping the r/e groups together in each region B and C seems reasonable. Moreover, from the graphs of the total AIDS cases in the regions, it is reasonable to lump regions B and C together. Thus for homosexual/bisexual males the three aggregated groups shown in Figure 10.5 seem to be needed: 1) whites in region A, 2) blacks and Hispanics in region A and 3) all r/e groups in regions B and C.

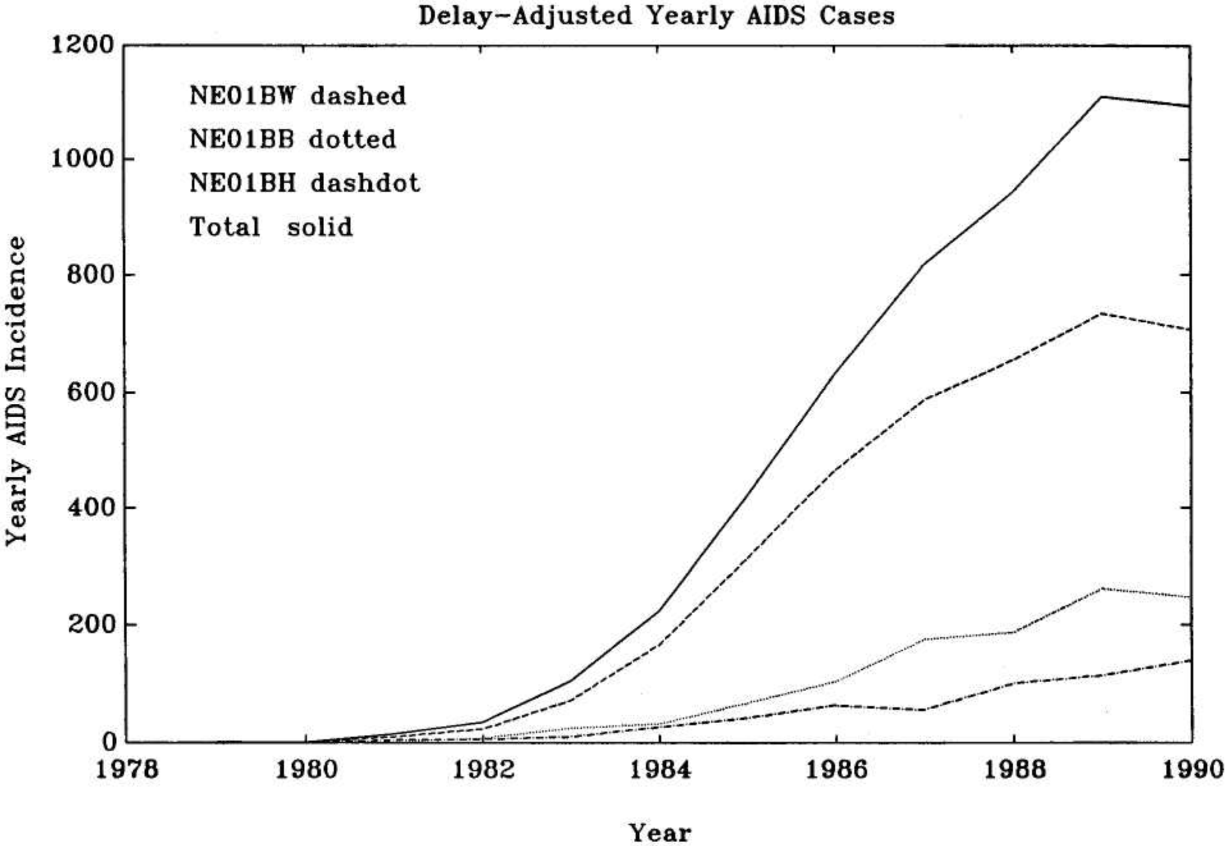

Figure 10.3. AIDS incidence in white, black, and Hispanic homosexual men in NE subregion B.

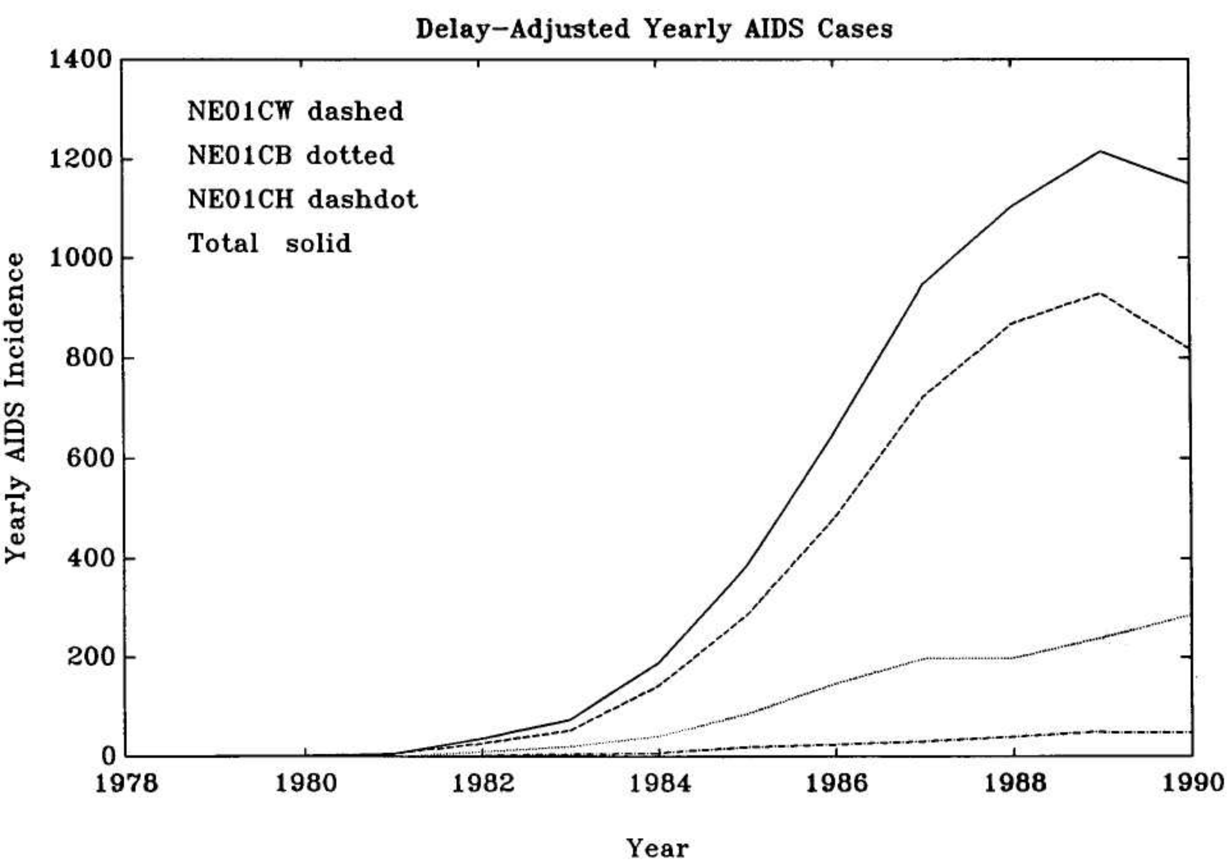

Figure 10.4. AIDS incidence in white, black, and Hispanic homosexual men in NE subregion C.

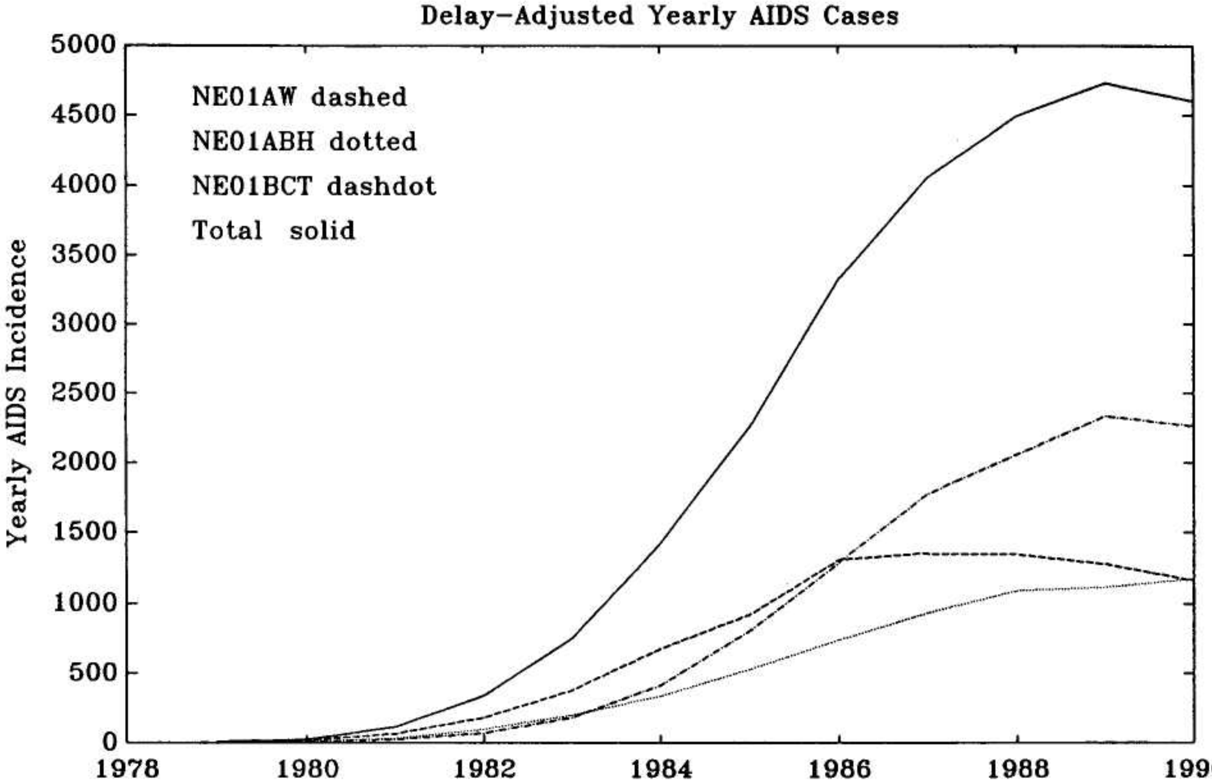

Figure 10.5. AIDS incidence in homosexual men who are whites in NE subregion A (New York City), blacks and Hispanics (other r/e groups) in subregion A, and all r/e groups in subregions B and C (other subregions.)

For homosexual IVDU males, the AIDS incidence in the r/e groups in the NE regions often jumps up and down from year to year in an erratic fashion. These jumps may be due to random fluctuations or may be due to changes in classification or reporting. Conclusions about aggregation or disaggregation in homosexual IVDUs are difficult since clear trends are not evident. Figure 10.6 shows the AIDS incidence for homosexual IVDUs aggregated in the same way as homosexual men in Figure 10.5. The patterns in Figure 10.6 are generally the same as in Figure 10.5 since white males in region A seem to level off in about 1986, but homosexual IVDUs in other r/e groups in region A increase more rapidly up to 1987 and then decrease. In both Figures 10.5 and 10.6, AIDS incidence outside region A increases through 1989. Thus the aggregation of homosexual IVDUs in Figure 10.6 may be reasonable.

For male (heterosexual) IVDUs in Figures 10.7 to 10.9, there do not seem to be any major differences between the r/e groups in the trends in the regions. In region A the r/e distribution is consistently about 15% whites, 43% blacks and 42% Hispanics. In region B the r/e distribution is also uniform over time with 23% whites, 56% blacks and 20% Hispanics. The pattern in region C is slightly erratic, but the r/e distribution does not differ greatly over time from 27% whites, 40% blacks and 31% Hispanics. The graphs of the totals in Figure 10.10 reveal that the AIDS cases are growing together in regions A and B, but are growing faster in region C after 1986. Thus for male (heterosexual) IVDUs, two aggregated groups seem appropriate: 1) all r/e groups in regions A and B, and 2) all r/e groups in region C.

The AIDS incidences in female IVDUs in the r/e groups in the NE regions are smaller, but are similar to those for male (heterosexual) IVDUs so aggregation of r/e groups within the NE

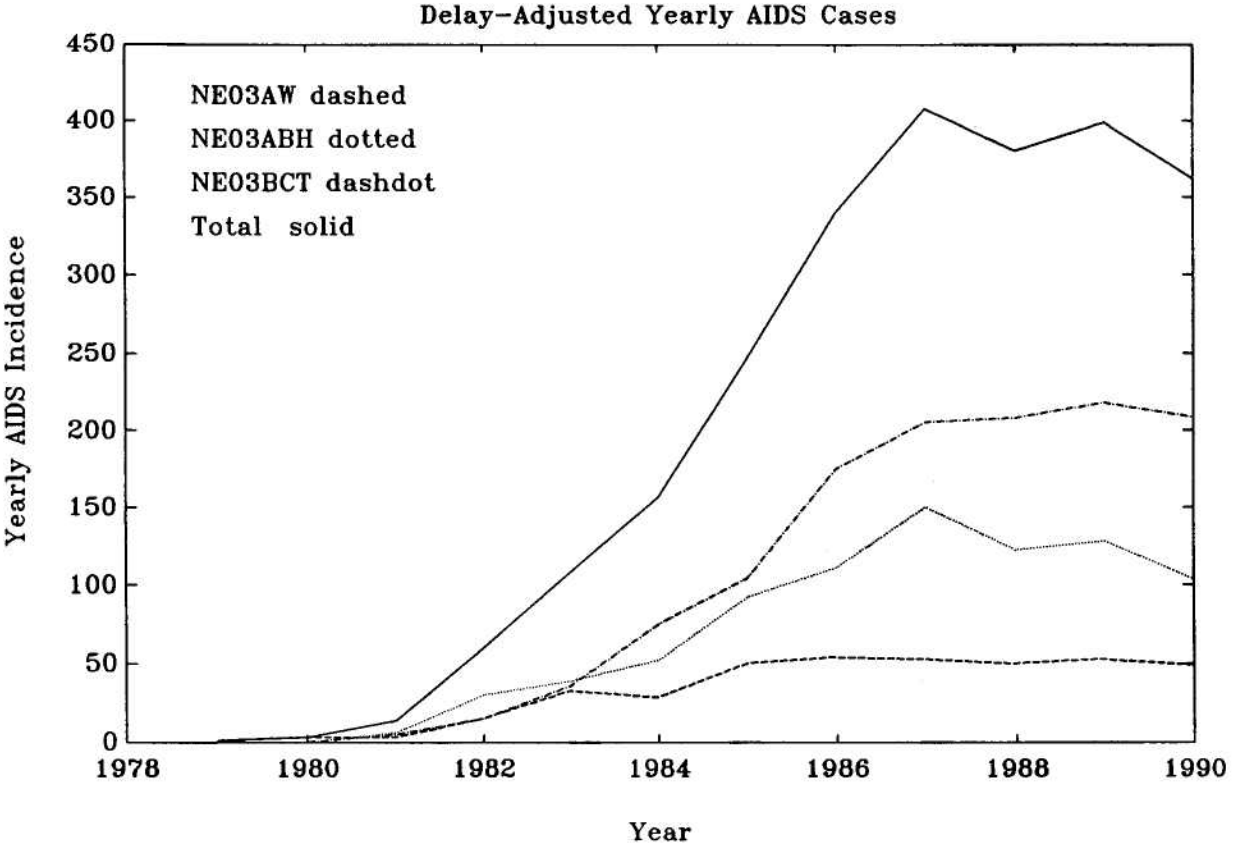

Figure 10.6. AIDS incidence in homosexual IVDUs who are white in NE subregion A (New York City), blacks and Hispanic in subregion A, and all r/e groups in subregions B and C (other subregions).

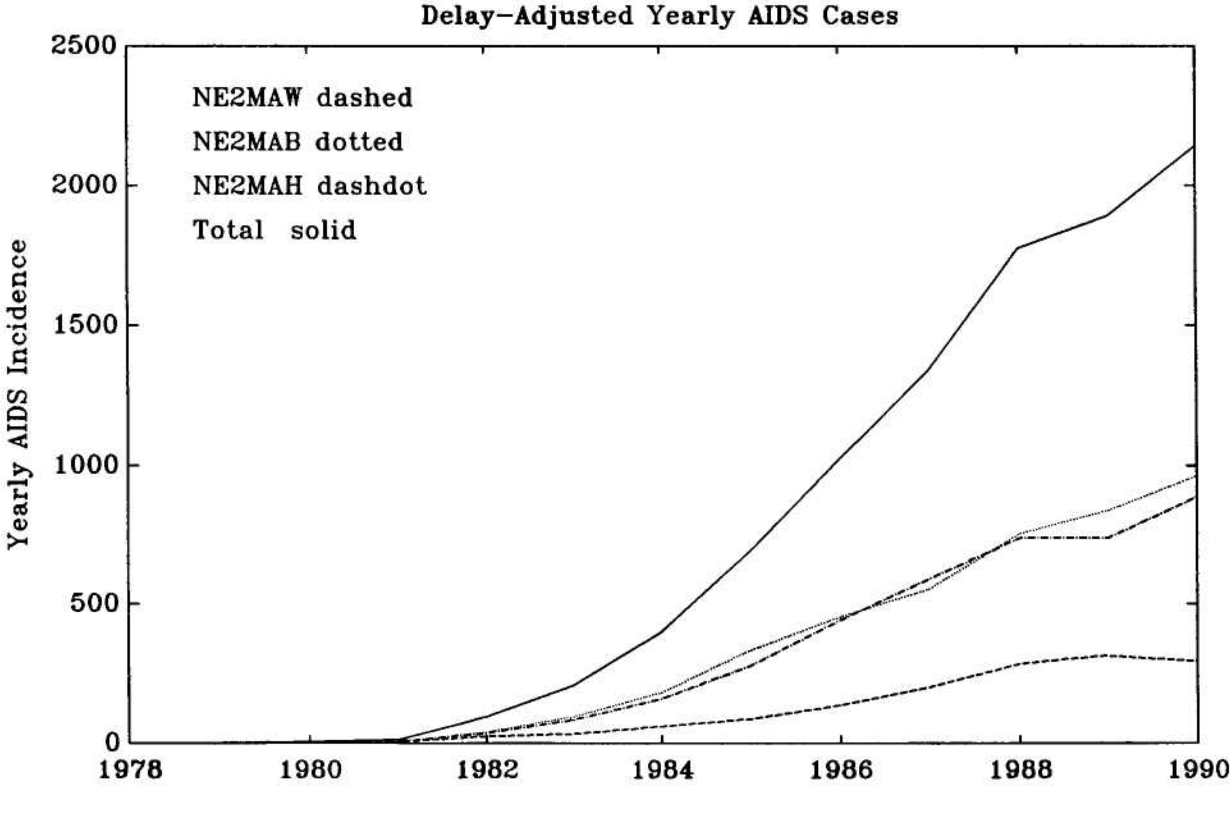

Figure 10.7. AIDS incidence in male (heterosexual) IVDUs who are white, black, and Hispanic in NE subregion A (New York City).

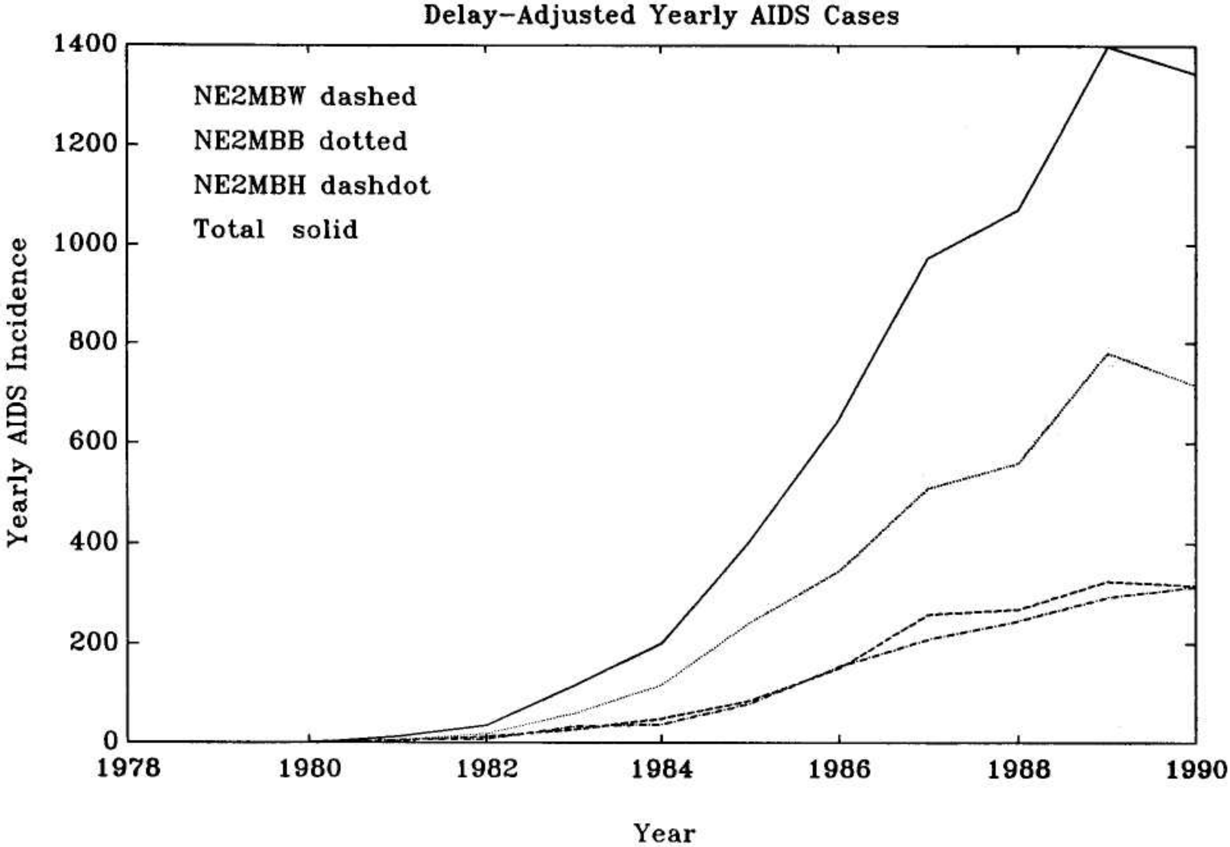

Figure 10.8. AIDS incidence in male (heterosexual) IVDUs who are white, black, and Hispanic in NE subregion B.

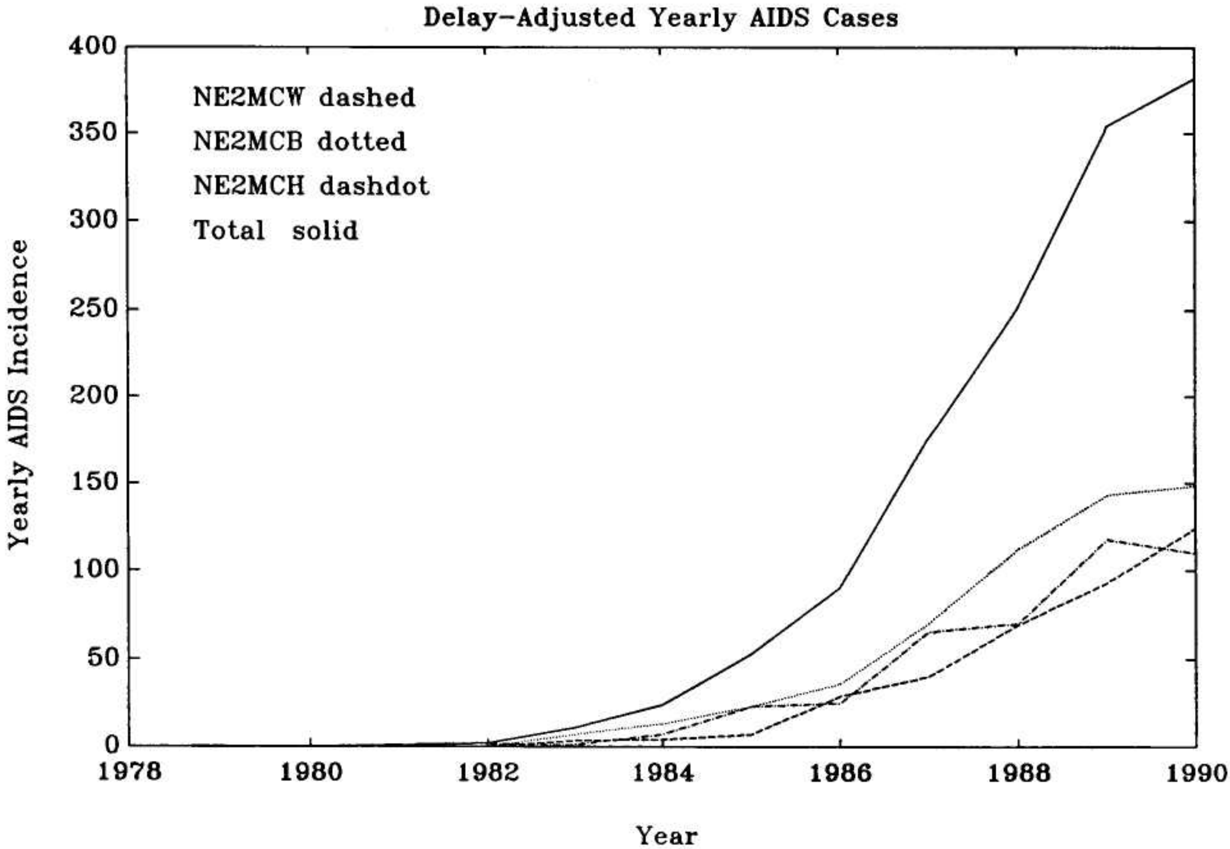

Figure 10.9. AIDS incidence in male (heterosexual) IVDUs who are white, black, and Hispanic in NE subregion C.

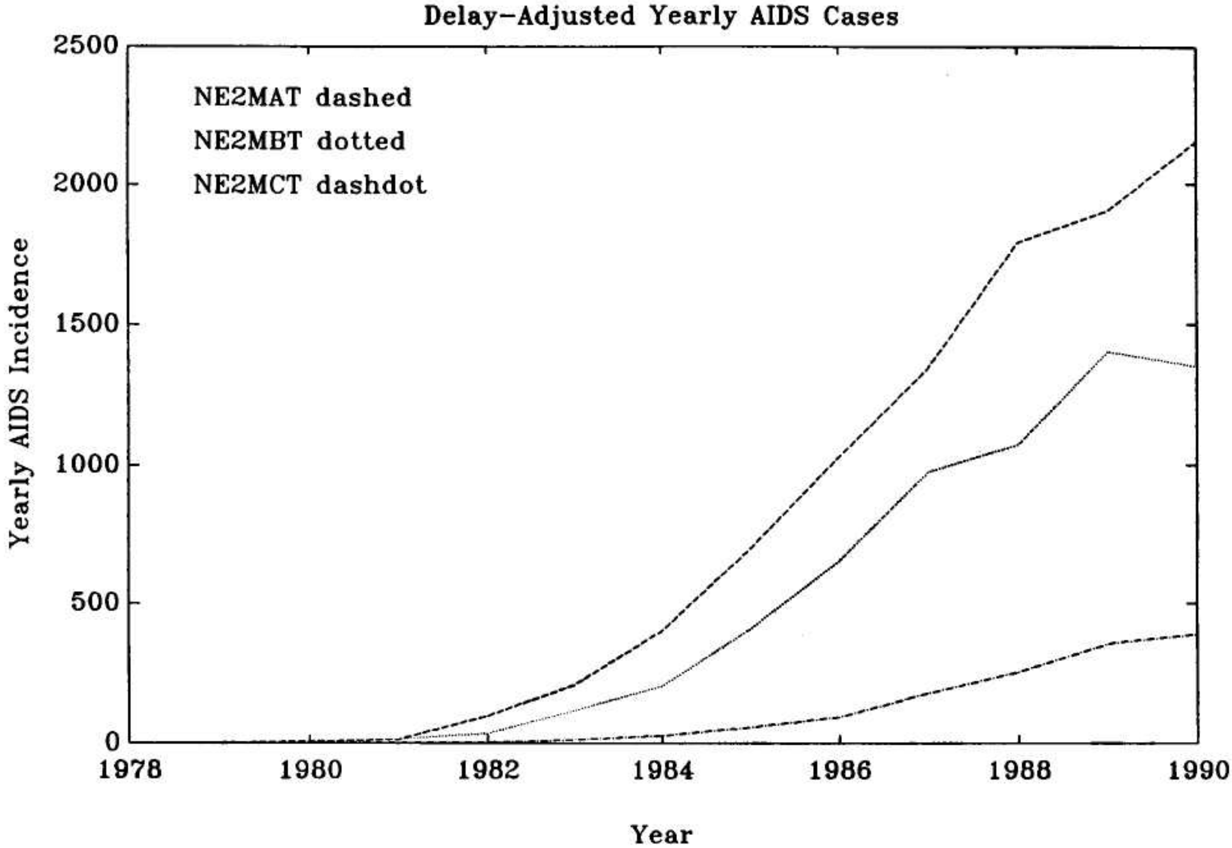

Figure 10.10. AIDS incidence in male (heterosexual) IVDUs in NE subregions A, B, and C.

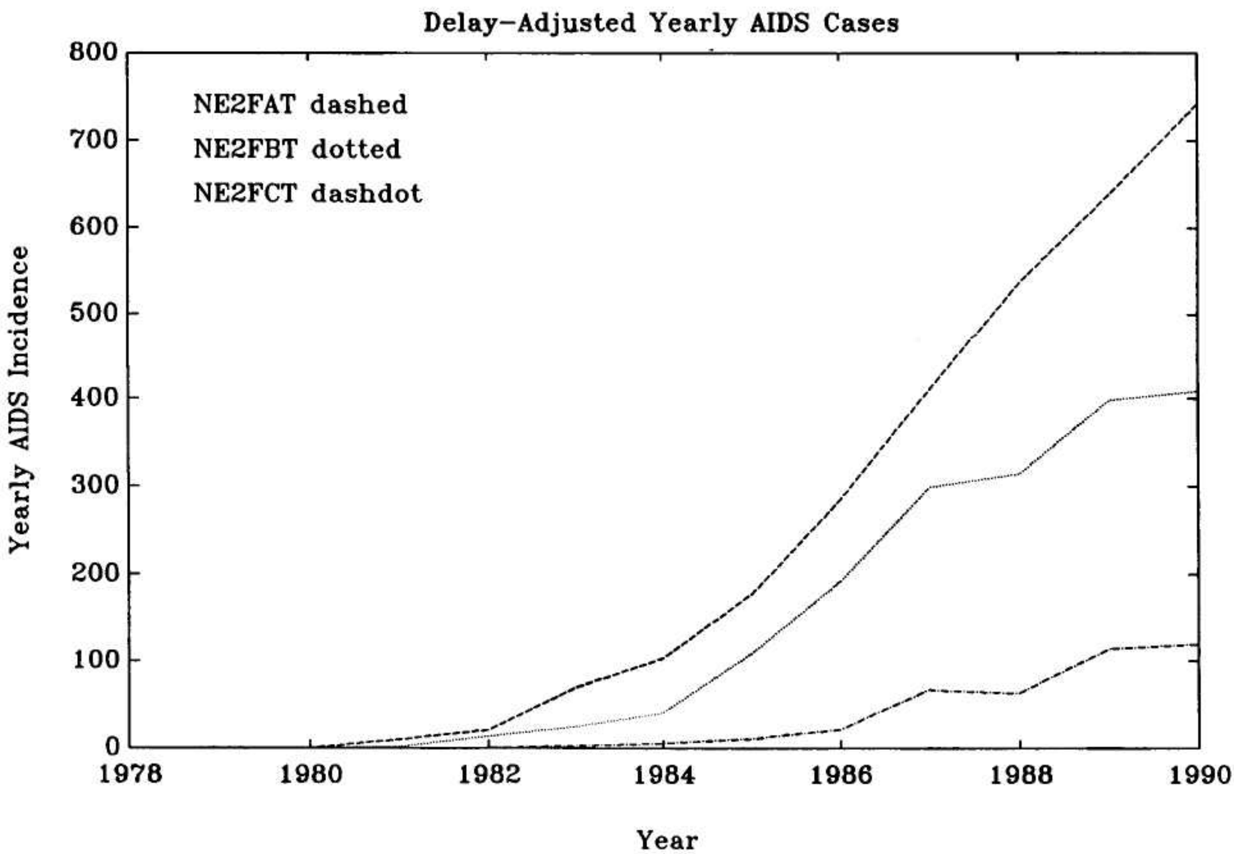

Figure 10.11. AIDS incidence in female IVDUs in NE subregions A, B, and C.

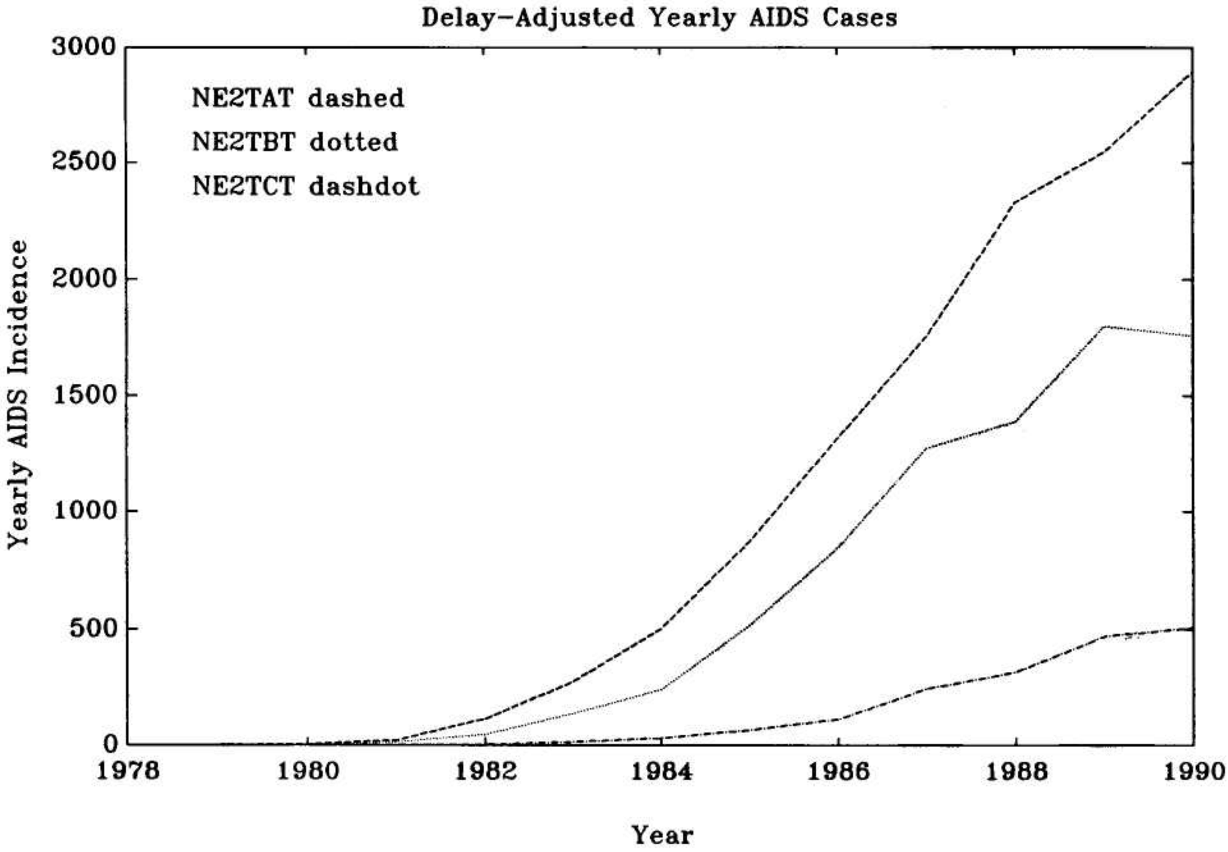

Figure 10.12. AIDS incidence in combined male (heterosexual) and female IVDUs in NE subregions A, B, and C.

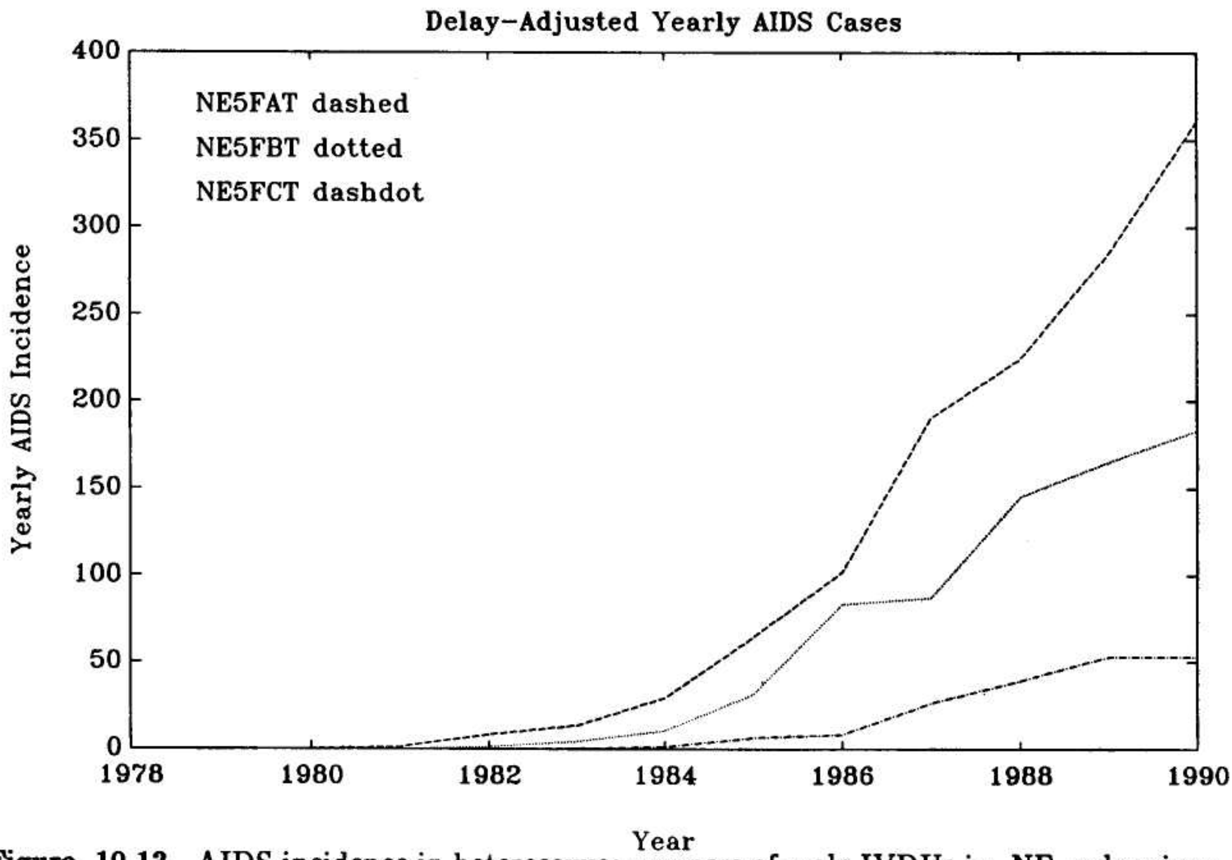

Figure 10.13. AIDS incidence in heterosexual partners of male IVDUs in NE subregions A, B, and C.

regions is reasonable. Figure 10.11 shows the AIDS incidences in female IVDUs in the three NE regions. The time trends are similar to those in Figure 10.10 so the male and female IVDUs can also be aggregated. Figure 10.12 shows the combined male and female IVDUs in the three regions. The AIDS incidence in region C starts lower and then grows faster than in regions A and B. Thus it is reasonable to combine regions A and B, but region C must be treated separately.

Yearly AIDS incidences for female heterosexual partners of IVDUs for the three regions are shown in Figure 10.13. Since the numbers of cases in the r/e groups is small in each region, these r/e groups have been combined. The time trends in Figure 10.13 are similar to those for male (heterosexual) IVDUs in Figure 10.10. Note that in region C the initial growth rate is low, but the growth rate after 1986 is higher in region C than in regions A and B. Figure 10.13 shows that combining regions A and B, but treating C separately, is also reasonable for female heterosexual partners of IVDUs. Yearly AIDS incidences for male sexual partners of female IVDUs are very erratic, especially in regions A and C where there are very few cases. The detailed analysis in Chapter 9 of r/e patterns suggests that many males may be misclassified as heterosexual partners of female IVDUs. Because the number of cases is small and there are no distinct patterns, both female and male heterosexual partners are combined.

Since the AIDS incidences in children in the r/e groups in the three regions are small and subject to random fluctuations and changes in reporting practices, the graphs are rather erratic. Combining r/e groups usually leads to smoother graphs for the larger populations. Figure 10.14 shows the yearly pediatric AIDS cases in children whose mothers are either IVDUs or heterosexual partners of IVDUs. The time trends in Figure 10.14 are roughly similar to those for female IVDUs in Figure 10.11 and for female heterosexual partners of IVDUs in Figure 10.13. The AIDS incidence in children in region B drops down in 1988 primarily due to unexplainable decreases in AIDS cases in black children. Since there is no similar decrease in AIDS cases in black female IVDUs or partners of IVDUs, the lower incidences in 1988 are probably due to a reporting problem in some part of region B. Generally, the combination of cases in regions A and B, but not with region C, also seems reasonable for pediatric cases.

The two primary reasons why the three subregions of the NE region of the U.S. were originally chosen are: 1) the HIV epidemic in homosexual men is different inside and outside New York City and 2) the HIV epidemic in IVDUs is different in regions A and B (New York, New Jersey, Connecticut and Rhode Island) than in region C (the other NE states). The aggregations suggested in this Section by comparing time trends justify these choices of subregions. For homosexual/bisexual males, all r/e groups in regions B and C can be lumped, but region A (New York City) is different. Only for homosexual/bisexual males in New York City is it necessary to analyze time trends for r/e groups separately; namely, the AIDS incidence curve for white males has a different character from the AIDS incidence curve for black and Hispanic males. For male and female IVDUs, all r/e groups can be aggregated in each region and regions A and B can be aggregated, but region C is different. The aggregation into these two groups also seems to work for exposure categories connected to IVDUs; namely, for female sexual partners of male IVDUs, for children with IVDU mothers and for children of female sexual partners of male IVDUs.

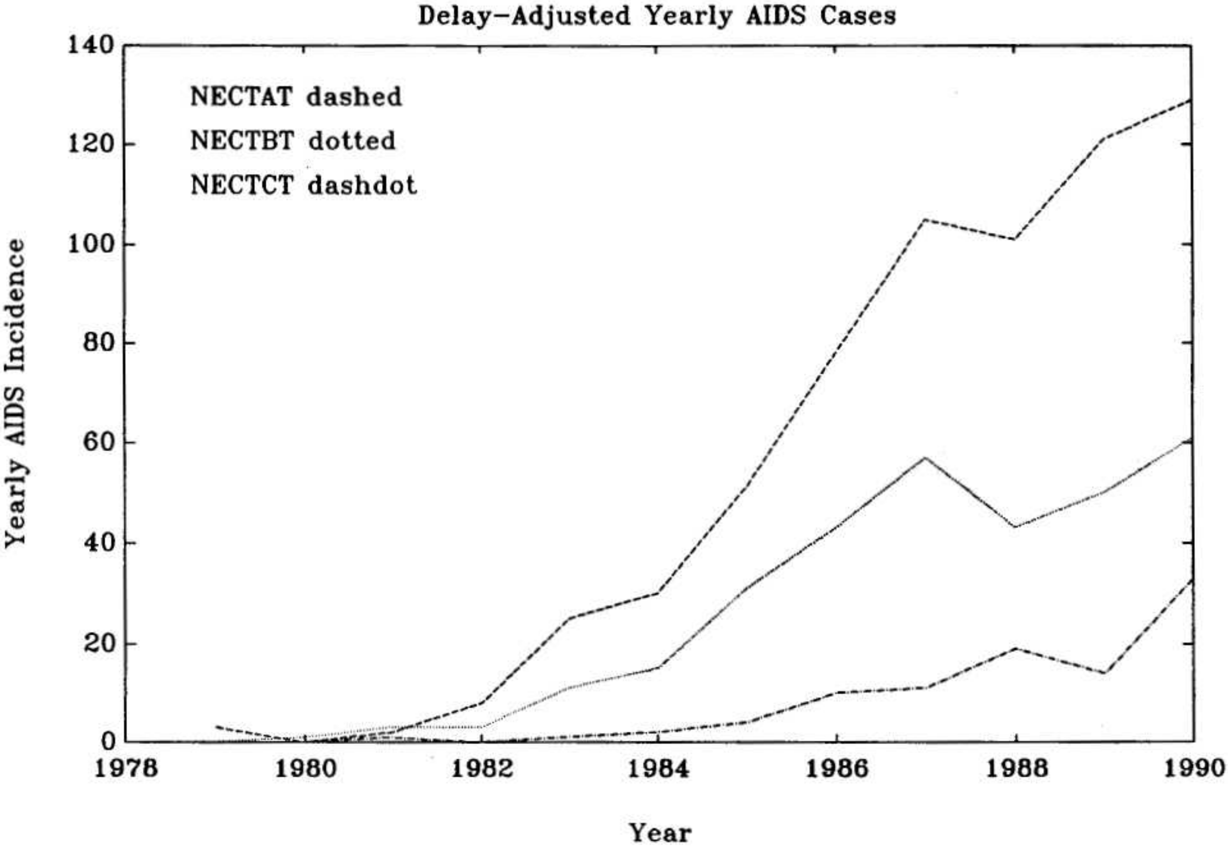

Figure 10.14. AIDS incidence in children of female IVDUs and heterosexual partners of male IVDUs in NE subregions A, B, and C.

10.3. The Northeast Region: Computer Simulations of the Aggregated Groups

The simulation model described in Chapter 7 has been fit to the AIDS incidences of the aggregated groups found in Section 10.2. The parameter values and simulation values for the white homosexual men in New York City (labeled NE01AW) are given in Table 10.2 and the HIV and AIDS incidences are given in Figure 10.15. Table 10.3 and Figure 10.16 correspond to the black and Hispanic homosexual men in NYC (labeled NE01ABH). Table 10.4 and Figure 10.17 correspond to AIDS in all r/e groups in regions B and C (labeled NE01BCT). The NE subregions A, B and C are defined in Table 10.1. Many of the parameter values in the simulation are fixed at the values found from the detailed analysis in Chapter 6 of HIV incidences and AIDS incidences in homosexual men in San Francisco. The parameters which have been varied to fit the AIDS incidences in the NE region are the population size, the epidemic starting year, the external mixing fraction, the average number of partners per month before reduction, the reduction starting and stopping dates, and the yearly reduction factor.

Based on data in Chapter 6 for homosexual men in San Francisco, rules of thumb are used for obtaining crude guesses for two of the parameter values. The homosexual population size is crudely estimated to be 7.67 times the total AIDS cases through 1989. The epidemic starting year is approximately 7 years before the date when the cumulative AIDS cases reach 40. This crude starting date estimate and the population estimate often work reasonably well. For example, the populations of homosexual men at risk for HIV in New York City are estimated to be 60,000 for

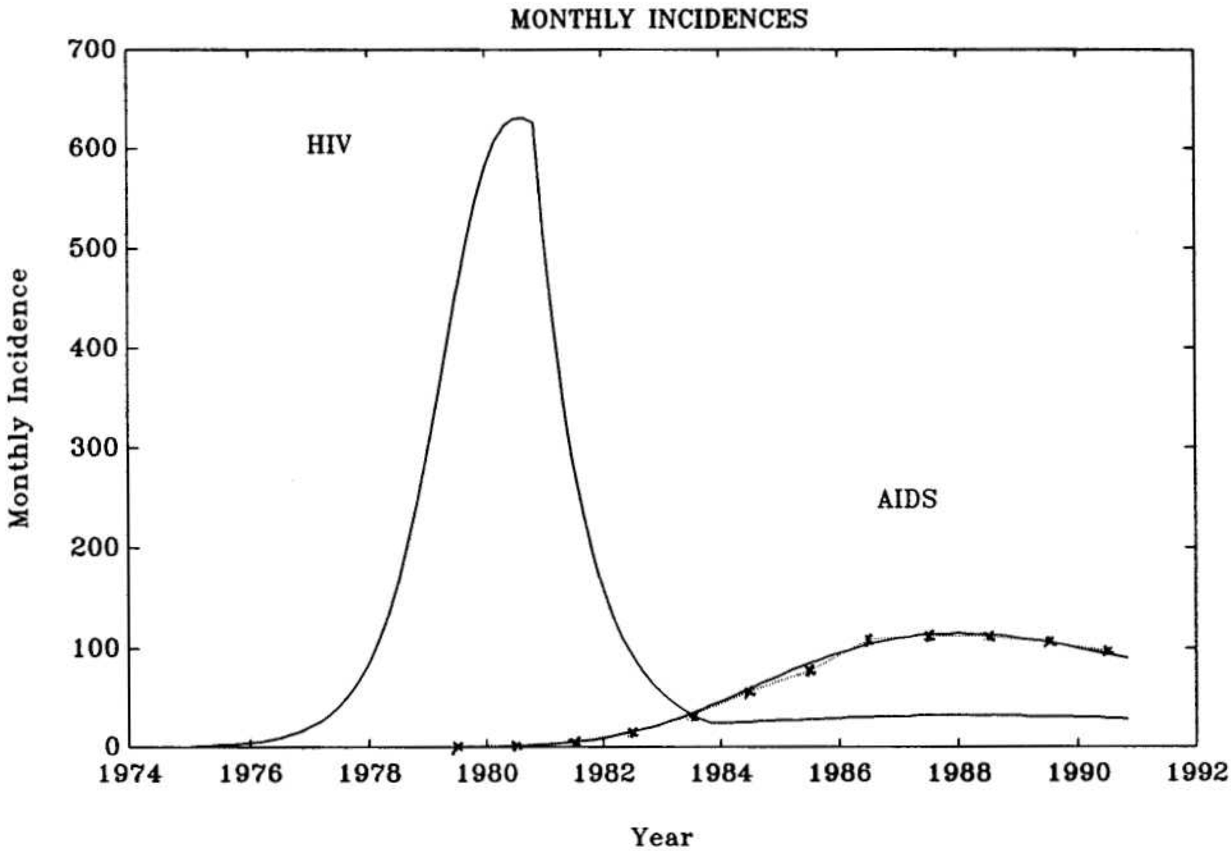

Figure 10.15. Estimated AIDS incidences (*) and simulated HIV and AIDS incidences for white homosexual men in NE subregion A (New York City) corresponding to parameter values in Table 10.2.

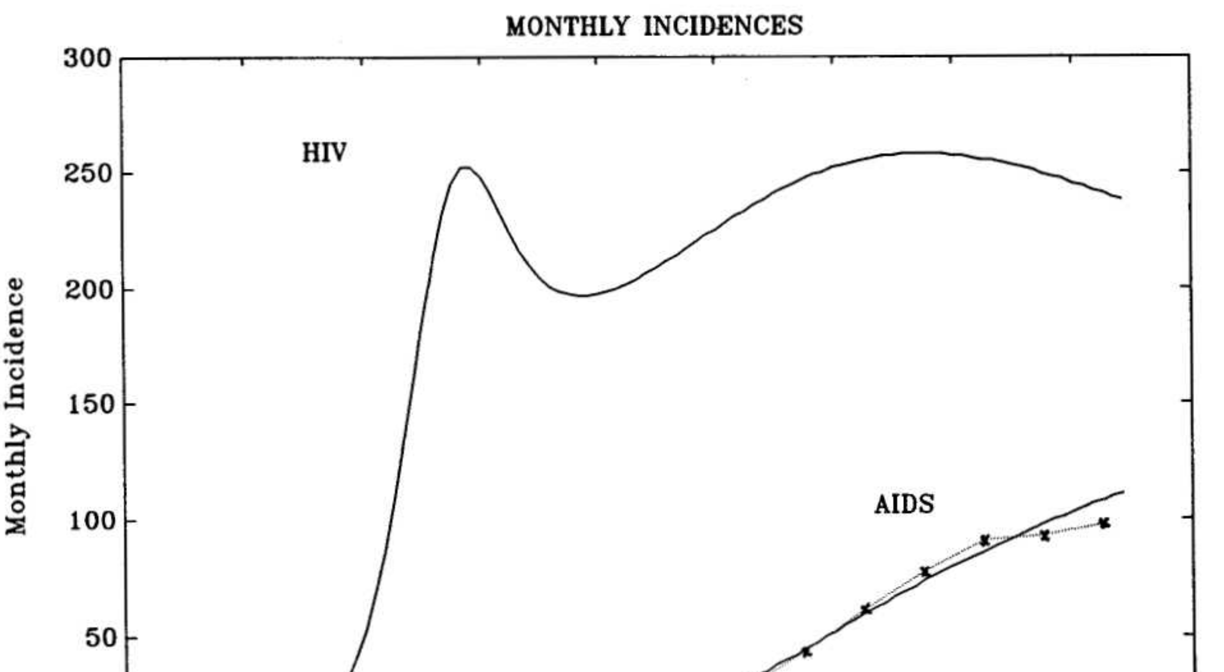

Figure 10.16. Estimated AIDS incidences for black and Hispanic homosexual men in NE subregion A (New York City) corresponding to parameter values in Table 10.3.

Table 10.2 Parameter values and corresponding simulation values for white homosexual men in NYC.

THE POPULATION SIZE IS 60000, THE VERY ACTIVE FRACTION IS 1.000000E-01 AND THE ACTIVITY RATIO IS 10.000000
THE NATURAL MORTALITY RATE XMU IS 5.320000E-04
THE INTERCHANGE RATE FROM THE VERY ACTIVE CLASS TO THE ACTIVE CLASS IS 4.166667E-03 AND THE TURNOVER RATE IS DLT = 4.166667E-03
THE NUMBER OF INFECTIOUS STAGES IS M = 7
THE G PARAMETERS FOR THE TRANSFER BETWEEN STAGES ARE 7.355444E-02 6.433708E-02 4.867545E-02 4.199281E-02 3.997889E-02 5.152515E-02 5.398798E-02
THE WEIGHTS OF TRANSMISSION PER INFECTIOUS PARTNER TIMES THE FRACTION STILL SEXUALLY ACTIVE FOR THE STAGES ARE WRH(I) = 2.000000 1.000000 1.000000 1.500000 1.500000 1.500000 7.500000
THE PROBABILITY OF TRANSMISSION IS QH = 5.000000E-02
THE EXTERNAL MIXING FRACTION IS ETA = 1.000000
THE AVERAGE NUMBER OF PARTNERS PER MONTH IS 5.633000E-01 BEFORE 1981 1, THEN IT IS REDUCED EACH YEAR BY A FACTOR OF 3.401000E-01UNTIL DEC, 1983
THE STARTING YEAR AND MONTH ARE 1974 4
THE STARTING NUMBER OF VERY ACTIVE INFECTIVES IS 1.000000

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YEAR	HIV INC SIM	HIV PREV	FRACTNAL_PREV ALL	V_A	ACT	YR AIDS INC DATA	SIM	AIDS(SIMULATION) PREV	DTHS	OUTSF
1974	5.	5.	.00	.00	.00	*****	0.	0.	0.	0.
1975	23.	28.	.00	.00	.00	*****	0.	0.	0.	0.
1976	103.	128.	.00	.01	.00	*****	0.	0.	0.	0.
1977	455.	567.	.01	.05	.01	*****	0.	0.	0.	0.
1978	1789.	2289.	.04	.19	.02	*****	1.	1.	0.	0.
1979	4947.	7001.	.12	.51	.07	3.	4.	3.	1.	1.
1980	7370.	13798.	.23	.80	.17	16.	16.	15.	5.	2.
1981	4209.	17102.	.29	.85	.22	62.	58.	54.	19.	9.
1982	1350.	17412.	.29	.81	.23	178.	170.	161.	62.	31.
1983	475.	16762.	.28	.75	.23	377.	383.	380.	164.	82.
1984	304.	15816.	.26	.68	.22	677.	677.	714.	343.	174.
1985	337.	14731.	.25	.61	.21	918.	984.	1112.	585.	302.
1986	366.	13498.	.22	.54	.19	1305.	1225.	1492.	845.	445.
1987	384.	12150.	.20	.48	.17	1354.	1355.	1779.	1069.	575.
1988	390.	10753.	.18	.42	.15	1347.	1369.	1931.	1217.	670.
1989	380.	9378.	.16	.36	.13	1278.	1291.	1947.	1275.	718.
1990	359.	8089.	.13	.31	.12	1166.	1155.	1851.	1250.	722.

CHISQ = 11.852450

Table 10.3 Parameter values and corresponding simulation values for black and Hispanic homosexual men in NYC.

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THE POPULATION SIZE IS        40000, THE VERY ACTIVE FRACTION IS
  1.000000E-01 AND THE ACTIVITY RATIO IS        10.000000
THE NATURAL MORTALITY RATE XMU IS   5.320000E-04
THE INTERCHANGE RATE  FROM THE VERY ACTIVE CLASS TO THE ACTIVE CLASS IS
   4.166667E-03  AND THE TURNOVER RATE IS DLT =    4.166667E-03
THE NUMBER OF INFECTIOUS STAGES IS  M =            7
THE G PARAMETERS FOR THE TRANSFER BETWEEN STAGES ARE    7.355444E-02
   6.433708E-02    4.867545E-02    4.199281E-02    3.997889E-02
   5.152515E-02    5.398798E-02
THE WEIGHTS OF TRANSMISSION PER INFECTIOUS PARTNER TIMES THE FRACTION STILL
SEXUALLY ACTIVE FOR THE STAGES ARE WRH(I) =       2.000000        1.000000
       1.000000        1.500000        1.500000        1.500000
       7.500000
THE PROBABILITY OF TRANSMISSION IS QH =    5.000000E-02
THE EXTERNAL MIXING FRACTION IS ETA =    4.168000E-01
THE AVERAGE NUMBER OF PARTNERS PER MONTH IS    4.581000E-01 BEFORE        2222
          1, THEN IT IS REDUCED EACH YEAR BY A FACTOR OF        1.000000UNTIL
DEC,        2222
THE STARTING YEAR AND MONTH ARE        1974         12
THE STARTING NUMBER OF VERY ACTIVE INFECTIVES IS      1.000000
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YEAR	HIV INC SIM	HIV PREV	FRACTNAL_PREV ALL	V_A	ACT	YR AIDS INC DATA	SIM	AIDS(SIMULATION) PREV	DTHS	OUTSF
1974	0.	1.	.00	.00	.00	*****	0.	0.	0.	0.
1975	8.	9.	.00	.00	.00	*****	0.	0.	0.	0.
1976	47.	55.	.00	.01	.00	*****	0.	0.	0.	0.
1977	261.	308.	.01	.06	.00	*****	0.	0.	0.	0.
1978	1169.	1438.	.04	.27	.01	*****	0.	0.	0.	0.
1979	2722.	4016.	.10	.66	.04	2.	2.	2.	0.	0.
1980	2770.	6490.	.16	.88	.08	7.	9.	8.	2.	1.
1981	2406.	8467.	.21	.92	.13	32.	34.	31.	11.	5.
1982	2420.	10327.	.26	.93	.18	93.	95.	91.	36.	18.
1983	2587.	12198.	.30	.93	.24	195.	203.	204.	90.	45.
1984	2782.	14070.	.35	.92	.29	335.	351.	374.	181.	92.
1985	2948.	15885.	.40	.89	.34	529.	523.	589.	307.	159.
1986	3056.	17567.	.44	.87	.39	738.	699.	831.	457.	240.
1987	3097.	19051.	.48	.83	.44	932.	868.	1080.	619.	330.
1988	3076.	20286.	.51	.80	.48	1089.	1023.	1323.	780.	422.
1989	3008.	21248.	.53	.76	.51	1115.	1164.	1552.	935.	513.
1990	2908.	21932.	.55	.73	.53	1174.	1289.	1761.	1079.	599.

CHISQ =   25.353680

Table 10.4 Parameter values and corresponding simulation values for homosexual men in NE subregions B and C.

```
THE POPULATION SIZE IS       250000, THE VERY ACTIVE FRACTION IS
  1.000000E-01 AND THE ACTIVITY RATIO IS        10.000000
THE NATURAL MORTALITY RATE XMU IS   5.320000E-04
THE INTERCHANGE RATE  FROM THE VERY ACTIVE CLASS TO THE ACTIVE CLASS IS
   4.166667E-03  AND THE TURNOVER RATE IS DLT =    4.166667E-03
THE NUMBER OF INFECTIOUS STAGES IS  M =             7
THE G PARAMETERS FOR THE TRANSFER BETWEEN STAGES ARE    7.355444E-02
   6.433708E-02    4.867545E-02    4.199281E-02    3.997889E-02
   5.152515E-02    5.398798E-02
THE WEIGHTS OF TRANSMISSION PER INFECTIOUS PARTNER TIMES THE FRACTION STILL
SEXUALLY ACTIVE FOR THE STAGES ARE WRH(I) =       2.000000        1.000000
       1.000000        1.500000        1.500000        1.500000
       7.500000
THE PROBABILITY OF TRANSMISSION IS QH =    5.000000E-02
THE EXTERNAL MIXING FRACTION IS ETA =    2.960000E-02
THE AVERAGE NUMBER OF PARTNERS PER MONTH IS    3.287000E-01 BEFORE        1984
          7, THEN IT IS REDUCED EACH YEAR BY A FACTOR OF    3.809000E-01UNTIL
DEC,        1987
THE STARTING YEAR AND MONTH ARE         1975            1
THE STARTING NUMBER OF VERY ACTIVE INFECTIVES IS       1.000000

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```

YEAR	HIV INC SIM	HIV PREV	FRACTNAL_PREV ALL	V_A	ACT	YR AIDS INC DATA	SIM	AIDS(SIMULATION) PREV	DTHS	OUTSF
1975	4.	5.	.00	.00	.00	*****	0.	0.	0.	0.
1976	20.	24.	.00	.00	.00	*****	0.	0.	0.	0.
1977	88.	109.	.00	.00	.00	*****	0.	0.	0.	0.
1978	391.	486.	.00	.02	.00	*****	0.	0.	0.	0.
1979	1638.	2066.	.01	.08	.00	2.	1.	1.	0.	0.
1980	5480.	7317.	.03	.28	.00	2.	3.	3.	1.	0.
1981	9964.	16630.	.07	.61	.01	21.	14.	13.	4.	2.
1982	8019.	23495.	.09	.83	.01	69.	55.	51.	17.	8.
1983	4953.	26965.	.11	.90	.02	176.	176.	165.	61.	30.
1984	3641.	28858.	.12	.90	.03	412.	431.	421.	175.	87.
1985	1865.	28713.	.11	.85	.03	806.	827.	853.	395.	200.
1986	986.	27418.	.11	.77	.04	1288.	1300.	1428.	725.	372.
1987	507.	25364.	.10	.68	.04	1772.	1752.	2058.	1123.	586.
1988	403.	22961.	.09	.59	.04	2060.	2095.	2629.	1523.	810.
1989	470.	20459.	.08	.51	.03	2337.	2277.	3050.	1856.	1008.
1990	513.	17950.	.07	.43	.03	2264.	2290.	3268.	2072.	1149.

CHISQ = 14.260470

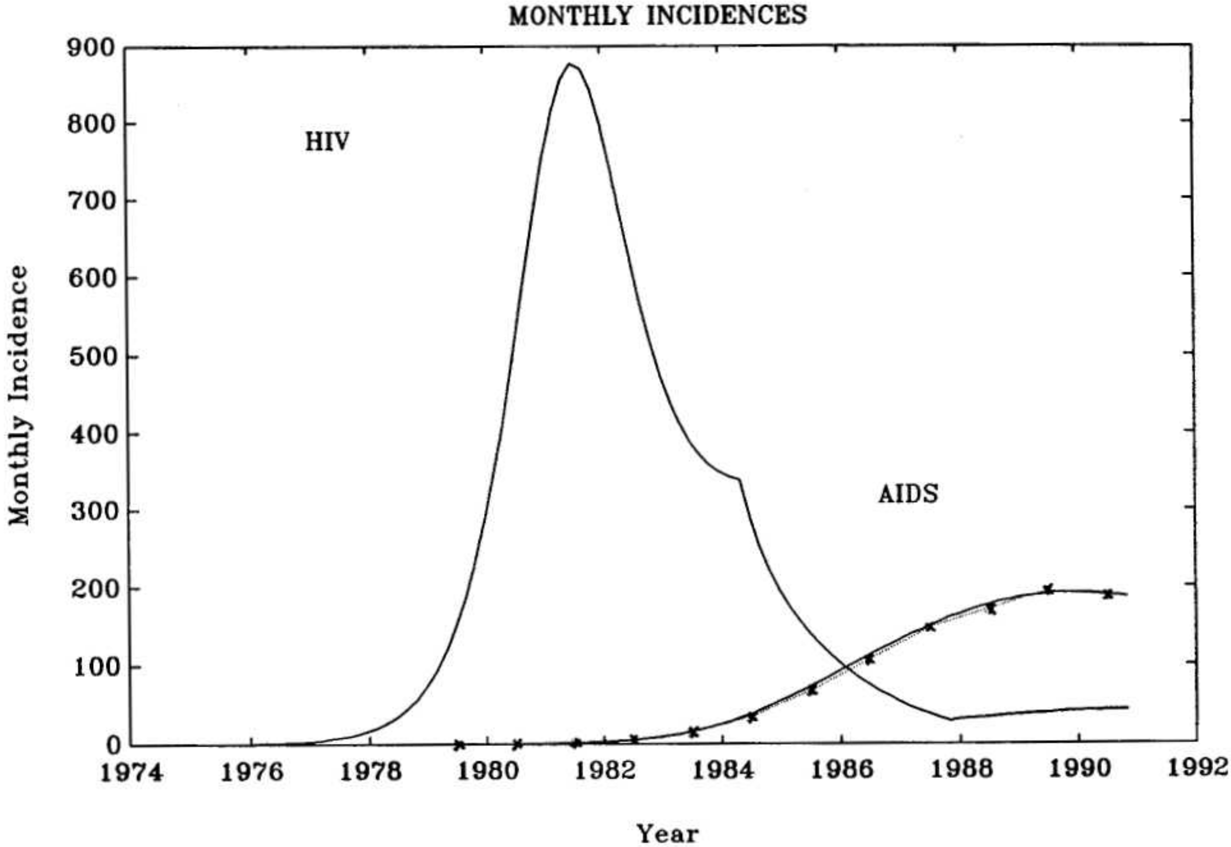

Figure 10.17. Estimated AIDS incidences (*) and simulated HIV and AIDS incidences for homosexual men in all r/e groups in NE subregions B and C corresponding to parameter values in Table 10.4.

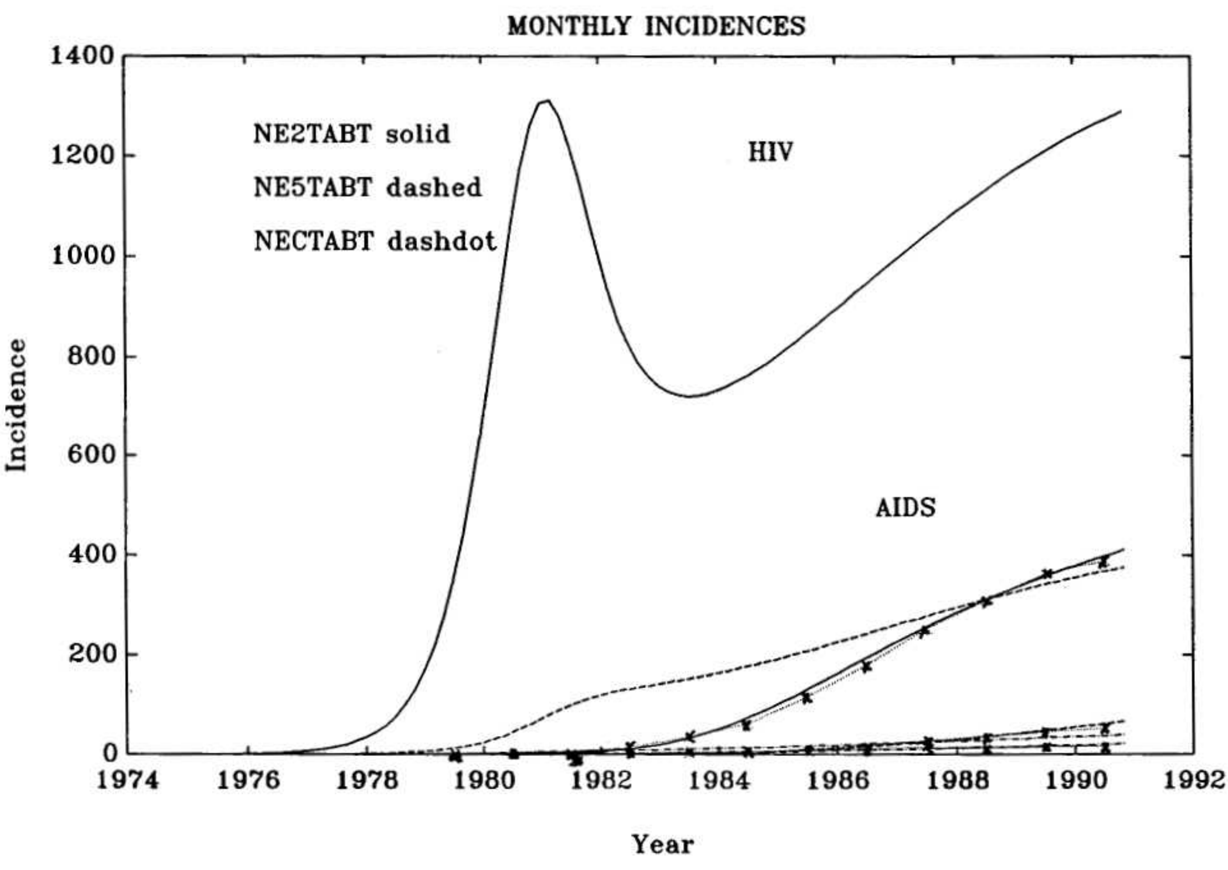

Figure 10.18. Estimated AIDS incidences (*) and simulated HIV and AIDS incidences for IVDUs, their heterosexual partners, and related pediatric cases in NE subregions A and B corresponding to parameter values in Table 10.5.

whites and 40,000 for blacks and Hispanics. The total of 100,000 homosexual men at risk in New York City is the same as the estimate in Chapter 8 on New York City.

A computer program (see Appendix), which varies the values of the external mixing fraction ETA, the average number of partners PAS and the yearly reduction factor RDN, has been used to find these values for various reduction starting and stopping dates. Comparisons of outputs of these computer runs leads to the best fitting simulations in the sense that the chi–square value for fitting the AIDS incidence curve is minimized. The simulations shown in Figures 10.15–10.17 are not meant to be predictive since other simulations also yield adequate fits. More specifically, the HIV incidences in recent years may not be as high as shown in Figure 10.16; the HIV incidences shown occur because the AIDS incidences have not yet shown a clear decrease. A detailed sensitivity analysis has not been carried out for each data set. However, the other adequate simulations usually have similar parameter values so comparisons of the parameter values can be enlightening.

Rather than go through Tables 10.2 to 10.4 individually, it is more interesting to compare parameter values in these Tables. The epidemic starting dates are April 1974 for whites in NYC, December 1974 for blacks and Hispanics in NYC and January 1975 for homosexual men in regions B and C. The slightly later start in blacks and Hispanics in NYC and in homosexual men outside NYC is not surprising. The population estimates of 100,000 homosexual men at risk inside NYC and 250,000 in the NE outside NYC seem plausible.

The average number of partners per month before reduction is 0.56 for white homosexual men in NYC, 0.46 for black and Hispanic men in NYC, and 0.33 for homosexual men in NE outside NYC. This suggests that the initial growth rate was fastest in white homosexual men in NYC, slower for NYC blacks and Hispanics and slowest outside NYC.

A striking difference is that the AIDS incidence for the blacks and Hispanics in NYC have been fit without any reductions in sexual behavior, but reductions have been necessary to fit the white homosexual men in NYC. This difference is consistent with the AIDS incidence graphs in Figure 10.5. For homosexual men in regions B and C, the best fit involves a reduction in high risk behavior, but the fit without any change in behavior is almost as good. For NYC white homosexual men, the reduction factor of 0.34 per year from January 1981 through 1983 yields an overall reduction factor of 0.039 over the 3 year period. Thus the decrease in AIDS incidence in white homosexual men in NYC in recent years can be explained by a precipitous decrease in high risk sexual behavior, starting in 1981. The other two populations of homosexual men have been fit adequately without such precipitous decreases, but recent decreases in AIDS incidence suggest that change in behavior may have occurred later in these populations.

The external mixing fraction, ETA, is different in Tables 10.2 to 10.4. For white homosexual men in NYC, ETA is 1, which corresponds to proportional mixing (random mixing) between the very active and active risk groups. For black and Hispanic homosexual men in NYC, ETA is 0.42 which means the very active and active risk groups are less strongly connected. For homosexual men outside NYC, the connection between the very active and active groups is very weak since ETA = 0.03. One reason why ETA is small is that the population size is large (250,000) and most of the AIDS cases so far have occurred in the one–tenth (25,000) that are in the very active group. Indeed, in some reasonably good fits, ETA was zero so there was no connection between the very active and active groups. The weak connection implies that there could be a biphasic epidemic with the first epidemic in the very active group and the second, later epidemic in the active risk group. It is interesting that fits to the homosexual men outside NYC with smaller population sizes had larger values of ETA so the active and very active groups were more closely linked.

For IVDUs in the NE the two aggregated groups from Section 10.2 are all IVDUs in regions A and B (labeled NE2TOT) and all IVDUs in region C (labeled NE2TCT). Many of the parameter values in the simulations of AIDS incidence in IVDUs are the same as those used for homosexual men. For example, HIV–infected IVDUs are assumed to progress towards AIDS and death in the same way as homosexual men. Simulations which fit the AIDS incidence data for the two IVDU groups are shown in Tables 10.5 and 10.6 and in Figures 10.18 and 10.19. Only the parameter values which are varied to fit the data are compared and discussed.

The population size estimates are 300,000 IVDUs at risk in regions A and B and 100,000 IVDUs in region C. These estimates are educated guesses. They use information such as the estimate in Chapter 8 on NYC that there are 150,000 IVDUs in NYC (region A). In Chapter 9 on r/e patterns it was estimated that 3/4 of IVDU are men, 2/3 of IVDU men have a female sexual partner who is not an IVDU and almost no female IVDUs have a non–IVDU male sexual partner. Since $(3/4)(2/3) = 1/2$, the population sizes of heterosexual partners are set at half of the IVDU population sizes. In the NE subregions A and B, 23% of AIDS cases in IVDUs are women and 86% of AIDS cases in heterosexual partners are women; these percentages are 23% and 70% in subregion C.

In Table 10.5 corresponding to subregions A and B, the IVDUs are fit without any reduction in needle–sharing partnership rates. The connection between the very active and active groups is somewhat weak since ETA = 0.15, but this seems to be due to the large population size. In Table 10.6 corresponding to subregion C, the initial number of needle–sharing partners per month is higher than in Table 10.5, but there is a yearly reduction of 0.72 starting in July 1981. In Table 10.6, ETA = 1 so the high and low activity groups are very closely connected. The epidemic starting date in regions A and B is January 1975, but it is January 1977 in region C. Visually the differences in the behaviors and fits don't seem that much different in Figures 10.18 and 10.19 except that the peak HIV incidence is about 3 years later in subregion C than in subregions A and B. As in Figure 10.16 the high HIV incidences in recent years are not predictions; they occur because the observed AIDS incidences have not yet indicated that there has been a decrease in needle–sharing partnerships.

Table 10.5 Parameter values and corresponding simulation values for IVDUs, heterosexual partners and related pediatric cases in NE subregions A and B.

```
THE IVDU & HTRO POPULATION SIZES ARE      300000      150000
THE VERY ACTIVE FRACTION IS    1.000000E-01
THE ACTIVITY RATIO IS       10.000000
THE NATURAL MORTALITY RATE XMU IS   5.320000E-04
THE INTERCHANGE RATE  FROM THE VERY ACTIVE CLASS TO THE ACTIVE CLASS IS
   4.166667E-03  AND THE TURNOVER RATE IS DLT =    4.166667E-03
THE NUMBER OF INFECTIOUS STAGES IS  M =          7
THE G PARAMETERS FOR THE TRANSFER BETWEEN ADULT STAGES ARE    7.355444E-02
   6.433708E-02    4.867545E-02    4.199281E-02    3.997889E-02
   5.152515E-02    5.398798E-02
THE WEIGHTS OF TRANSMISSION PER INFECTIOUS PARTNER TIMES THE FRACTION STILL
SEXUALLY ACTIVE FOR THE STAGES ARE WRH(I) =        2.000000        1.000000
       1.000000        1.500000        1.500000        1.500000
       7.500000
THE PROBABILITIES OF TRANSMISSION ARE QH, QHP & QC =    5.000000E-02
   1.000000E-01    1.000000E-01
THE EXTERNAL MIXING FRACTION IS ETA =    1.518000E-01
THE AVERAGE NUMBER OF NEEDLE-SHARING PARTNERS PER MONTH IS    3.766000E-01
BEFORE         2222            2, THEN IT IS REDUCED EACH YEAR BY A FACTOR OF
      1.000000 UNTIL DEC,        2222
THE FRACTION OF IVDU WHO ARE WOMEN IS    2.300000E-01
THE FRACTION OF HETEROSEXUALS WHO ARE WOMEN IS    8.600000E-01
THE AVERAGE NUMBER OF IVDU PARTNERS OF HETEROSEXUALS PER MONTH IS
  2.700000E-02
THE FRACTION   3.400000E-01 OF CHILDREN PROGRESS RAPIDLY TO AIDS WITH RATE
CONSTANT   8.000000E-02. OTHERS MOVE THROUGH M STAGES WITH SPEED FACTOR
      1.550000
THE FECUNDITY FC (CHILDREN/MONTH) IS   5.900000E-03
THE STARTING YEAR AND MONTH ARE        1975          0
THE STARTING NUMBER OF VERY ACTIVE INFECTIVES IS      1.000000
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THE SIMULATED INCIDENCES ARE GIVEN ON THE NEXT PAGE
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ne2tabt.m ne2tabt.m ne2tabt.m ne2tabt.m ne2tabt.m

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YEAR		HIV	HIV	FRACTNAL_PREV			YR AIDS INC		AIDS(SIMULATION)		
	CLASS	INC	PREV	ALL	V_A	ACT	DATA	SIM	PREV	DTHS	OUTSF
1975	IVDU	6.	7.	.00	.00	.00	0.	0.	0.	0.	0.
	HTRO	0.	0.	.00	-	-	****	0.	0.	0.	0.
	PED	0.	0.	-	-	-	0.	0.	0.	0.	
1976	IVDU	32.	39.	.00	.00	.00	0.	0.	0.	0.	0.
	HTRO	1.	1.	.00	-	-	0.	0.	0.	0.	0.
	PED	0.	0.	-	-	-	0.	0.	0.	0.	
1977	IVDU	166.	199.	.00	.01	.00	0.	0.	0.	0.	0.
	HTRO	5.	6.	.00	-	-	0.	0.	0.	0.	0.
	PED	0.	0.	-	-	-	0.	0.	0.	0.	
1978	IVDU	837.	1009.	.00	.03	.00	0.	0.	0.	0.	0.
	HTRO	26.	31.	.00	-	-	0.	0.	0.	0.	0.
	PED	1.	2.	-	-	-	0.	0.	0.	0.	
1979	IVDU	3796.	4676.	.02	.14	.00	0.	1.	1.	0.	0.
	HTRO	123.	150.	.00	-	-	0.	0.	1.	0.	0.
	PED	7.	8.	-	-	-	3.	1.	1.	0.	
1980	IVDU	11473.	15639.	.05	.45	.01	5.	6.	3.	2.	1.
	HTRO	479.	611.	.00	-	-	0.	0.	3.	0.	0.
	PED	27.	34.	-	-	-	1.	3.	4.	2.	
1981	IVDU	14793.	29175.	.10	.78	.02	34.	29.	9.	8.	4.
	HTRO	1108.	1659.	.01	-	-	1.	1.	9.	0.	0.
	PED	66.	95.	-	-	-	5.	9.	12.	6.	
1982	IVDU	10497.	37750.	.13	.89	.04	162.	118.	19.	37.	18.
	HTRO	1540.	3069.	.02	-	-	9.	4.	19.	1.	1.
	PED	100.	181.	-	-	-	11.	19.	24.	14.	
1983	IVDU	8748.	44078.	.15	.92	.06	414.	360.	31.	129.	64.
	HTRO	1796.	4647.	.03	-	-	17.	15.	31.	5.	2.
	PED	127.	283.	-	-	-	36.	31.	37.	25.	
1984	IVDU	9063.	50162.	.17	.92	.08	744.	824.	45.	349.	174.
	HTRO	2086.	6412.	.04	-	-	47.	41.	45.	16.	8.
	PED	157.	402.	-	-	-	45.	45.	52.	38.	
1985	IVDU	10032.	56494.	.19	.91	.11	1386.	1484.	63.	741.	376.
	HTRO	2448.	8409.	.06	-	-	99.	92.	63.	40.	20.
	PED	194.	543.	-	-	-	82.	63.	72.	54.	
1986	IVDU	11188.	63094.	.21	.90	.13	2158.	2243.	86.	1294.	667.
	HTRO	2858.	10656.	.07	-	-	203.	171.	86.	84.	43.
	PED	239.	708.	-	-	-	121.	86.	96.	74.	
1987	IVDU	12353.	69868.	.23	.87	.16	3026.	2990.	113.	1949.	1021.
	HTRO	3280.	13127.	.09	-	-	319.	278.	113.	153.	78.
	PED	288.	897.	-	-	-	162.	113.	126.	98.	
1988	IVDU	13437.	76707.	.26	.84	.19	3712.	3658.	144.	2631.	1402.
	HTRO	3683.	15768.	.11	-	-	423.	409.	144.	246.	128.
	PED	341.	1110.	-	-	-	144.	144.	159.	128.	
1989	IVDU	14382.	83507.	.28	.81	.22	4344.	4229.	179.	3281.	1778.
	HTRO	4049.	18513.	.12	-	-	541.	560.	179.	363.	191.
	PED	395.	1344.	-	-	-	171.	179.	196.	161.	
1990	IVDU	15162.	90165.	.30	.78	.25	4655.	4724.	218.	3872.	2129.
	HTRO	4370.	21295.	.14	-	-	635.	728.	218.	501.	267.
	PED	449.	1595.	-	-	-	190.	218.	236.	198.	

CHISQD = 49.249570
CHISQP = 32.489760
CHISQC = 51.331530
SUM OF CHISQ-D,P,C = 133.070800

Table 10.6 Parameter values and corresponding simulation values for IVDUs, heterosexual partners and related pediatric cases in NE subregion C.

```
THE IVDU & HTRO POPULATION SIZES ARE       100000        50000
THE VERY ACTIVE FRACTION IS    1.000000E-01
THE ACTIVITY RATIO IS        10.000000
THE NATURAL MORTALITY RATE XMU IS   5.320000E-04
THE INTERCHANGE RATE  FROM THE VERY ACTIVE CLASS TO THE ACTIVE CLASS IS
   4.166667E-03  AND THE TURNOVER RATE IS DLT =    4.166667E-03
THE NUMBER OF INFECTIOUS STAGES IS  M =            7
THE G PARAMETERS FOR THE TRANSFER BETWEEN ADULT STAGES ARE    7.355444E-02
   6.433708E-02    4.867545E-02    4.199281E-02    3.997889E-02
   5.152515E-02    5.398798E-02
THE WEIGHTS OF TRANSMISSION PER INFECTIOUS PARTNER TIMES THE FRACTION STILL
SEXUALLY ACTIVE FOR THE STAGES ARE WRH(I) =        2.000000         1.000000
       1.000000         1.500000         1.500000         1.500000
       7.500000
THE PROBABILITIES OF TRANSMISSION ARE QH, QHP & QC =    5.000000E-02
   1.000000E-01    1.000000E-01
THE EXTERNAL MIXING FRACTION IS ETA =        1.000000
THE AVERAGE NUMBER OF NEEDLE-SHARING PARTNERS PER MONTH IS    4.852000E-01
BEFORE        1981           7, THEN IT IS REDUCED EACH YEAR BY A FACTOR OF
  7.150000E-01 UNTIL DEC,        1987
THE FRACTION OF IVDU WHO ARE WOMEN IS    2.300000E-01
THE FRACTION OF HETEROSEXUALS WHO ARE WOMEN IS    7.000000E-01
THE AVERAGE NUMBER OF IVDU PARTNERS OF HETEROSEXUALS PER MONTH IS
  4.600000E-02
THE FRACTION   3.400000E-01 OF CHILDREN PROGRESS RAPIDLY TO AIDS WITH RATE
CONSTANT   8.000000E-02. OTHERS MOVE THROUGH M STAGES WITH SPEED FACTOR
      1.550000
THE FECUNDITY FC (CHILDREN/MONTH) IS   6.200000E-03
THE STARTING YEAR AND MONTH ARE        1977          1
THE STARTING NUMBER OF VERY ACTIVE INFECTIVES IS       1.000000
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THE SIMULATED INCIDENCES ARE GIVEN ON THE NEXT PAGE
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ne2tct.m ne2tct.m ne2tct.m ne2tct.m ne2tct.m
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YEAR	CLASS	HIV INC	HIV PREV	FRACTNAL_PREV ALL	V_A	ACT	YR AIDS INC DATA	SIM	AIDS(SIMULATION) PREV	DTHS	OUTSF
1977	IVDU	6.	6.	.00	.00	.00	0.	0.	0.	0.	0.
	HTRO	0.	0.	.00	-	-	****	0.	0.	0.	0.
	PED	0.	0.	-	-	-	0.	0.	0.	0.	
1978	IVDU	20.	25.	.00	.00	.00	0.	0.	0.	0.	0.
	HTRO	1.	1.	.00	-	-	0.	0.	0.	0.	0.
	PED	0.	0.	-	-	-	0.	0.	0.	0.	
1979	IVDU	70.	93.	.00	.00	.00	0.	0.	0.	0.	0.
	HTRO	4.	6.	.00	-	-	0.	0.	0.	0.	0.
	PED	0.	0.	-	-	-	0.	0.	0.	0.	
1980	IVDU	248.	331.	.00	.02	.00	0.	0.	0.	0.	0.
	HTRO	16.	21.	.00	-	-	0.	0.	0.	0.	0.
	PED	1.	1.	-	-	-	0.	0.	0.	0.	
1981	IVDU	791.	1087.	.01	.05	.01	1.	1.	0.	0.	0.
	HTRO	56.	75.	.00	-	-	0.	0.	0.	0.	0.
	PED	2.	3.	-	-	-	1.	0.	0.	0.	
1982	IVDU	1465.	2456.	.02	.12	.01	2.	3.	1.	1.	0.
	HTRO	146.	213.	.00	-	-	0.	0.	1.	0.	0.
	PED	6.	8.	-	-	-	0.	1.	1.	0.	
1983	IVDU	1798.	4071.	.04	.19	.02	13.	9.	2.	3.	1.
	HTRO	264.	459.	.01	-	-	0.	1.	2.	0.	0.
	PED	11.	18.	-	-	-	1.	2.	2.	1.	
1984	IVDU	1719.	5512.	.06	.25	.03	30.	27.	3.	10.	5.
	HTRO	377.	801.	.02	-	-	1.	2.	3.	1.	0.
	PED	17.	32.	-	-	-	2.	3.	4.	2.	
1985	IVDU	1439.	6584.	.07	.29	.04	64.	67.	6.	27.	14.
	HTRO	466.	1210.	.02	-	-	6.	6.	6.	2.	1.
	PED	22.	50.	-	-	-	4.	6.	6.	4.	
1986	IVDU	1134.	7268.	.07	.31	.05	112.	134.	8.	62.	31.
	HTRO	536.	1660.	.03	-	-	10.	13.	8.	5.	3.
	PED	28.	71.	-	-	-	10.	8.	9.	7.	
1987	IVDU	872.	7606.	.08	.31	.05	244.	226.	11.	120.	61.
	HTRO	593.	2136.	.04	-	-	35.	26.	11.	12.	6.
	PED	33.	95.	-	-	-	11.	11.	13.	10.	
1988	IVDU	794.	7778.	.08	.31	.05	316.	333.	15.	199.	103.
	HTRO	643.	2623.	.05	-	-	55.	47.	15.	24.	12.
	PED	39.	121.	-	-	-	19.	15.	17.	13.	
1989	IVDU	848.	7908.	.08	.31	.05	469.	437.	19.	291.	153.
	HTRO	697.	3120.	.06	-	-	76.	73.	19.	42.	21.
	PED	46.	150.	-	-	-	14.	19.	21.	17.	
1990	IVDU	897.	7994.	.08	.30	.06	504.	523.	24.	385.	206.
	HTRO	746.	3615.	.07	-	-	82.	106.	24.	65.	34.
	PED	52.	181.	-	-	-	33.	24.	26.	21.	

CHISQD = 11.419700
CHISQP = 11.762620
CHISQC = 10.166080
SUM OF CHISQ-D,P,C = 33.348400

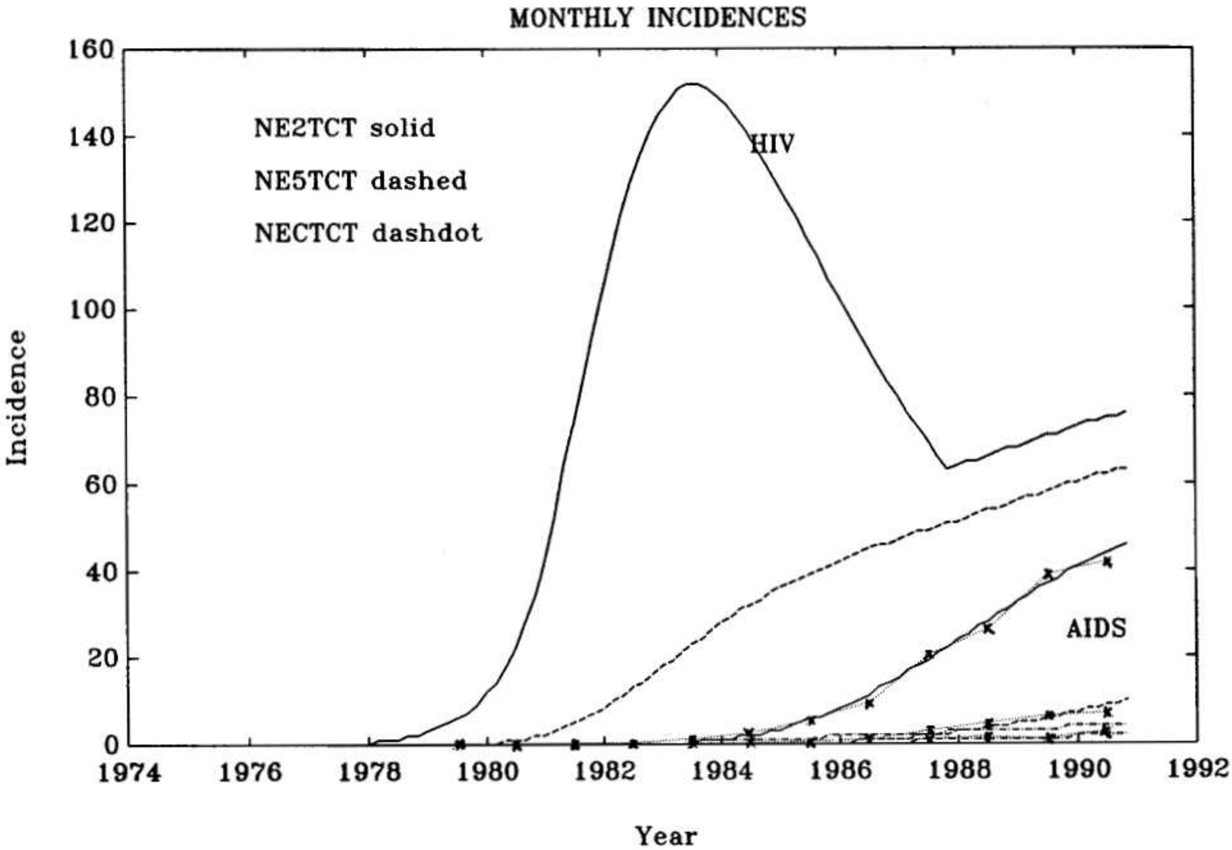

Figure 10.19. Estimated AIDS incidences (*) and simulated HIV and AIDS incidences for IVDUs, their heterosexual partners, and related pediatric cases in NE subregion C corresponding to parameter values in Table 10.6.

In Chapter 9 on r/e patterns, it was found that the AIDS incidence in heterosexual partners relative to that in IVDUs is higher in region C than in regions A and B. Thus it is not surprising that the average number of heterosexual partners per month of IVDUs in region C is 70% higher than that in regions A and B. The values of the fecundity which give the best fit to the pediatric AIDS incidence are almost the same in Tables 10.5 and 10.6. The near equality of these fecundity values suggests that the differences in the heterosexual partnership parameter values may be realistic and not just due to reporting differences. That is, the modeling suggests that IVDUs in region C are about twice as likely to have non–IVDU heterosexual partners or are twice as likely to transmit HIV infection to their heterosexual partners as IVDUs in regions A and B. It may be that IVDUs in regions A and B tend to have sex partners who are also IVDUs. The fecundities of about 0.006 births per female per month are consistent with birth rate data of 70 births per 1000 women per year (World Almanac, 1988).

10.4. The North Central Region: Aggregation of Racial/Ethnic and Risk Groups

The four subregions of the North Central region defined in Table 10.1 are Chicago (A), Detroit (B), large cities (C) and small cities (D). In regions A, C and D the time trends for AIDS incidences for homosexual/bisexual men in the r/e groups are the same in the sense that the percentages in each r/e group remain roughly the same over time. For example, the time trends in whites, blacks and Hispanics in Chicago are shown in Figure 10.20. The time trends for AIDS

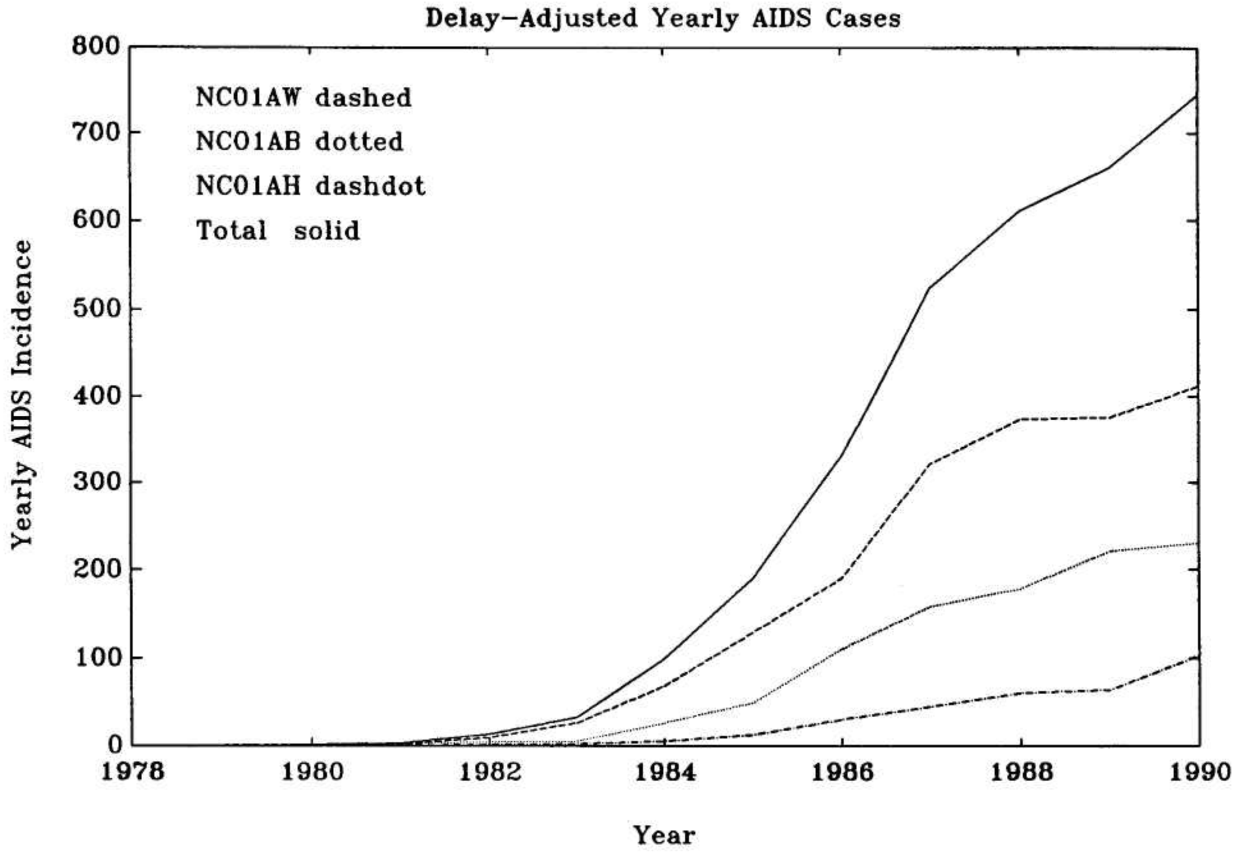

Figure 10.20. AIDS incidences in white, black, and Hispanic homosexual men in NC subregion A (Chicago).

in homosexual men in Detroit shown in Figure 10.21 are somewhat different for whites and blacks, however, since both are increasing and the numbers are small, it seems reasonable to combine them. Thus the r/e groups of homosexual men can be lumped together in all four subregions. The r/e percentages are 61% white (W), 30% black (B) and 7% Hispanic (H) in Chicago, 56% W and 44% B in Detroit, 83% W and 17% B in large cities, and 94% W and 9% B in small cities.

The time trends for AIDS are shown in Figure 10.22 for homosexual men in the four NC subregions. Some erratic changes have occurred in the last few years. The Chicago (A) time trend is somewhat different and it suggests that AIDS has not grown quite as fast in this group in recent years. However, the trend is increasing in all subregions so the Chicago homosexual men are not analyzed separately. Examination of the percentages of AIDS cases in each subregion over time shows that AIDS cases are growing at similar rates in all four subregions so that they can be combined. For AIDS cases in homosexual men in the NC region, 30% are from Chicago, 6% from Detroit, 37% from large cities and 27% from small cities.

In the four NC subregions the AIDS incidences in r/e subgroups of homosexual IVDUs are small and erratic so that there is no indication of differences between the subgroups; thus the r/e subgroups can be combined. Cumulative AIDS incidences in homosexual IVDUs are 6% of that in homosexual men in Chicago, 11% in Detroit, 7% in large cities and 14% in small cities. The time trends for NC homosexual IVDUs are similar to those for NC homosexual men and AIDS incidence in homosexual IVDUs is about 7% of AIDS incidence in homosexual men.

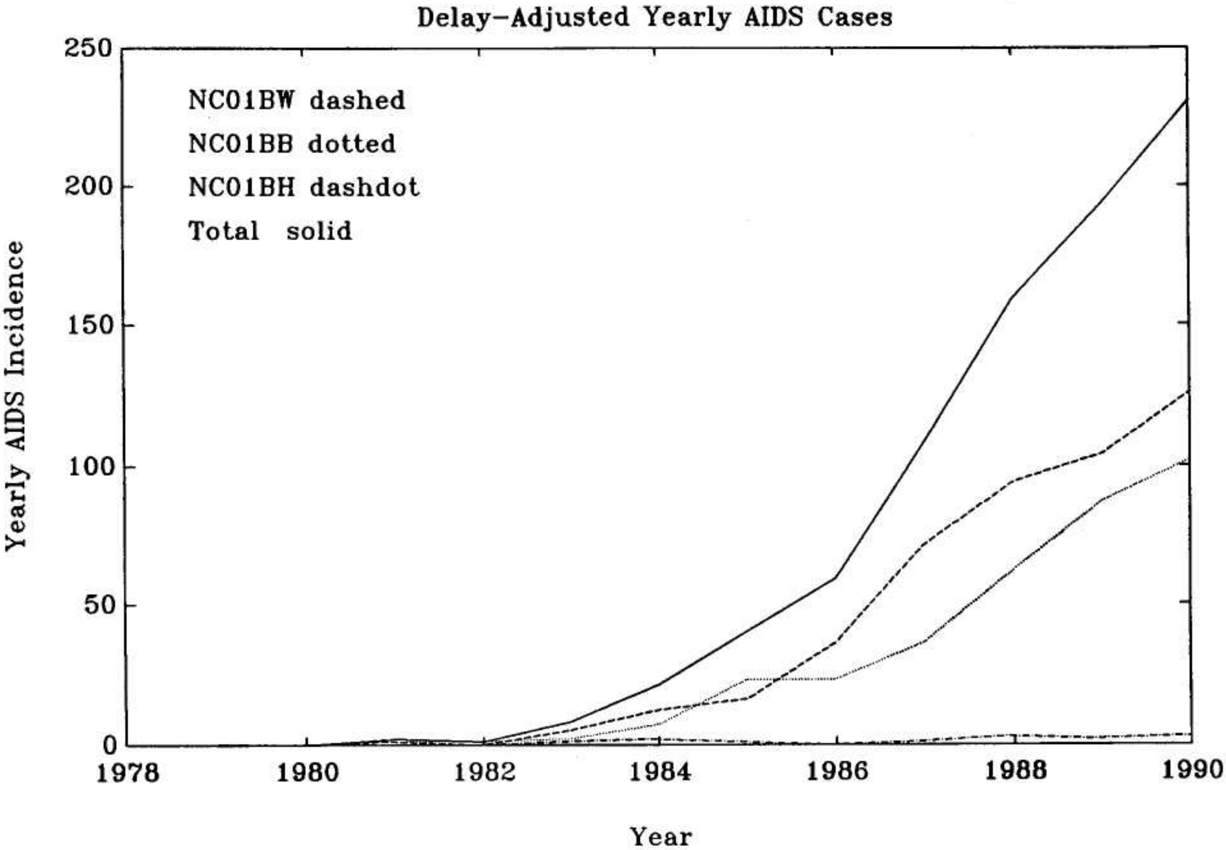

Figure 10.21. AIDS incidence in white, black, and Hispanic homosexual men in NC subregion B (Detroit).

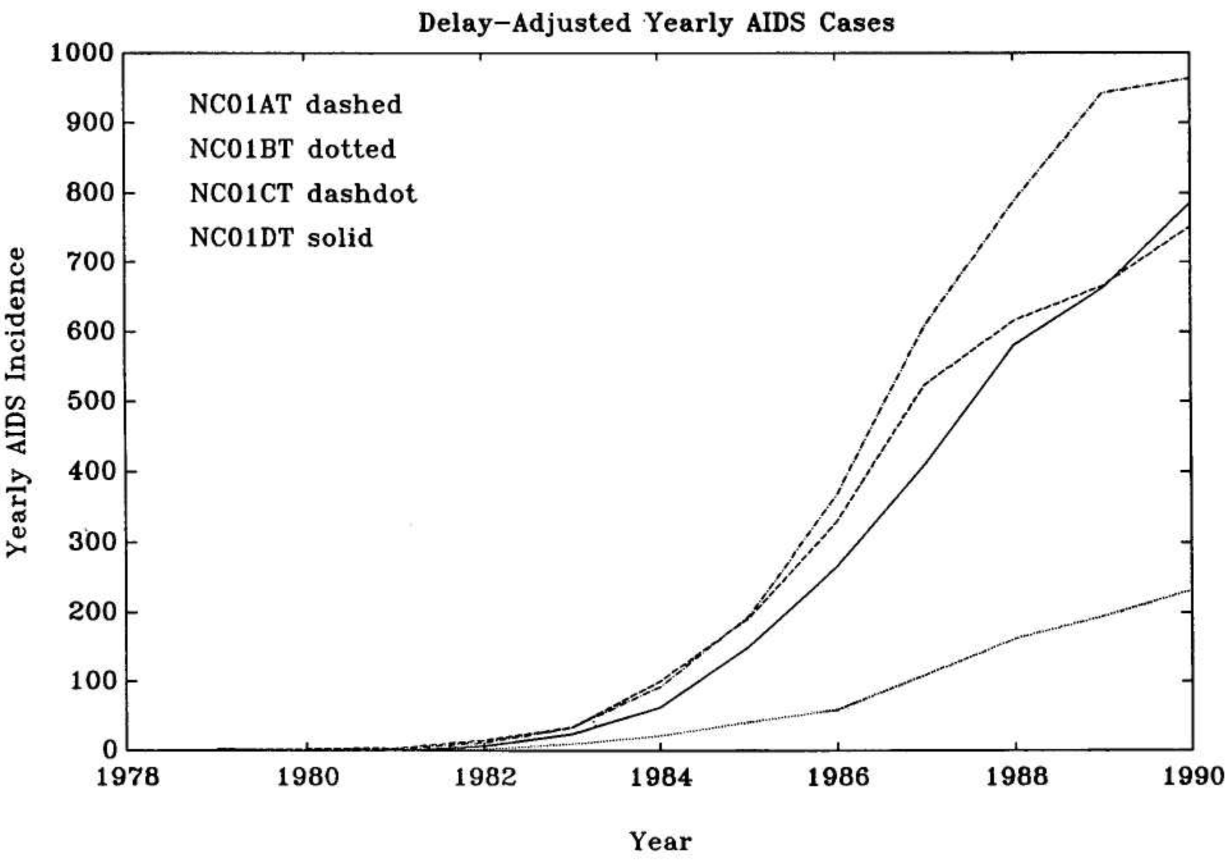

Figure 10.22. AIDS incidence in homosexual men in the four NC subregions: Chicago (A), Detroit (B), other large cities (C), and small cities (D).

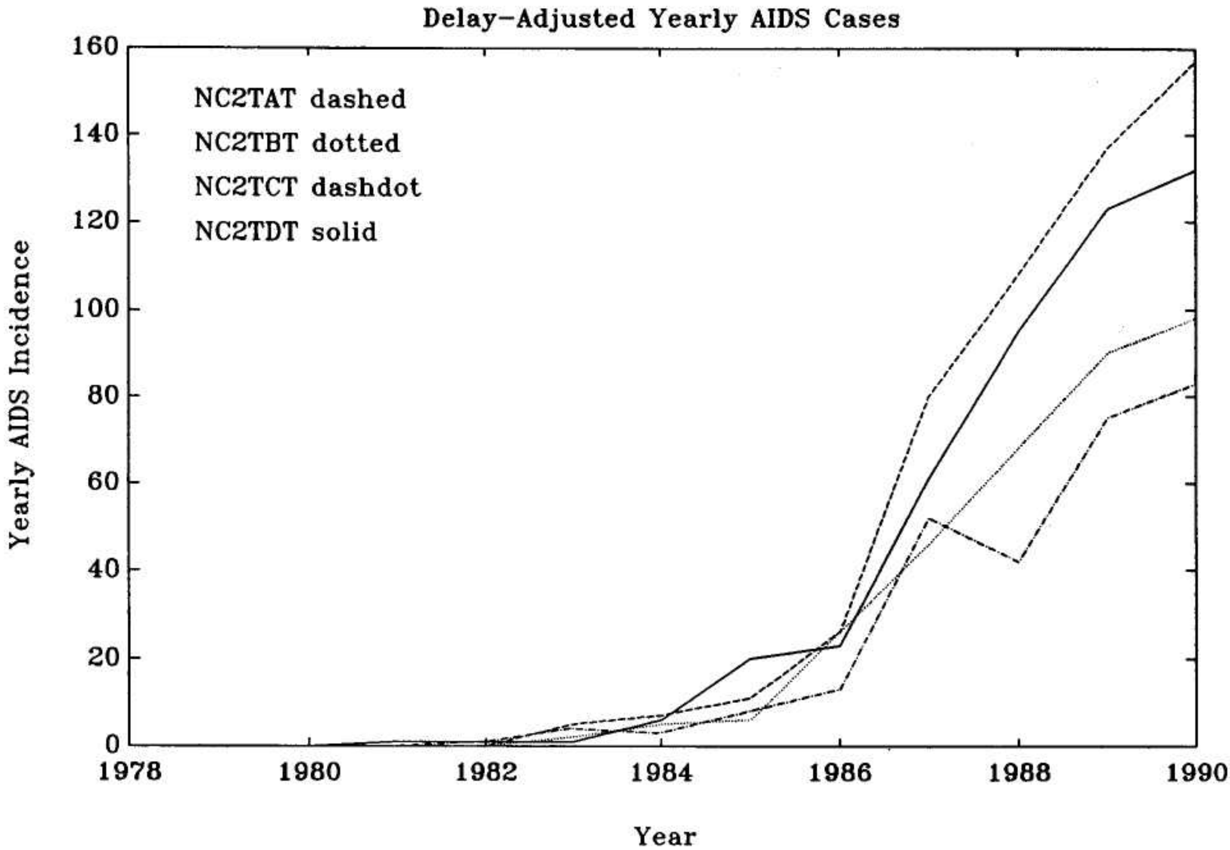

Figure 10.23. AIDS incidence in combined male (heterosexual) and female IVDUs in the four NC regions: Chicago (A), Detroit (B), large cities (C), and small cities (D).

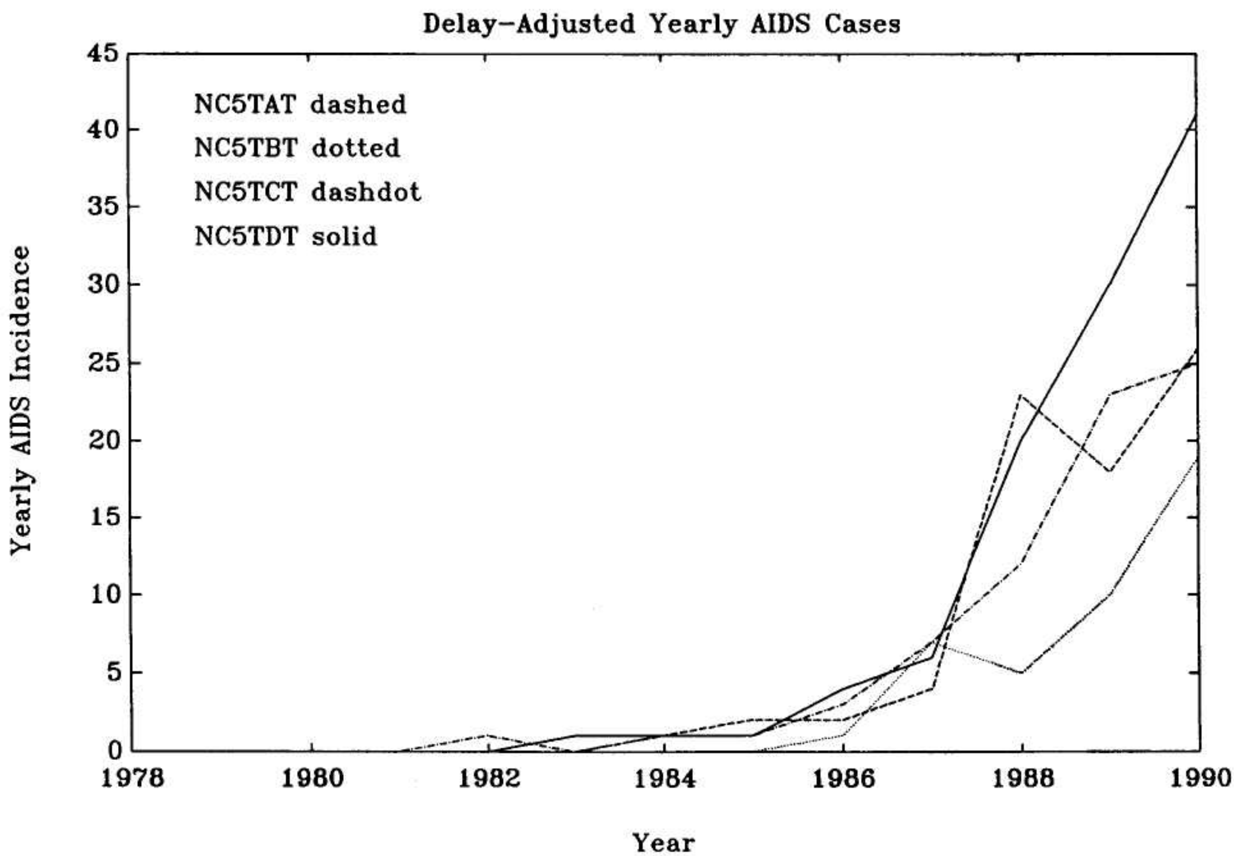

Figure 10.24. AIDS incidence in heterosexual partners of IVDUs in the four NC subregions: Chicago (A), Detroit (B), other large cities (C), and small cities (D).

The AIDS incidences for IVDUs in NC subregions are small and erratic, particularly for females. The variability of the incidence data is probably due to random effects in incidence and reporting. Since trends cannot be detected in erratic data, aggregation is necessary so that the yearly incidences are large enough to give smooth time trends. Thus the r/e groups are lumped together for male IVDUs and female IVDUs in each subregion. For AIDS cases in male IVDUs the r/e percentages are 28% W, 43% B and 30% H in Chicago, 4% W and 96%B in Detroit, 43% W and 56% B in large cities, and 38% W and 62% B in small cities. Since the time trends in female IVDUs are similar to those in male IVDUs, these risk groups are combined. The percentages of AIDS cases who are women are 20% in Chicago, 29% in Detroit, 20% in large cities (with very few white females) and 16% in small cities. Figure 10.23 shows the male and female heterosexual IVDUs by subregion. The AIDS incidences seem to be increasing slower in large cities and Detroit so these regions (B and C) are combined. Chicago and small cities (A and D) are lumped since the AIDS growth is faster in these cities.

For heterosexual partners (male and female) of IVDUs the AIDS incidences shown in Figure 10.24 in the subregions are somewhat erratic, but the growth rate is slowest in Detroit, somewhat faster in larger cities, faster in small cities and fastest in Chicago. This ordering is the same as for the IVDUs in the regions, as would be expected. The downward trend after 1988 in Chicago and the low incidences in 1988 and 1989 in Detroit are hard to explain, but they are probably due to reporting problems.

The number of perinatal AIDS cases is small enough so that it is impossible to determine time trends in r/e subgroups or in the subregions. Thus it is assumed that the aggregations used for IVDUs and heterosexual partners also apply.

10.5. The North Central Region: Computer Simulations of the Aggregated Groups

The simulation model in Chapter 7 has been fit to the combined groups given in Section 10.4. Recall that all homosexual men in the NC region have been combined into one group. The AIDS incidences for this group have been fit as shown in Table 10.7 and Figure 10.25. The estimate of 500,000 has been used for the population size of homosexual men at risk in the North Central region. The sexual behavior parameters are similar to those for homosexual men in NYC; namely, the average number of partners before reduction is 0.55, the yearly reduction starts in January 1981, and the activity level groups are mixing randomly. The epidemic starting date of January 1976 is later than any of the NE starting dates for homosexual men.

Table 10.8 and Figure 10.26 show the simulations for IVDUs, their heterosexual partners and related pediatric cases in the combined regions A and D. Table 10.9 and Figure 10.27 correspond to combined regions B and C. The populations sizes are different, but many of the parameter values are similar in Tables 10.8 and 10.9. Although the epidemic starting date is 6 months earlier in regions A and D, both dates are near the beginning of 1978, the average numbers of new needle–sharing partners per month are about 0.5 and the changes in behavior start in July 1981. In the North Central subregions AD and BC, respectively 19% and 26% of AIDS cases in IVDUs are women and 59% and 68% of AIDS cases in heterosexual partners are women. The average numbers of new heterosexual partners per month are both close to the value for IVDUs in

Table 10.7 Parameter values and corresponding simulation values for all homosexual men in NC region.

```
THE POPULATION SIZE IS       500000, THE VERY ACTIVE FRACTION IS
  1.000000E-01 AND THE ACTIVITY RATIO IS       10.000000
THE NATURAL MORTALITY RATE XMU IS   5.320000E-04
THE INTERCHANGE RATE  FROM THE VERY ACTIVE CLASS TO THE ACTIVE CLASS IS
   4.166667E-03  AND THE TURNOVER RATE IS DLT =    4.166667E-03
THE NUMBER OF INFECTIOUS STAGES IS  M =          7
THE G PARAMETERS FOR THE TRANSFER BETWEEN STAGES ARE    7.355444E-02
   6.433708E-02    4.867545E-02    4.199281E-02    3.997889E-02
   5.152515E-02    5.398798E-02
THE WEIGHTS OF TRANSMISSION PER INFECTIOUS PARTNER TIMES THE FRACTION STILL
SEXUALLY ACTIVE FOR THE STAGES ARE WRH(I) =       2.000000        1.000000
       1.000000        1.500000        1.500000        1.500000
       7.500000
THE PROBABILITY OF TRANSMISSION IS QH =    5.000000E-02
THE EXTERNAL MIXING FRACTION IS ETA =       1.000000
THE AVERAGE NUMBER OF PARTNERS PER MONTH IS    5.539000E-01 BEFORE        1981
         1, THEN IT IS REDUCED EACH YEAR BY A FACTOR OF    6.346000E-01UNTIL
DEC,         1990
THE STARTING YEAR AND MONTH ARE          1975          12
THE STARTING NUMBER OF VERY ACTIVE INFECTIVES IS        1.000000
```

****

YEAR	HIV INC	HIV	FRACTNAL_PREV			YR AIDS	INC	AIDS(SIMULATION)		
	SIM	PREV	ALL	V_A	ACT	DATA	SIM	PREV	DTHS	OUTSF
1975	0.	1.	.00	.00	.00	*****	0.	0.	0.	0.
1976	8.	9.	.00	.00	.00	*****	0.	0.	0.	0.
1977	36.	44.	.00	.00	.00	*****	0.	0.	0.	0.
1978	157.	196.	.00	.00	.00	*****	0.	0.	0.	0.
1979	691.	863.	.00	.01	.00	1.	0.	0.	0.	0.
1980	2975.	3734.	.01	.04	.00	1.	1.	1.	0.	0.
1981	7819.	11167.	.02	.11	.01	6.	6.	5.	2.	1.
1982	9992.	20283.	.04	.19	.02	32.	25.	23.	7.	4.
1983	8655.	27565.	.06	.25	.03	99.	93.	86.	30.	15.
1984	6263.	32049.	.06	.28	.04	275.	267.	254.	99.	49.
1985	4254.	34184.	.07	.29	.04	575.	595.	592.	257.	129.
1986	2841.	34568.	.07	.28	.05	1022.	1066.	1122.	536.	272.
1987	1885.	33636.	.07	.27	.05	1650.	1607.	1798.	931.	480.
1988	1236.	31700.	.06	.24	.04	2145.	2116.	2520.	1394.	731.
1989	794.	29028.	.06	.21	.04	2463.	2503.	3172.	1851.	989.
1990	497.	25875.	.05	.19	.04	2733.	2718.	3658.	2232.	1216.

CHISQ =   9.766908

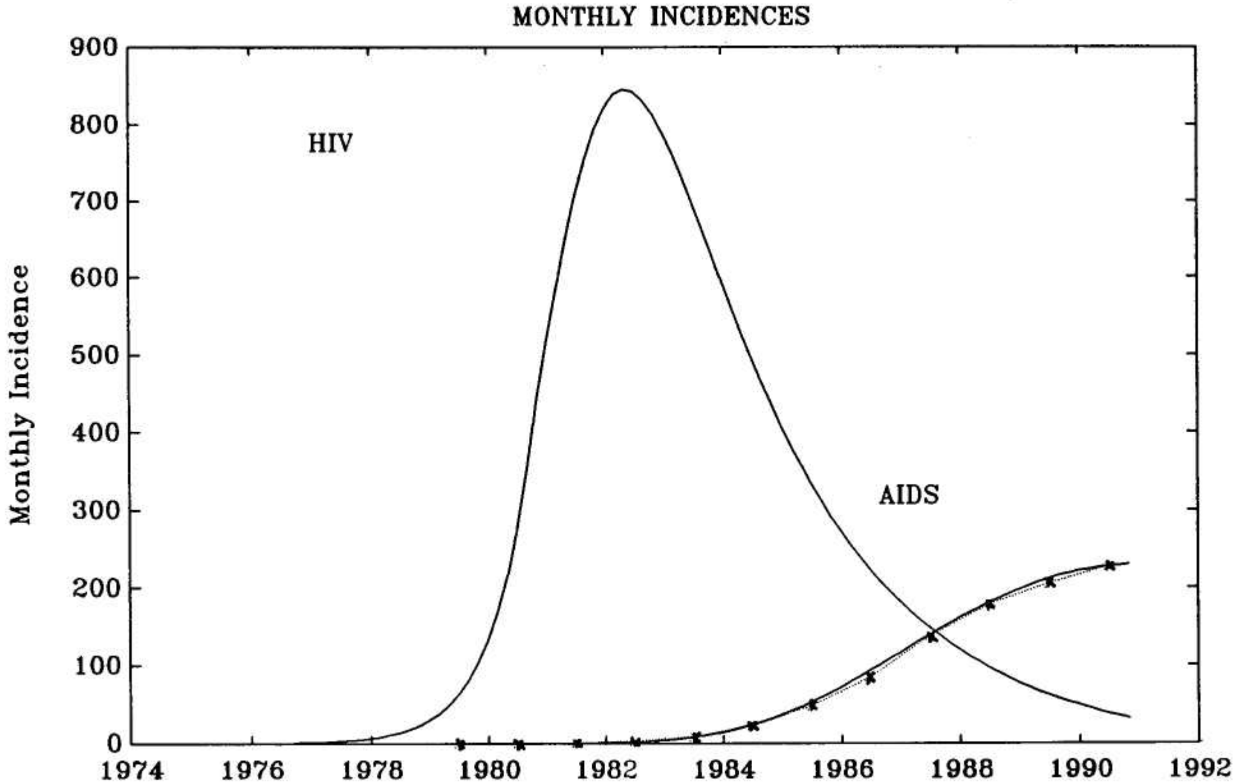

Figure 10.25. Estimated AIDS incidences (*) and simulated HIV and AIDS incidences for homosexual men in the NC region corresponding to parameter values in Table 10.7.

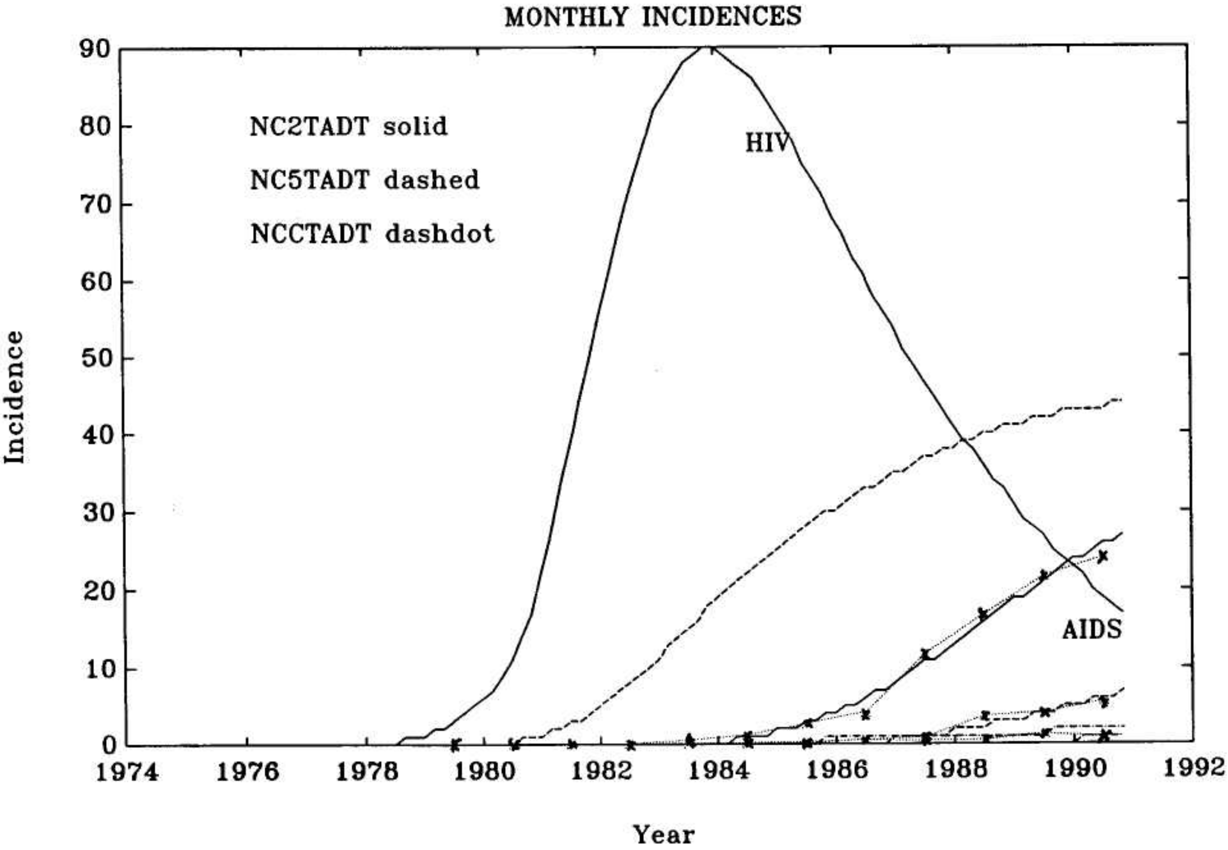

Figure 10.26. Estimated AIDS incidences (*) and simulates HIV and AIDS incidences for IVDUs, their heterosexual partners, and related pediatric cases in combined NC subregions A and D corresponding to parameter values in Table 10.8.

Table 10.8 Parameter values and corresponding simulation values for IVDUs, heterosexual partners and related pediatric cases in NC subregions A and D.

```
THE IVDU & HTRO POPULATION SIZES ARE      100000       50000
THE VERY ACTIVE FRACTION IS    1.000000E-01
THE ACTIVITY RATIO IS       10.000000
THE NATURAL MORTALITY RATE XMU IS   5.320000E-04
THE INTERCHANGE RATE  FROM THE VERY ACTIVE CLASS TO THE ACTIVE CLASS IS
   4.166667E-03  AND THE TURNOVER RATE IS DLT =    4.166667E-03
THE NUMBER OF INFECTIOUS STAGES IS  M =           7
THE G PARAMETERS FOR THE TRANSFER BETWEEN ADULT STAGES ARE    7.355444E-02
   6.433708E-02    4.867545E-02    4.199281E-02    3.997889E-02
   5.152515E-02    5.398798E-02
THE WEIGHTS OF TRANSMISSION PER INFECTIOUS PARTNER TIMES THE FRACTION STILL
SEXUALLY ACTIVE FOR THE STAGES ARE WRH(I) =       2.000000        1.000000
       1.000000        1.500000        1.500000        1.500000
       7.500000
THE PROBABILITIES OF TRANSMISSION ARE QH, QHP & QC =    5.000000E-02
   1.000000E-01    1.000000E-01
THE EXTERNAL MIXING FRACTION IS ETA =         1.000000
THE AVERAGE NUMBER OF NEEDLE-SHARING PARTNERS PER MONTH IS    4.827000E-01
BEFORE       1981            7, THEN IT IS REDUCED EACH YEAR BY A FACTOR OF
  7.160000E-01 UNTIL DEC,        1990
THE FRACTION OF IVDU WHO ARE WOMEN IS    1.900000E-01
THE FRACTION OF HETEROSEXUALS WHO ARE WOMEN IS    5.900000E-01
THE AVERAGE NUMBER OF IVDU PARTNERS OF HETEROSEXUALS PER MONTH IS
  5.600000E-02
THE FRACTION   3.400000E-01 OF CHILDREN PROGRESS RAPIDLY TO AIDS WITH RATE
CONSTANT   8.000000E-02. OTHERS MOVE THROUGH M STAGES WITH SPEED FACTOR
      1.550000
THE FECUNDITY FC (CHILDREN/MONTH) IS   5.800000E-03
THE STARTING YEAR AND MONTH ARE        1977          7
THE STARTING NUMBER OF VERY ACTIVE INFECTIVES IS      1.000000
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THE SIMULATED INCIDENCES ARE GIVEN ON THE NEXT PAGE
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nc2tadt.m nc2tadt.m nc2tadt.m nc2tadt.m nc2tadt.m

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YEAR	CLASS	HIV INC	HIV PREV	FRACTNAL_PREV ALL	V_A	ACT	YR AIDS INC DATA	SIM	AIDS(SIMULATION) PREV	DTHS	OUTSF
1977	IVDU	2.	3.	.00	.00	.00	****	0.	0.	0.	0.
	HTRO	0.	0.	.00	-	-	****	0.	0.	0.	0,
	PED	0.	0.	-	-	-	0.	0.	0.	0.	
1978	IVDU	10.	13.	.00	.00	.00	0.	0.	0.	0.	0.
	HTRO	1.	1.	.00	-	-	****	0.	0.	0.	0.
	PED	0.	0.	-	-	-	0.	0.	0.	0.	
1979	IVDU	36.	48.	.00	.00	.00	0.	0.	0.	0.	0.
	HTRO	3.	4.	.00	-	-	0.	0.	0.	0.	0.
	PED	0.	0.	-	-	-	0.	0.	0.	0.	
1980	IVDU	128.	171.	.00	.01	.00	0.	0.	0.	0.	0.
	HTRO	10.	13.	.00	-	-	0.	0.	0.	0.	0.
	PED	0.	0.	-	-	-	0.	0.	0.	0.	
1981	IVDU	413.	566.	.01	.03	.00	1.	0.	0.	0.	0.
	HTRO	35.	47.	.00	-	-	0.	0.	0.	0.	0.
	PED	1.	1.	-	-	-	0.	0.	0.	0.	
1982	IVDU	796.	1312.	.01	.07	.01	1.	1.	0.	0.	0.
	HTRO	94.	136.	.00	-	-	0.	0.	0.	0.	0.
	PED	2.	3.	-	-	-	0.	0.	0.	0.	
1983	IVDU	1039.	2251.	.02	.11	.01	6.	5.	1.	2.	1.
	HTRO	176.	301.	.01	-	-	1.	0.	1.	0.	0.
	PED	5.	8.	-	-	-	0.	1.	1.	1.	
1984	IVDU	1058.	3153.	.03	.15	.02	13.	14.	2.	5.	3.
	HTRO	261.	538.	.01	-	-	2.	1.	2.	0.	0.
	PED	8.	14.	-	-	-	0.	2.	2.	1.	
1985	IVDU	930.	3872.	.04	.18	.02	31.	35.	3.	14.	7.
	HTRO	333.	832.	.02	-	-	3.	4.	3.	1.	1.
	PED	11.	23.	-	-	-	0.	3.	3.	2.	
1986	IVDU	757.	4365.	.04	.19	.03	49.	72.	4.	33.	17.
	HTRO	391.	1164.	.02	-	-	6.	8.	4.	4.	2.
	PED	14.	34.	-	-	-	7.	4.	4.	3.	
1987	IVDU	592.	4641.	.05	.20	.03	141.	125.	5.	65.	33
	HTRO	438.	1520.	.03	-	-	10.	17.	5.	8.	4.
	PED	17.	46.	-	-	-	5.	5.	6.	5.	
1988	IVDU	452.	4724.	.05	.20	.03	203.	188.	7.	110.	57.
	HTRO	478.	1887.	.04	-	-	43.	31.	7.	16.	8.
	PED	20.	60.	-	-	-	6.	7.	8.	6.	
1989	IVDU	339.	4642.	.05	.19	.03	260.	252.	9.	165.	87.
	HTRO	508.	2252.	.05	-	-	48.	50.	9.	28.	14.
	PED	23.	75.	-	-	-	15.	9.	10.	8.	
1990	IVDU	249.	4424.	.04	.17	.03	289.	308.	12.	222.	119.
	HTRO	526.	2600.	.05	-	-	67.	73.	12.	45.	23.
	PED	26.	90.	-	-	-	11.	12.	13.	11.	

CHISQD = 14.597640
CHISQP = 10.765990
CHISQC = 10.959110
SUM OF CHISQ-D,P,C = 36.322740

Table 10.9 Parameter values and corresponding simulation values for IVDUs, heterosexual partners and related pediatric cases in NC subregions B and C.

```
THE IVDU & HTRO POPULATION SIZES ARE        50000        25000
THE VERY ACTIVE FRACTION IS    1.000000E-01
THE ACTIVITY RATIO IS       10.000000
THE NATURAL MORTALITY RATE XMU IS   5.320000E-04
THE INTERCHANGE RATE  FROM THE VERY ACTIVE CLASS TO THE ACTIVE CLASS IS
   4.166667E-03  AND THE TURNOVER RATE IS DLT =    4.166667E-03
THE NUMBER OF INFECTIOUS STAGES IS  M =            7
THE G PARAMETERS FOR THE TRANSFER BETWEEN ADULT STAGES ARE    7.355444E-02
   6.433708E-02    4.867545E-02    4.199281E-02    3.997889E-02
   5.152515E-02    5.398798E-02
THE WEIGHTS OF TRANSMISSION PER INFECTIOUS PARTNER TIMES THE FRACTION STILL
SEXUALLY ACTIVE FOR THE STAGES ARE WRH(I) =        2.000000        1.000000
       1.000000        1.500000        1.500000        1.500000
       7.500000
THE PROBABILITIES OF TRANSMISSION ARE QH, QHP & QC =    5.000000E-02
   1.000000E-01    1.000000E-01
THE EXTERNAL MIXING FRACTION IS ETA =          1.000000
THE AVERAGE NUMBER OF NEEDLE-SHARING PARTNERS PER MONTH IS    5.027000E-01
BEFORE        1981           7, THEN IT IS REDUCED EACH YEAR BY A FACTOR OF
  6.958000E-01 UNTIL DEC,        1990
THE FRACTION OF IVDU WHO ARE WOMEN IS    2.600000E-01
THE FRACTION OF HETEROSEXUALS WHO ARE WOMEN IS    6.800000E-01
THE AVERAGE NUMBER OF IVDU PARTNERS OF HETEROSEXUALS PER MONTH IS
  5.900000E-02
THE FRACTION   3.400000E-01 OF CHILDREN PROGRESS RAPIDLY TO AIDS WITH RATE
CONSTANT   8.000000E-02. OTHERS MOVE THROUGH M STAGES WITH SPEED FACTOR
      1.550000
THE FECUNDITY FC (CHILDREN/MONTH) IS   5.400000E-03
THE STARTING YEAR AND MONTH ARE         1978          1
THE STARTING NUMBER OF VERY ACTIVE INFECTIVES IS       1.000000
*****************************************************

THE SIMULATED INCIDENCES ARE GIVEN ON THE NEXT PAGE
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nc2tbct.m nc2tbct.m nc2tbct.m nc2tbct.m nc2tbct.m

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YEAR	CLASS	HIV INC	HIV PREV	FRACTNAL_PREV ALL	V_A	ACT	YR AIDS DATA	INC SIM	AIDS(SIMULATION) PREV	DTHS	OUTSF
1978	IVDU	6.	7.	.00	.00	.00	0.	0.	0.	0.	0.
	HTRO	0.	0.	.00	-	-	****	0.	0.	0.	0.
	PED	0.	0.	-	-	-	0.	0.	0.	0.	
1979	IVDU	22.	28.	.00	.00	.00	0.	0.	0.	0.	0.
	HTRO	2.	2.	.00	-	-	0.	0.	0.	0.	0.
	PED	0.	0.	-	-	-	0.	0.	0.	0.	
1980	IVDU	83.	108.	.00	.01	.00	0.	0.	0.	0.	0.
	HTRO	7.	8.	.00	-	-	0.	0.	0.	0.	0.
	PED	0.	0.	-	-	-	0.	0.	0.	0.	
1981	IVDU	279.	375.	.01	.04	.00	0.	0.	0.	0.	0.
	HTRO	24.	32.	.00	-	-	0.	0.	0.	0.	0.
	PED	1.	1.	-	-	-	0.	0.	0.	0.	
1982	IVDU	531.	873.	.02	.09	.01	1.	1.	0.	0.	0.
	HTRO	66.	94.	.00	-	-	1.	0.	0.	0.	0.
	PED	2.	3.	-	-	-	0.	0.	0.	0.	
1983	IVDU	656.	1463.	.03	.14	.02	6.	3.	1.	1.	0.
	HTRO	122.	208.	.01	-	-	0.	0.	1.	0.	0.
	PED	4.	6.	-	-	-	0.	1.	1.	0.	
1984	IVDU	624.	1987.	.04	.18	.02	8.	9.	1.	3.	2.
	HTRO	174.	366.	.01	-	-	1.	1.	1.	0.	0.
	PED	6.	11.	-	-	-	1.	1.	1.	1.	
1985	IVDU	515.	2371.	.05	.21	.03	14.	23.	2.	9.	5.
	HTRO	215.	555.	.02	-	-	1.	2.	2.	1.	0.
	PED	8.	18.	-	-	-	0.	2.	2.	2.	
1986	IVDU	397.	2607.	.05	.23	.03	39.	47.	3.	22.	11.
	HTRO	247.	763.	.03	-	-	4.	6.	3.	2.	1.
	PED	10.	26.	-	-	-	4.	3.	3.	2.	
1987	IVDU	297.	2713.	.05	.23	.03	98.	81.	4.	42.	22.
	HTRO	272.	982.	.04	-	-	14.	12.	4.	5.	3.
	PED	12.	35.	-	-	-	5.	4.	5.	3.	
1988	IVDU	219.	2711.	.05	.22	.04	110.	119.	5.	71.	37.
	HTRO	293.	1203.	.05	-	-	17.	21.	5.	11.	6.
	PED	14.	44.	-	-	-	4.	5.	6.	5.	
1989	IVDU	158.	2619.	.05	.21	.04	165.	157.	7.	104.	55.
	HTRO	307.	1419.	.06	-	-	33.	34.	7.	19.	10.
	PED	16.	55.	-	-	-	11.	7.	8.	6.	
1990	IVDU	112.	2457.	.05	.19	.03	181.	188.	9.	138.	74.
	HTRO	315.	1620.	.06	-	-	44.	48.	9.	30.	16.
	PED	18.	65.	-	-	-	8.	9.	9.	8.	

CHISQD = 13.813320
CHISQP = 19.807490
CHISQC = 6.232977
SUM OF CHISQ-D,P,C = 39.853790

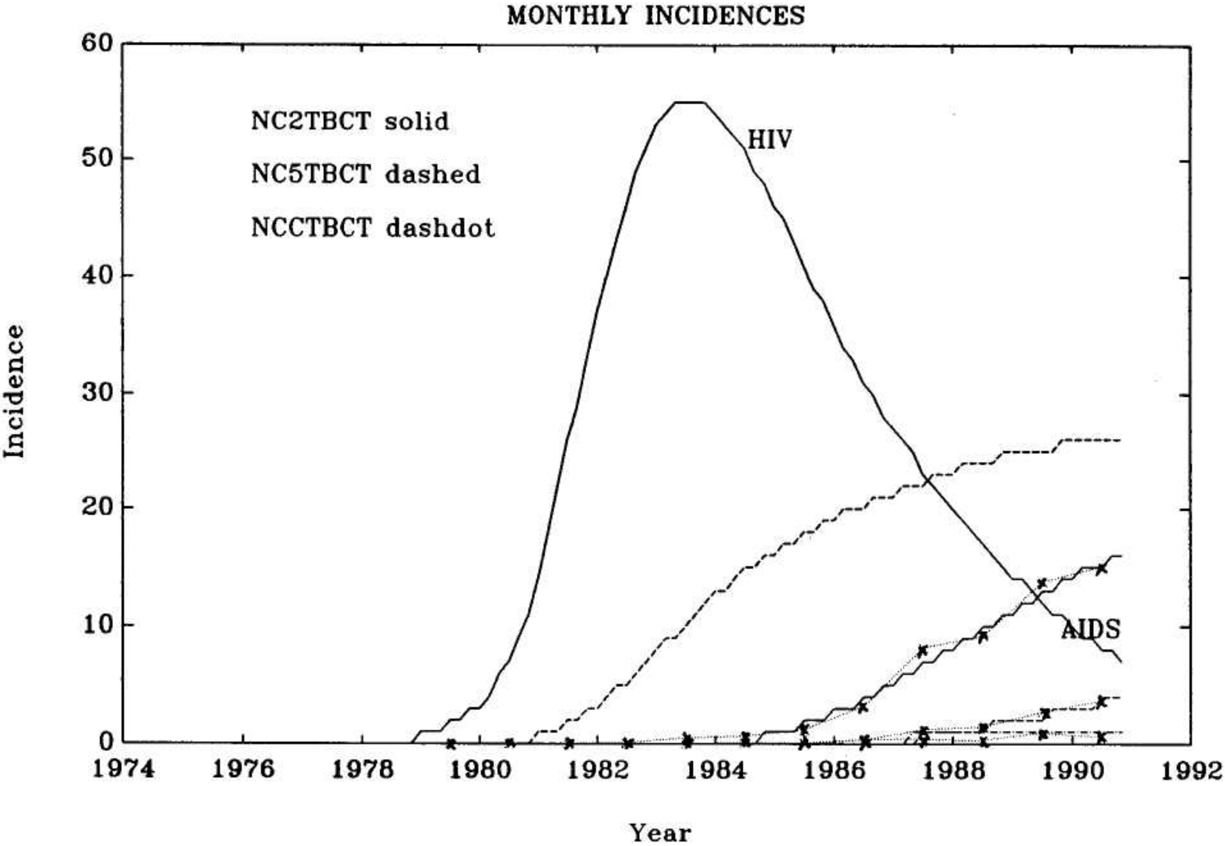

Figure 10.27. Estimated AIDS incidences (*) and simulated HIV and AIDS incidences for IVDUs, their heterosexual partners, and related pediatric cases in combined NC subregions B and C corresponding to parameter values in Table 10.9.

the NE region C. The fecundity of 0.0058 births per woman per month in regions A and D is close to the value of 0.0054 in regions B and C; these values are very close to the values in the NE region. The similar parameter values indicate that AIDS incidence in IVDUs in the combined regions A and D are really similar to those in the combined regions B and C so that it would be reasonable to combine all IVDUs in the NC region.

10.6. The South Region: Aggregation of Racial/Ethnic and Risk Groups

The five subregions of the South (S) region are Florida (A), Texas (B), Washington, D.C. and Baltimore (C), other cities over one million (D) and all other areas (E). Figure 10.28 shows the time trends in white, black and Hispanic homosexual men in Florida (A). These r/e groups in region A can be combined since the time trends are similar with 70% white, 13% black and 17% Hispanic. In Figure 10.29 for Texas (B) there are kinks in the AIDS incidence in white homosexual men; but these kinks may be due to reporting problems or to the 1987 AIDS definition change. Although the AIDS incidence in white homosexual men in subregion B (also in subregions C and D) seems to be increasing less rapidly than in blacks and Hispanics, the implications of these differences are not pursued here. Thus all r/e groups in Texas (B) can also be combined with about 76% white, 11% black and 13% Hispanic homosexual men. Figures 10.30 to 10.32 corresponding to subregions C, D, and E suggest that the r/e groups of homosexual men in each

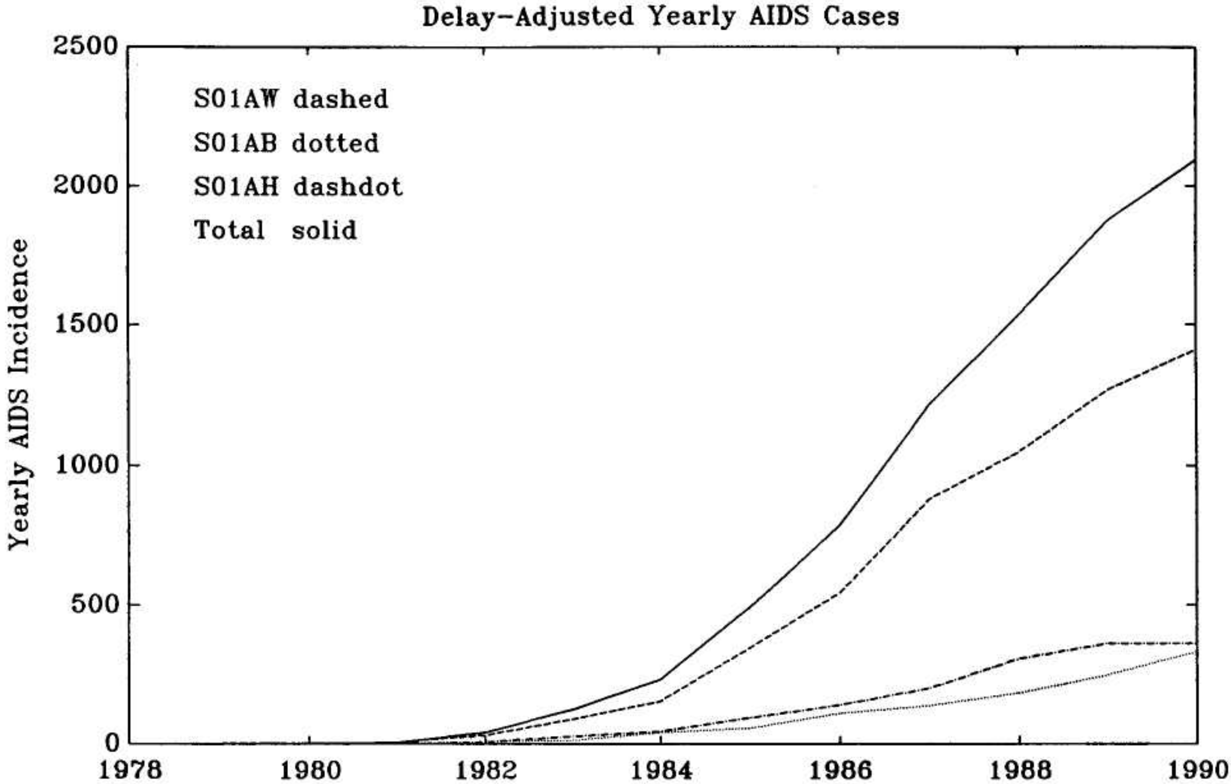

Figure 10.28. AIDS incidence in racial/ethnic groups of homosexual men in South subregion A (Florida).

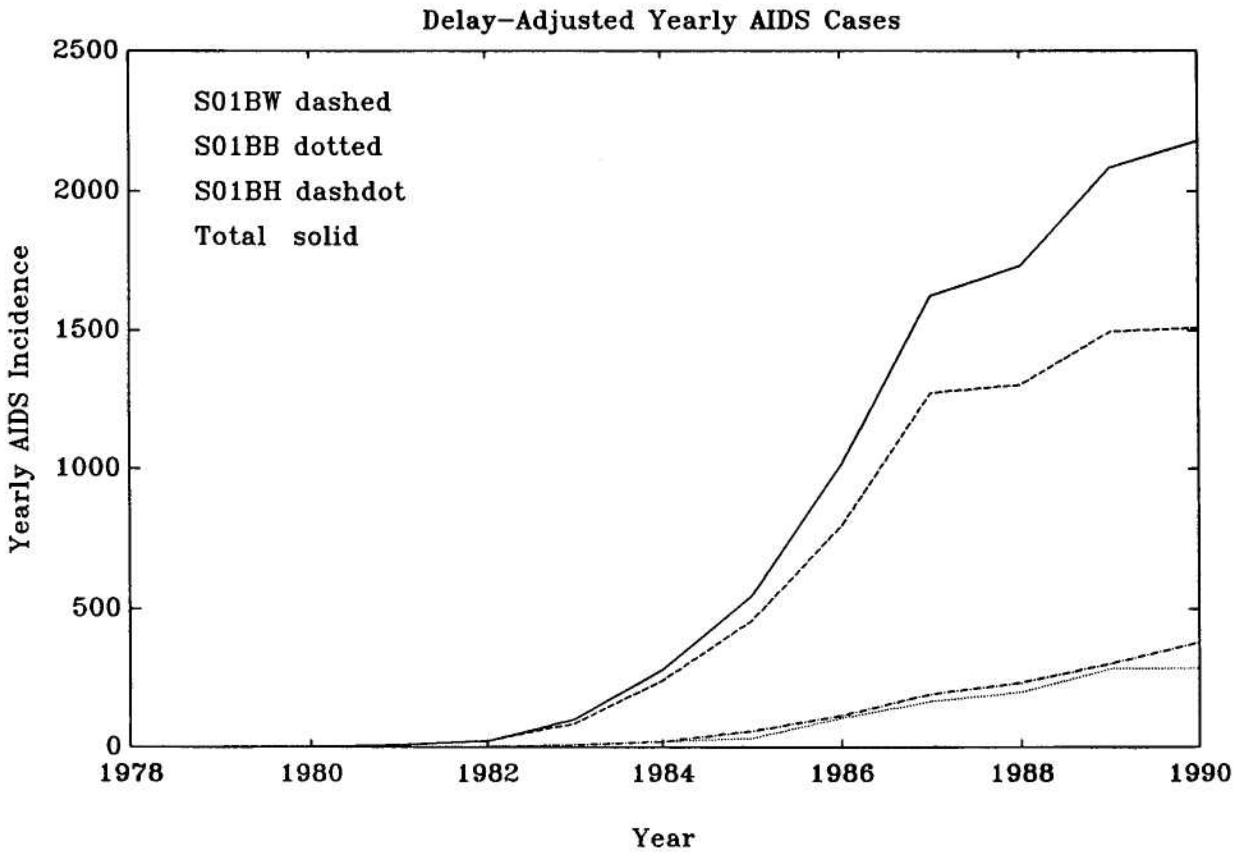

Figure 10.29. AIDS incidence in racial/ethnic groups of homosexual men in South subregion B (Texas).

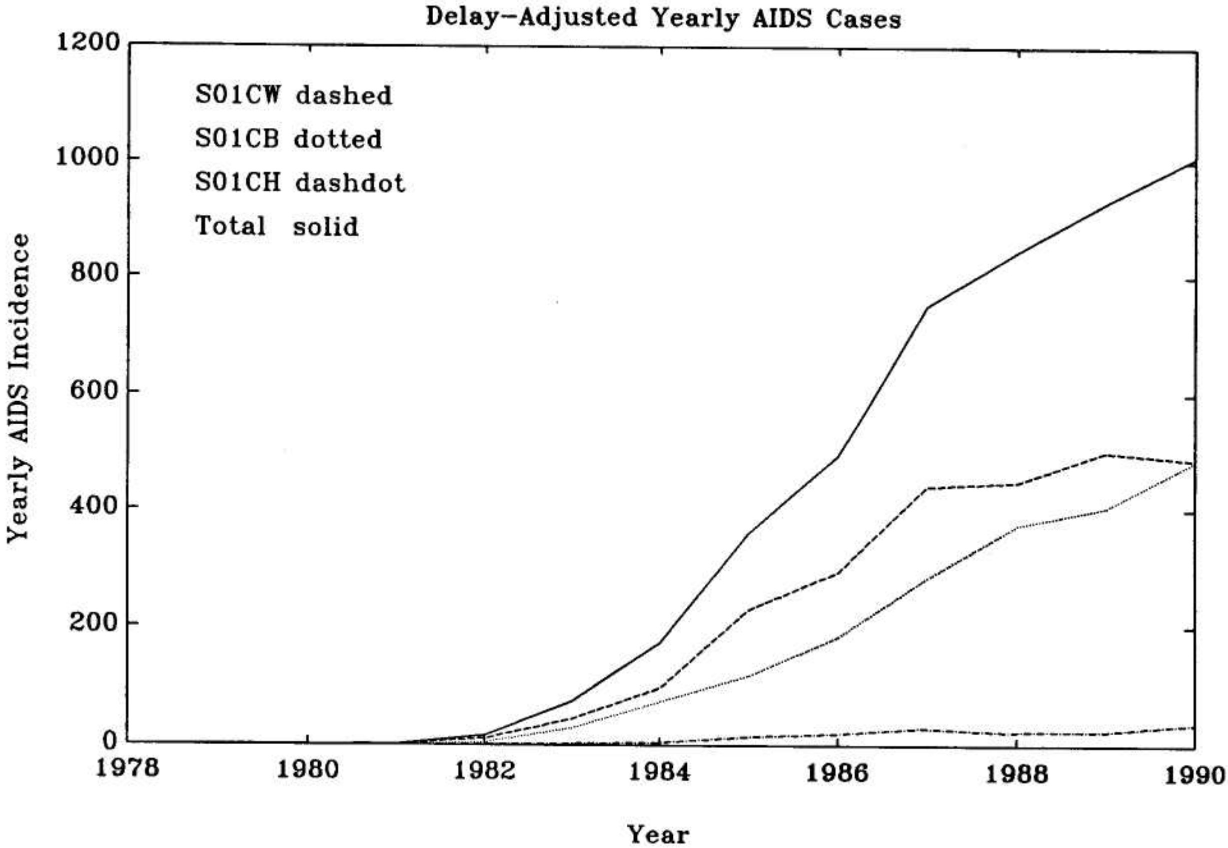

Figure 10.30. AIDS incidence in racial/ethnic groups of homosexual men in South subregion C (Washington, D.C. and Baltimore).

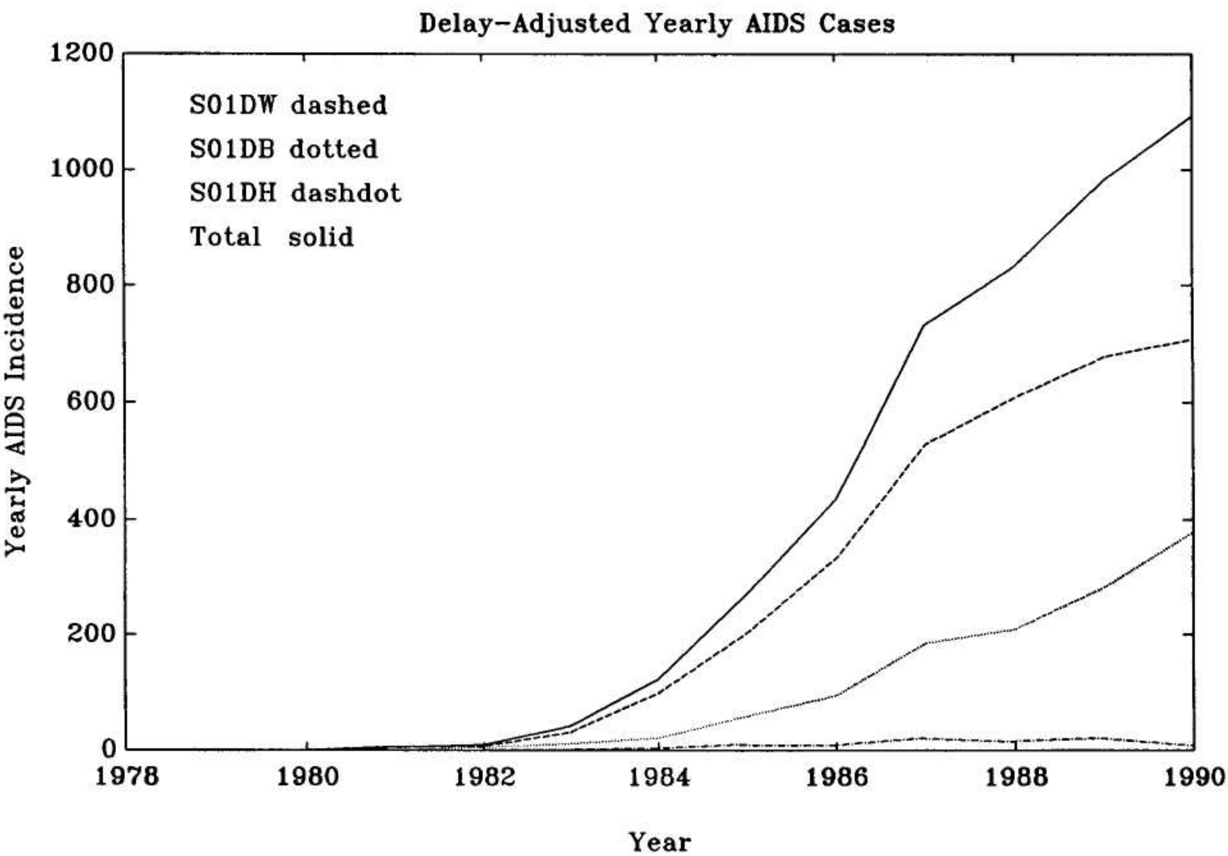

Figure 10.31. AIDS incidence in racial/ethnic groups of homosexual men in South subregion D (other cities over 1 million).

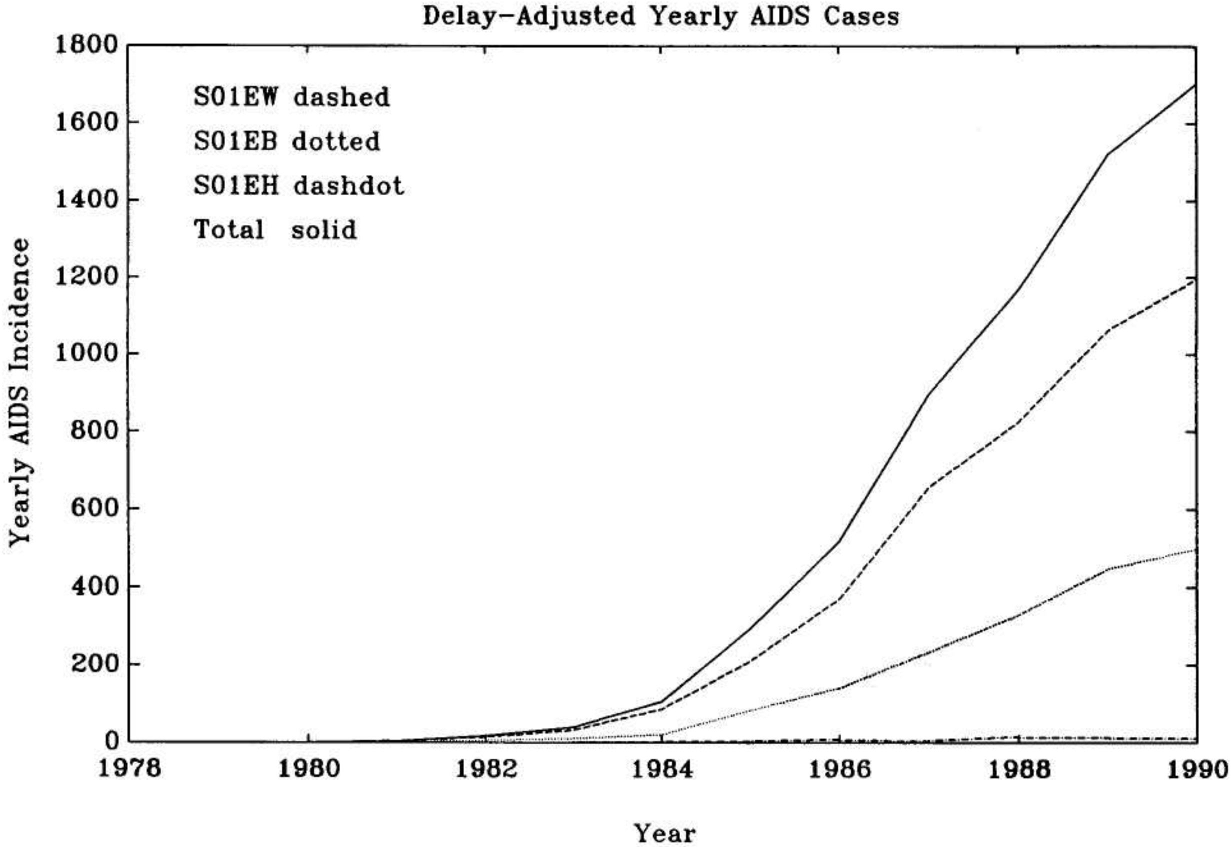

Figure 10.32. AIDS incidence in racial/ethnic groups of homosexual men in South subregion E (all other areas).

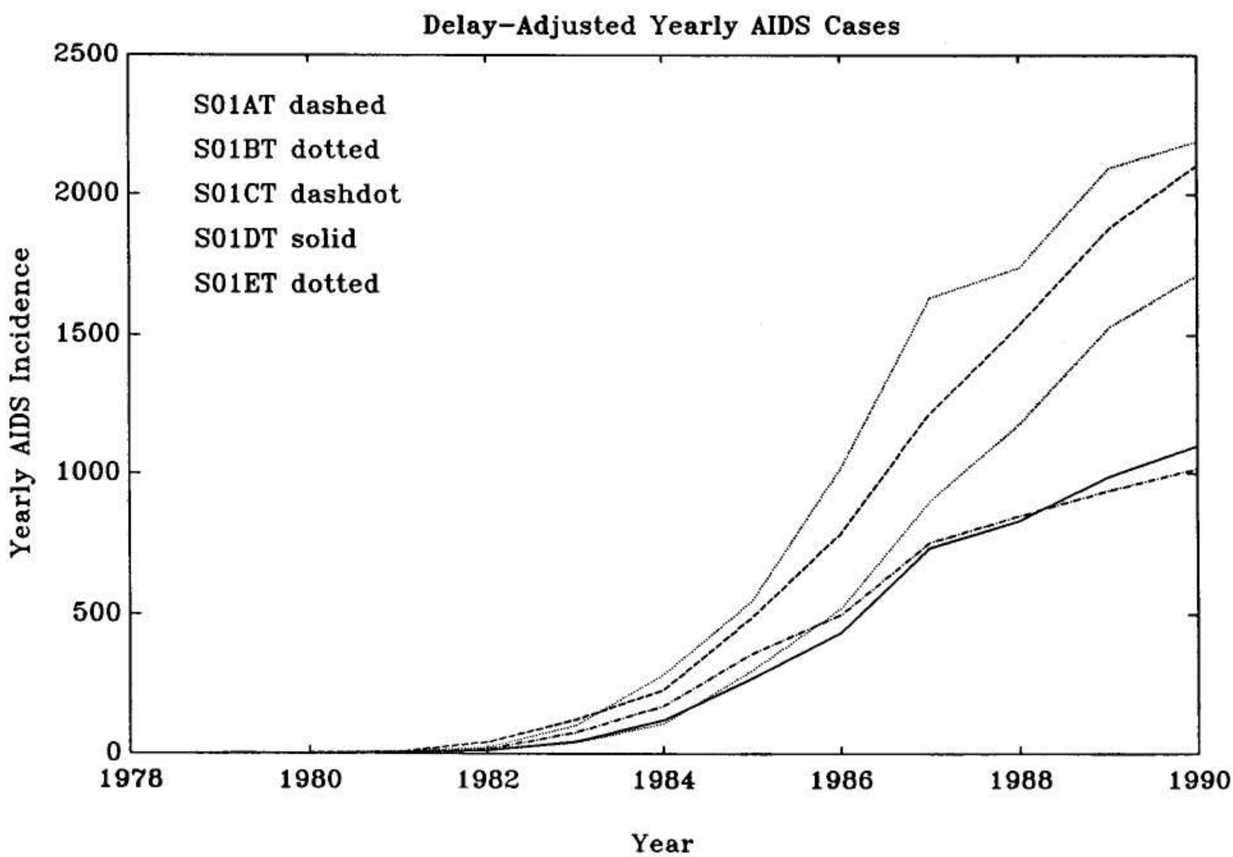

Figure 10.33. AIDS incidence in homosexual men in the five South subregions.

subregion can be lumped together. The r/e distributions are 55% W and 41% B in subregion C, 72% W and 25% B in subregion D, and 70% W and 28% B in subregion E.

Figure 10.33 shows the time trends of AIDS incidence in homosexual men in the five subregions of the South region. The time trends are generally similar for all regions except region C (Washington DC and Baltimore) where the growth rate is slower. Thus subregions A, B, D and E can be combined, but subregion C is considered separately.

The time trends in r/e groups of male (heterosexual) IVDUs in the five subregions are shown in Figures 10.34 to 10.38. Although there are some irregularities, the AIDS incidences in the r/e subgroups in each subregion are generally similar so that they can be combined. The r/e distributions are about 21%W, 67% B and 12% H in Florida (A), 37% W, 44% B and 19% H in Texas (B), 10% W and 90% B in Washington DC and Baltimore (C), 21% W and 79%B in other cities over one million (D), and 25% W and 75% B in all other areas (E). The AIDS incidences in female IVDUs are smaller and hence somewhat more erratic than in male IVDUs, but the time trends in r/e subgroups are generally similar in each subregion so that the r/e subgroups can be combined. Moreover, the male (heterosexual) and female IVDUs can be combined since they have similar AIDS incidence patterns. Figure 10.39 shows AIDS incidences for the combined male and female IVDUs in the five South subregions. The AIDS incidences in these subregions are all increasing together in a parallel pattern so that these five subregions can be combined. Figure 10.40 shows the AIDS incidences for heterosexual partners of IVDUs in the five South subregions. Although the time trends are not as smooth as for IVDUs, they are generally parallel so that all heterosexual partners of IVDUs in the South are combined together. Perinatal cases are also combined in the South region.

10.7. The South Region: Computer Simulations of the Aggregated Groups

The combined groups in Section 10.6 have been fit by the simulation model presented in Chapter 7. Recall that four subregions of homosexual men have been combined, but subregion C (Washington, D.C. and Baltimore) has not been combined because the growth rate there seemed to be slower. The simulated HIV and AIDS incidences for the four combined subregions and for subregion C are shown in Figures 10.41 and 10.42 and Tables 10.10 and 10.11. Note that there is no reduction in sexual behavior over time in the four combined subregions, but there is some reduction starting in January 1982 in subregion C. The population size of 500,000 in combined regions A, B, D and E is about 10 times the size of 50,000 for region C. The epidemic starting date of February 1975 for the combined subregions is 14 months earlier than the epidemic starting date of April 1976 in subregion C. The average number of new sexual partners and the external mixing fraction are smaller for the combined subregions than in subregion C. In summary, the AIDS incidences in subregion C (Washington D.C., and Baltimore) suggest that changes in behavior may have occurred there, but there is no evidence for changes in behavior in homosexual men in the four combined regions. Note that the high HIV incidences in recent years in Figure 10.41 are not predictions, but they do represent the situation if there have been no changes in sexual behavior in recent years.

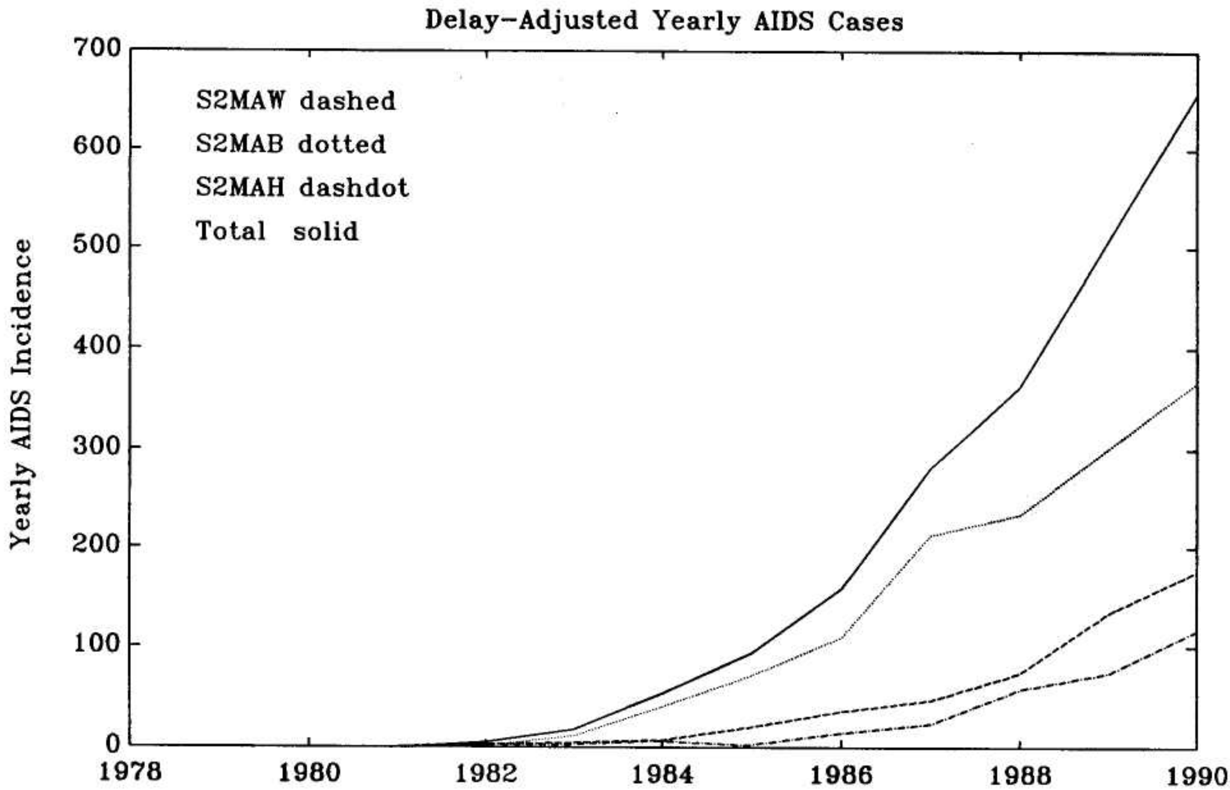

Figure 10.34. AIDS incidence in racial/ethnic groups of male (heterosexual) IVDUs in South subregion A (Florida).

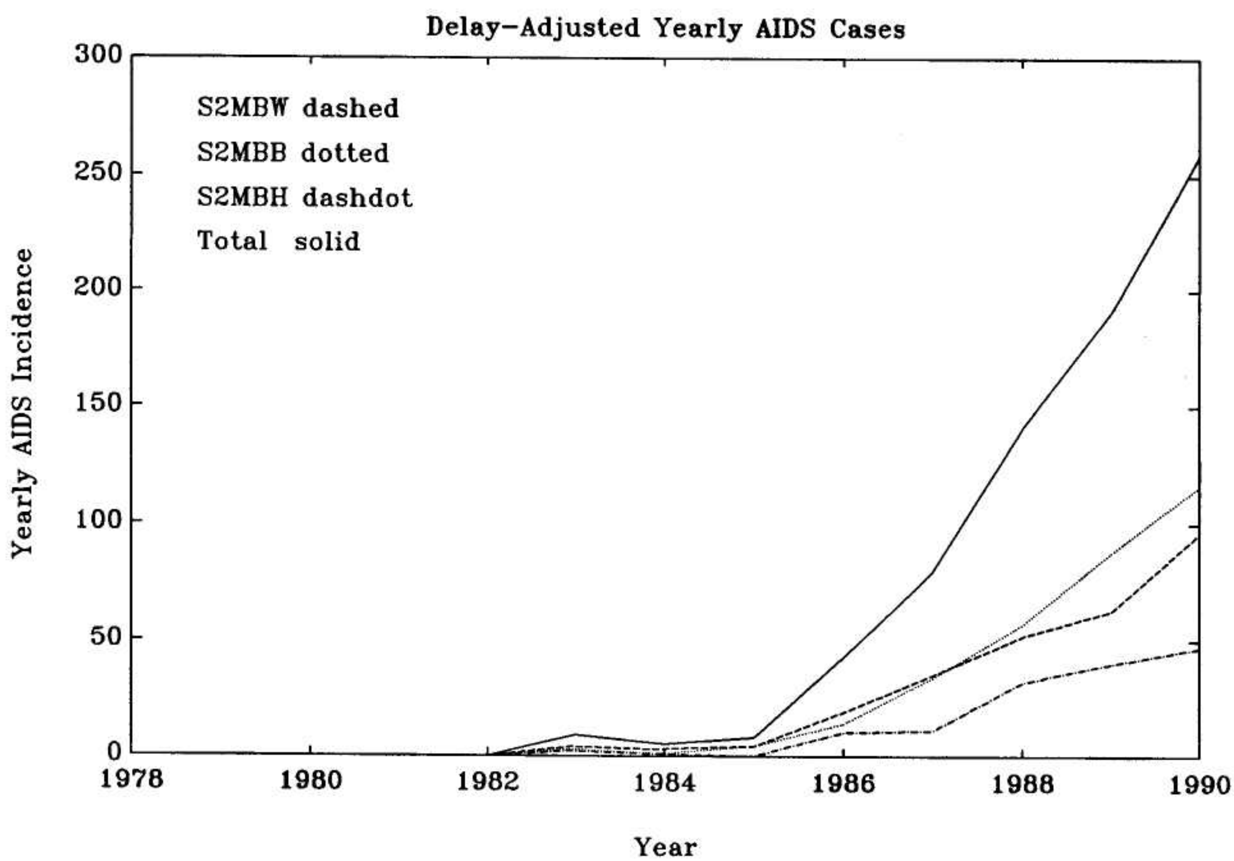

Figure 10.35. AIDS incidence in racial/ethnic groups of male (heterosexual) IVDUs in South subregion B (Texas).

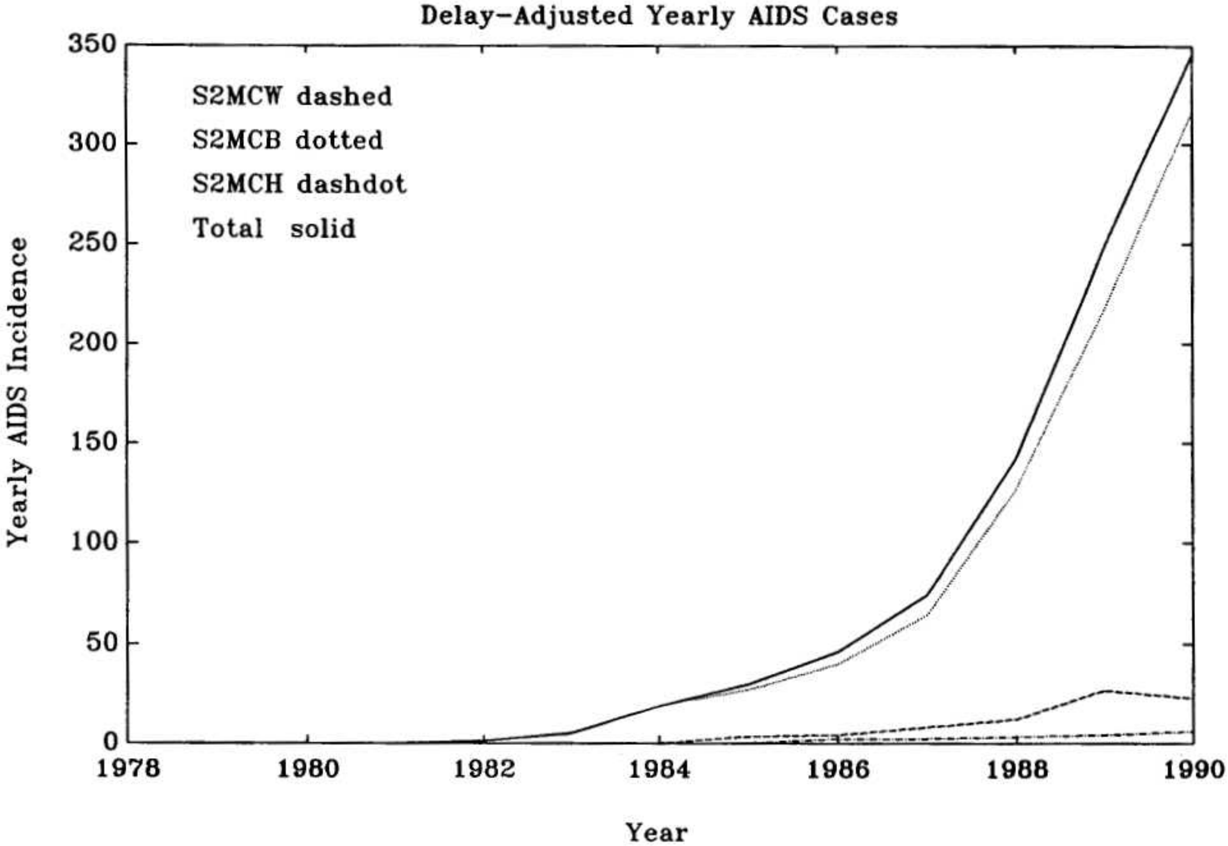

Figure 10.36. AIDS incidence in racial/ethnic groups of male (heterosexual) IVDUs in South subregion C (Washington, D.C. and Baltimore).

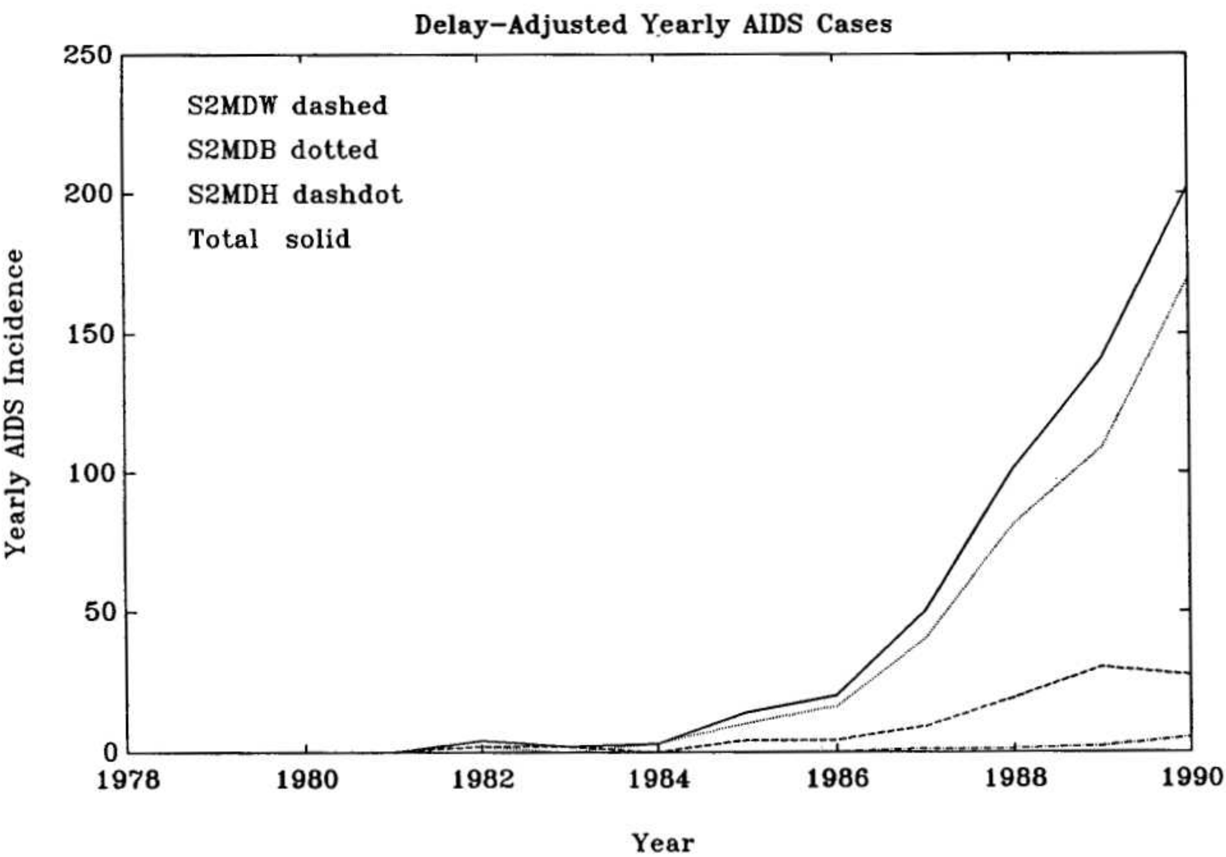

Figure 10.37. AIDS incidences in racial/ethnic groups of male (heterosexual) IVDUs in South subregion D (other cities over 1 million).

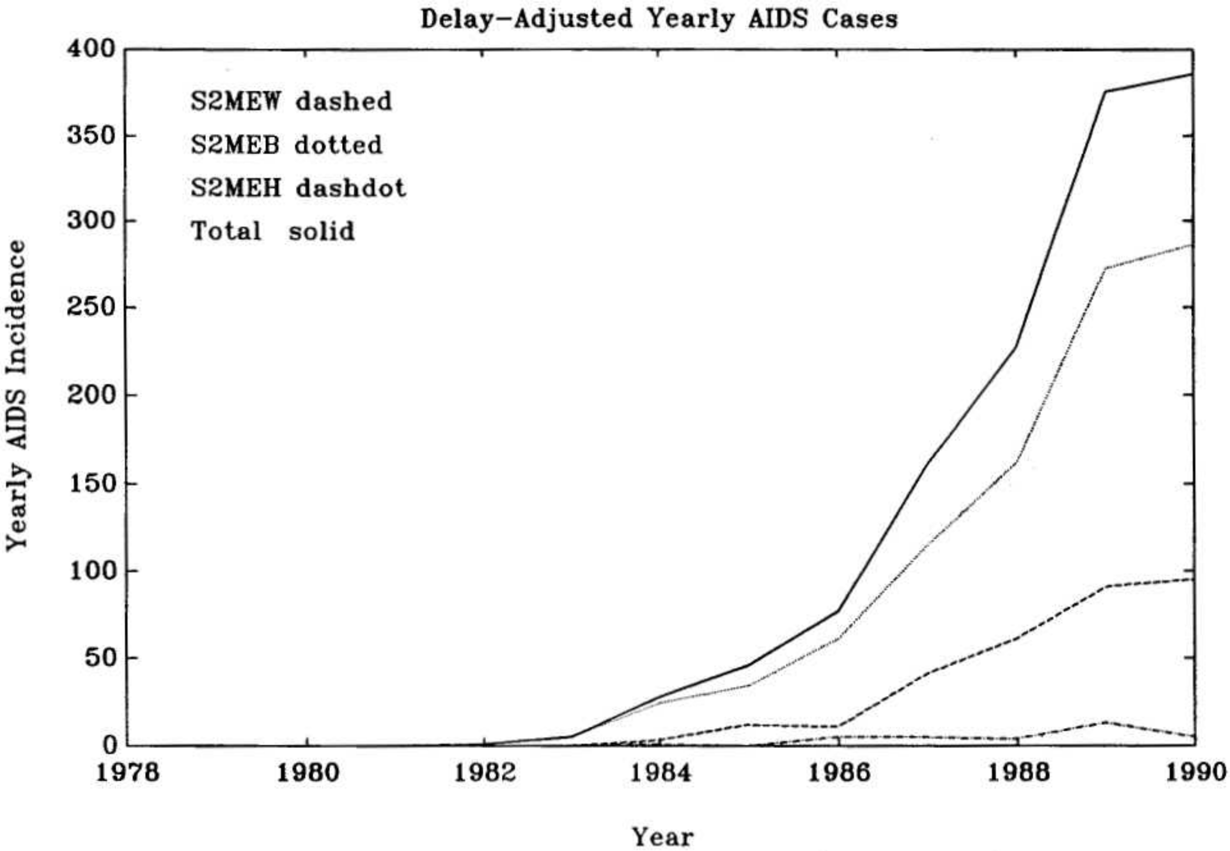

Figure 10.38. AIDS incidences in racial/ethnic groups of male (heterosexual) IVDUs in South subregion E (all other areas).

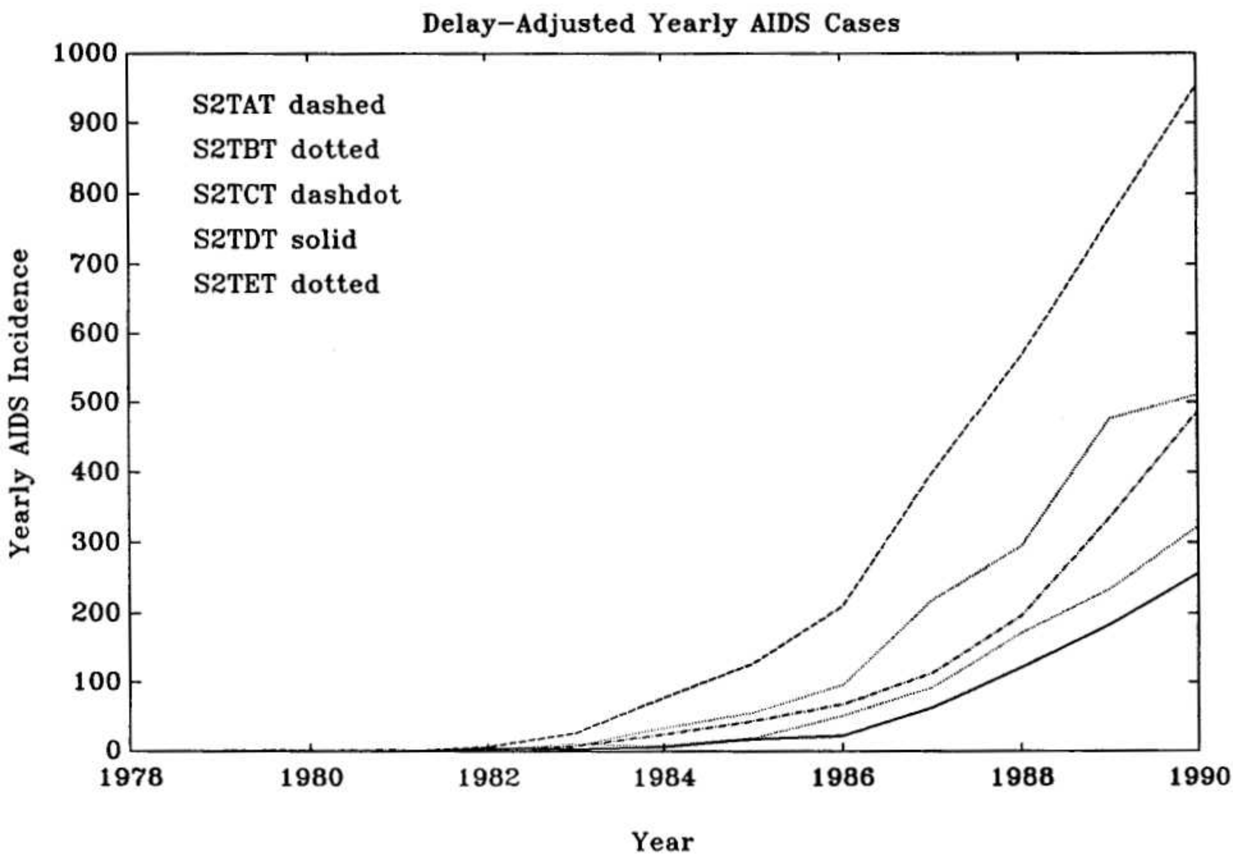

Figure 10.39. AIDS incidence in IVDUs in the five South subregions.

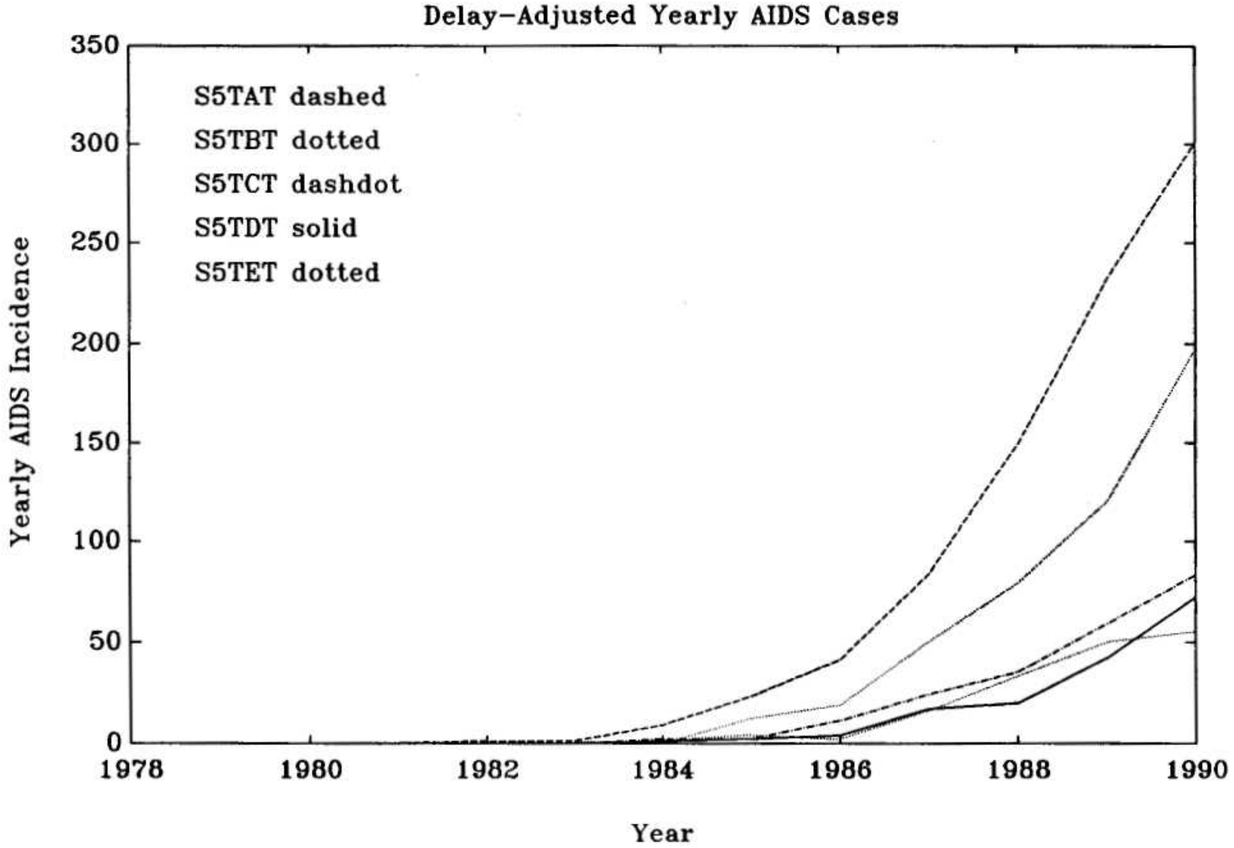

Figure 10.40. AIDS incidence in heterosexual partners of IVDUs in the five South subgroups.

Recall that the male and female IVDUs in the five South subregions have been combined into one group. Table 10.12 and Figure 10.43 show the simulated HIV and AIDS incidences for this aggregated group. The epidemic starting date of January 1975 is similar to that for IVDUs in the NE regions A and B, but earlier than in the NC regions. As in the NE regions the fits are obtained without any reduction in needle–sharing behavior over time. The average number of new needle–sharing partners per month of 0.26 is lower than the values in the other regions. The average number of new heterosexual partners of IVDUs per month of 0.76 is somewhat larger than in the NE and NC regions. The fecundity of 0.0045 births per woman per month is lower than in the other regions. In the South 26% of AIDS cases in IVDUs are women and 57% of AIDS cases in heterosexual partners of IVDUs are women.

10.8. The West Region: Aggregation of Racial/Ethnic and Risk Groups

The three subregions of the West region described in Table 10.1 are A (San Francisco and Seattle), B (Los Angeles, Oakland, Anaheim, Riverside and San Jose) and C (all other areas). AIDS incidences in homosexual men in subregion A are given for r/e groups in Figure 10.44. Figures 10.45 and 10.46 contain AIDS incidences for subregions B and C. All three show some kinks for white homosexual males, but the kink around 1987 is primarily due to reporting practices before and after the 1987 AIDS definition change. If the kinks are smoothed out, then the time trends in r/e groups are similar so that they can be combined in each subregion. The AIDS incidences are about 91% W, 4% B, and 5% H in region A, 72% W, 13% B and 15% H in region B, and 92% W, 5% B, and 3% H in region C.

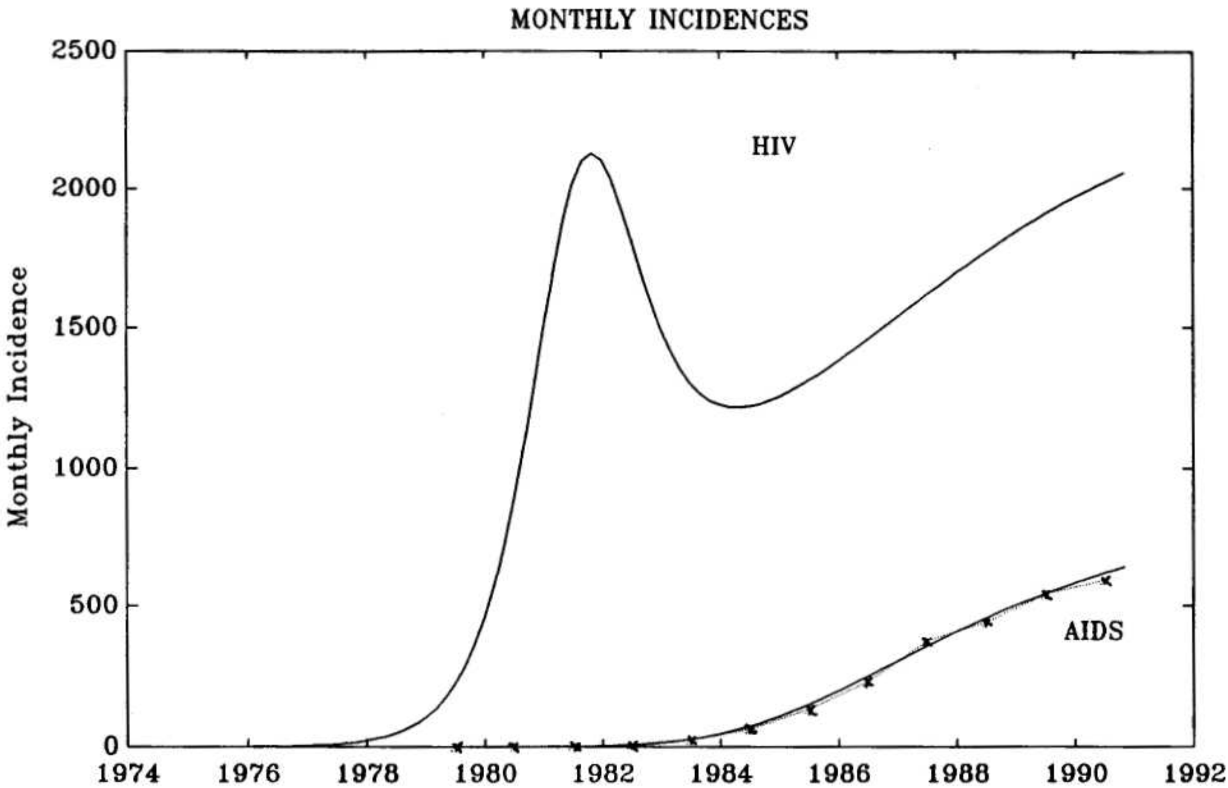

Figure 10.41. Estimated AIDS incidences (*) and simulated HIV and AIDS incidences for homosexual men in combined South subregions A, B, D, and E corresponding to parameters in Table 10.10.

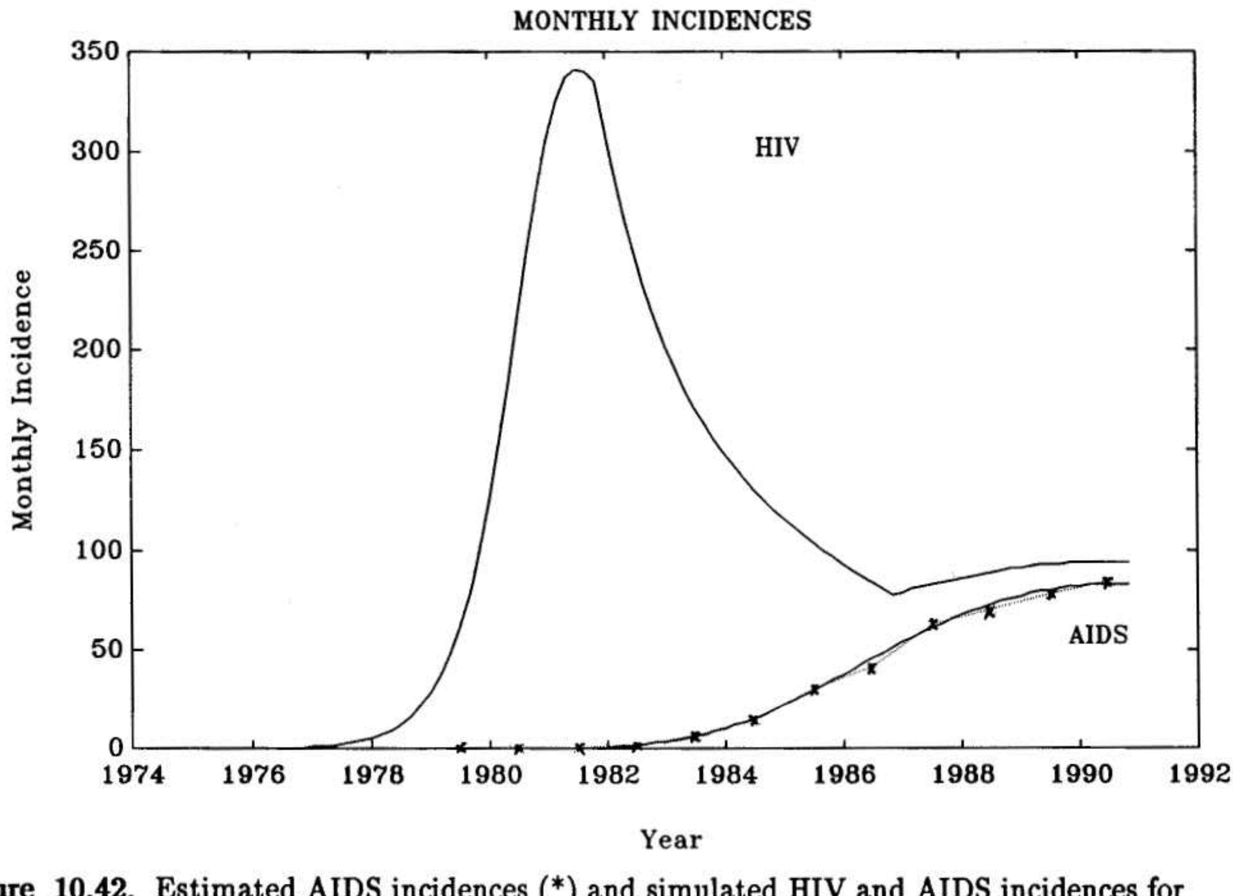

Figure 10.42. Estimated AIDS incidences (*) and simulated HIV and AIDS incidences for homosexual men in South subregion C (Washington, D.C. and Baltimore) corresponding to parameters in Table 10.11.

Table 10.10 Parameter values and corresponding simulation values for homosexual men in South subregions A, B, D, and E.

```
THE POPULATION SIZE IS      500000, THE VERY ACTIVE FRACTION IS
  1.000000E-01 AND THE ACTIVITY RATIO IS       10.000000
THE NATURAL MORTALITY RATE XMU IS   5.320000E-04
THE INTERCHANGE RATE  FROM THE VERY ACTIVE CLASS TO THE ACTIVE CLASS IS
   4.166667E-03  AND THE TURNOVER RATE IS DLT =    4.166667E-03
THE NUMBER OF INFECTIOUS STAGES IS  M =          7
THE G PARAMETERS FOR THE TRANSFER BETWEEN STAGES ARE    7.355444E-02
   6.433708E-02    4.867545E-02    4.199281E-02    3.997889E-02
   5.152515E-02    5.398798E-02
THE WEIGHTS OF TRANSMISSION PER INFECTIOUS PARTNER TIMES THE FRACTION STILL
SEXUALLY ACTIVE FOR THE STAGES ARE WRH(I) =      2.000000        1.000000
       1.000000        1.500000        1.500000        1.500000
       7.500000
THE PROBABILITY OF TRANSMISSION IS QH =    5.000000E-02
THE EXTERNAL MIXING FRACTION IS ETA =    1.612000E-01
THE AVERAGE NUMBER OF PARTNERS PER MONTH IS    3.665000E-01 BEFORE        2222
          2, THEN IT IS REDUCED EACH YEAR BY A FACTOR OF        1.000000UNTIL
DEC,       2222
THE STARTING YEAR AND MONTH ARE        1975          2
THE STARTING NUMBER OF VERY ACTIVE INFECTIVES IS      1.000000

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YEAR	HIV INC SIM	HIV PREV	FRACTNAL_PREV ALL	V_A	ACT	YR AIDS INC DATA	SIM	AIDS(SIMULATION) PREV	DTHS	OUTSF
1975	4.	5.	.00	.00	.00	*****	0.	0.	0.	0.
1976	22.	26.	.00	.00	.00	*****	0.	0.	0.	0.
1977	106.	129.	.00	.00	.00	*****	0.	0.	0.	0.
1978	515.	628.	.00	.01	.00	*****	0.	0.	0.	0.
1979	2402.	2950.	.01	.05	.00	0.	1.	1.	0.	0.
1980	9499.	12097.	.02	.21	.00	3.	4.	4.	1.	1.
1981	22205.	33113.	.07	.56	.01	24.	19.	17.	5.	3.
1982	22639.	53299.	.11	.82	.03	90.	82.	75.	24.	12.
1983	16326.	66173.	.13	.90	.05	304.	293.	272.	96.	47.
1984	14705.	76579.	.15	.92	.07	744.	801.	767.	306.	151.
1985	15586.	86859.	.17	.92	.09	1600.	1677.	1690.	754.	378.
1986	17267.	97531.	.20	.91	.12	2753.	2840.	3040.	1490.	759.
1987	19155.	108554.	.22	.89	.14	4476.	4112.	4681.	2470.	1279.
1988	21003.	119755.	.24	.86	.17	5282.	5327.	6424.	3585.	1889.
1989	22679.	130951.	.26	.83	.20	6485.	6396.	8106.	4713.	2526.
1990	24107.	141973.	.28	.80	.23	7106.	7309.	9642.	5773.	3142.

CHISQ =   53.533080

Table 10.11 Parameter values and corresponding simulation values for homosexual men in South subregions C (Washington D.C. and Baltimore).

```
THE POPULATION SIZE IS        50000, THE VERY ACTIVE FRACTION IS
  1.000000E-01 AND THE ACTIVITY RATIO IS       10.000000
THE NATURAL MORTALITY RATE XMU IS   5.320000E-04
THE INTERCHANGE RATE  FROM THE VERY ACTIVE CLASS TO THE ACTIVE CLASS IS
   4.166667E-03  AND THE TURNOVER RATE IS DLT =    4.166667E-03
THE NUMBER OF INFECTIOUS STAGES IS  M =            7
THE G PARAMETERS FOR THE TRANSFER BETWEEN STAGES ARE    7.355444E-02
   6.433708E-02    4.867545E-02    4.199281E-02    3.997889E-02
   5.152515E-02    5.398798E-02
THE WEIGHTS OF TRANSMISSION PER INFECTIOUS PARTNER TIMES THE FRACTION STILL
SEXUALLY ACTIVE FOR THE STAGES ARE WRH(I) =        2.000000        1.000000
       1.000000        1.500000        1.500000        1.500000
       7.500000
THE PROBABILITY OF TRANSMISSION IS QH =    5.000000E-02
THE EXTERNAL MIXING FRACTION IS ETA =    5.312000E-01
THE AVERAGE NUMBER OF PARTNERS PER MONTH IS    4.640000E-01 BEFORE        1982
          1, THEN IT IS REDUCED EACH YEAR BY A FACTOR OF    7.283000E-01UNTIL
DEC,        1986
THE STARTING YEAR AND MONTH ARE        1976          3
THE STARTING NUMBER OF VERY ACTIVE INFECTIVES IS       1.000000

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YEAR	HIV INC SIM	HIV PREV	FRACTNAL_PREV ALL	V_A	ACT	YR AIDS DATA	INC SIM	AIDS(SIMULATION) PREV	DTHS	OUTSF
1976	5.	6.	.00	.00	.00	*****	0.	0.	0.	0.
1977	27.	32.	.00	.00	.00	*****	0.	0.	0.	0.
1978	140.	168.	.00	.02	.00	*****	0.	0.	0.	0.
1979	668.	813.	.02	.11	.01	0.	0.	0.	0.	0.
1980	2327.	3047.	.06	.40	.02	1.	1.	1.	0.	0.
1981	3953.	6733.	.13	.75	.07	2.	5.	4.	1.	1.
1982	3177.	9447.	.19	.87	.11	16.	21.	19.	6.	3.
1983	2160.	11007.	.22	.88	.15	74.	71.	66.	24.	12.
1984	1625.	11917.	.24	.87	.17	171.	175.	170.	71.	35.
1985	1288.	12367.	.25	.83	.18	359.	335.	345.	160.	81.
1986	1040.	12426.	.25	.79	.19	496.	528.	579.	294.	151.
1987	991.	12287.	.25	.74	.19	753.	715.	838.	456.	238.
1988	1068.	12079.	.24	.70	.19	847.	865.	1081.	623.	331.
1989	1117.	11801.	.24	.67	.19	938.	961.	1274.	768.	416.
1990	1137.	11464.	.23	.63	.18	1015.	1001.	1400.	875.	483.

CHISQ =   10.268390

Table 10.12 Parameter values and corresponding simulation values for IVDUs, heterosexual partners and related pediatric cases in the South region.

```
THE IVDU & HTRO POPULATION SIZES ARE      300000      150000
THE VERY ACTIVE FRACTION IS    1.000000E-01
THE ACTIVITY RATIO IS        10.000000
THE NATURAL MORTALITY RATE XMU IS   5.320000E-04
THE INTERCHANGE RATE  FROM THE VERY ACTIVE CLASS TO THE ACTIVE CLASS IS
   4.166667E-03  AND THE TURNOVER RATE IS DLT =    4.166667E-03
THE NUMBER OF INFECTIOUS STAGES IS  M =           7
THE G PARAMETERS FOR THE TRANSFER BETWEEN ADULT STAGES ARE    7.355444E-02
   6.433708E-02    4.867545E-02    4.199281E-02    3.997889E-02
   5.152515E-02    5.398798E-02
THE WEIGHTS OF TRANSMISSION PER INFECTIOUS PARTNER TIMES THE FRACTION STILL
SEXUALLY ACTIVE FOR THE STAGES ARE WRH(I) =       2.000000        1.000000
       1.000000        1.500000        1.500000        1.500000
       7.500000
THE PROBABILITIES OF TRANSMISSION ARE QH, QHP & QC =    5.000000E-02
   1.000000E-01    1.000000E-01
THE EXTERNAL MIXING FRACTION IS ETA =    6.290000E-02
THE AVERAGE NUMBER OF NEEDLE-SHARING PARTNERS PER MONTH IS    2.641000E-01
BEFORE        2222           2, THEN IT IS REDUCED EACH YEAR BY A FACTOR OF
      1.000000 UNTIL DEC,        2222
THE FRACTION OF IVDU WHO ARE WOMEN IS    2.600000E-01
THE FRACTION OF HETEROSEXUALS WHO ARE WOMEN IS    5.700000E-01
THE AVERAGE NUMBER OF IVDU PARTNERS OF HETEROSEXUALS PER MONTH IS
  7.600000E-02
THE FRACTION   3.400000E-01 OF CHILDREN PROGRESS RAPIDLY TO AIDS WITH RATE
CONSTANT   8.000000E-02. OTHERS MOVE THROUGH M STAGES WITH SPEED FACTOR
      1.550000
THE FECUNDITY FC (CHILDREN/MONTH) IS   4.500000E-03
THE STARTING YEAR AND MONTH ARE        1975          1
THE STARTING NUMBER OF VERY ACTIVE INFECTIVES IS      1.000000
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THE SIMULATED INCIDENCES ARE GIVEN ON THE NEXT PAGE
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s2ttt.m s2ttt.m s2ttt.m s2ttt.m s2ttt.m

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YEAR	CLASS	HIV INC	HIV PREV	FRACTNAL_PREV ALL	V_A	ACT	YR AIDS INC DATA	SIM	AIDS(SIMULATION) PREV	DTHS	OUTSF
1975	IVDU	3.	4.	.00	.00	.00	0.	0.	0.	0.	0.
	HTRO	0.	0.	.00	-	-	****	0.	0.	0.	0.
	PED	0.	0.	-	-	-	0.	0.	0.	0.	
1976	IVDU	9.	12.	.00	.00	.00	0.	0.	0.	0.	0.
	HTRO	1.	1.	.00	-	-	0.	0.	0.	0.	0.
	PED	0.	0.	-	-	-	0.	0.	0.	0.	
1977	IVDU	28.	38.	.00	.00	.00	0.	0.	0.	0.	0.
	HTRO	3.	4.	.00	-	-	0.	0.	0.	0.	0.
	PED	0.	0.	-	-	-	0.	0.	0.	0.	
1978	IVDU	87.	121.	.00	.00	.00	0.	0.	0.	0.	0.
	HTRO	10.	14.	.00	-	-	0.	0.	0.	0.	0
	PED	0.	0.	-	-	-	0.	0.	0.	0.	
1979	IVDU	272.	381.	.00	.01	.00	0.	0.	0.	0.	0.
	HTRO	32.	45.	.00	-	-	0.	0.	0.	0.	0
	PED	1.	1.	-	-	-	0.	0.	0.	0.	
1980	IVDU	832.	1175.	.00	.04	.00	1.	1.	0.	0.	0.
	HTRO	99.	139.	.00	-	-	0.	0.	0.	0.	0.
	PED	2.	3.	-	-	-	0.	0.	0.	0.	
1981	IVDU	2380.	3439.	.01	.11	.00	2.	3.	1.	1.	1.
	HTRO	297.	423.	.00	-	-	0.	0.	1.	0.	0.
	PED	6.	8.	-	-	-	0.	1.	1.	0.	
1982	IVDU	5672.	8793.	.03	.27	.00	13.	11.	2.	4.	2.
	HTRO	805.	1187.	.01	-	-	1.	1.	2.	0.	0.
	PED	16.	23.	-	-	-	2.	2.	3.	1.	
1983	IVDU	9279.	17353.	.06	.52	.01	53.	33.	6.	12.	6.
	HTRO	1752.	2832.	.02	-	-	2.	4.	6.	1.	1.
	PED	36.	56.	-	-	-	6.	6.	7.	4.	
1984	IVDU	9334.	25453.	.08	.73	.01	148.	94.	12.	35.	17.
	HTRO	2801.	5407.	.04	-	-	13.	12.	12.	4.	2.
	PED	63.	110.	-	-	-	6.	12.	14.	8.	
1985	IVDU	7102.	30876.	.10	.84	.02	260.	239.	20.	96.	48.
	HTRO	3500.	8511.	.06	-	-	43.	32.	20.	12.	6.
	PED	88.	183.	-	-	-	14.	20.	24.	15.	
1986	IVDU	5725.	34540.	.12	.88	.03	444.	516.	30.	229.	115.
	HTRO	3953.	11866.	.08	-	-	77.	79.	30.	33.	16.
	PED	110.	268.	-	-	-	27.	30.	35.	25.	
1987	IVDU	5409.	37474.	.12	.88	.04	882.	936.	43.	470.	239.
	HTRO	4391.	15425.	.10	-	-	190.	168.	43.	76.	38.
	PED	135.	367.	-	-	-	53.	43.	48.	36.	
1988	IVDU	5605.	40111.	.13	.88	.05	1348.	1452.	58.	826.	426.
	HTRO	4873.	19185.	.13	-	-	316.	309.	58.	154.	78.
	PED	163.	481.	-	-	-	71.	58.	65.	50.	
1989	IVDU	5991.	42575.	.14	.86	.06	1995.	1983.	76.	1267.	663.
	HTRO	5362.	23101.	.15	-	-	503.	503.	76.	277.	142.
	PED	194.	608.	-	-	-	104.	76.	84.	66.	
1990	IVDU	6424.	44895.	.15	.84	.07	2530.	2454.	97.	1740.	926.
	HTRO	5801.	27072.	.18	-	-	709.	744.	97.	447.	233.
	PED	227.	749.	-	-	-	95.	97.	107.	86.	

CHISQD = 69.209290
CHISQP = 9.932351
CHISQC = 19.184600
SUM OF CHISQ-D,P,C = 98.326240

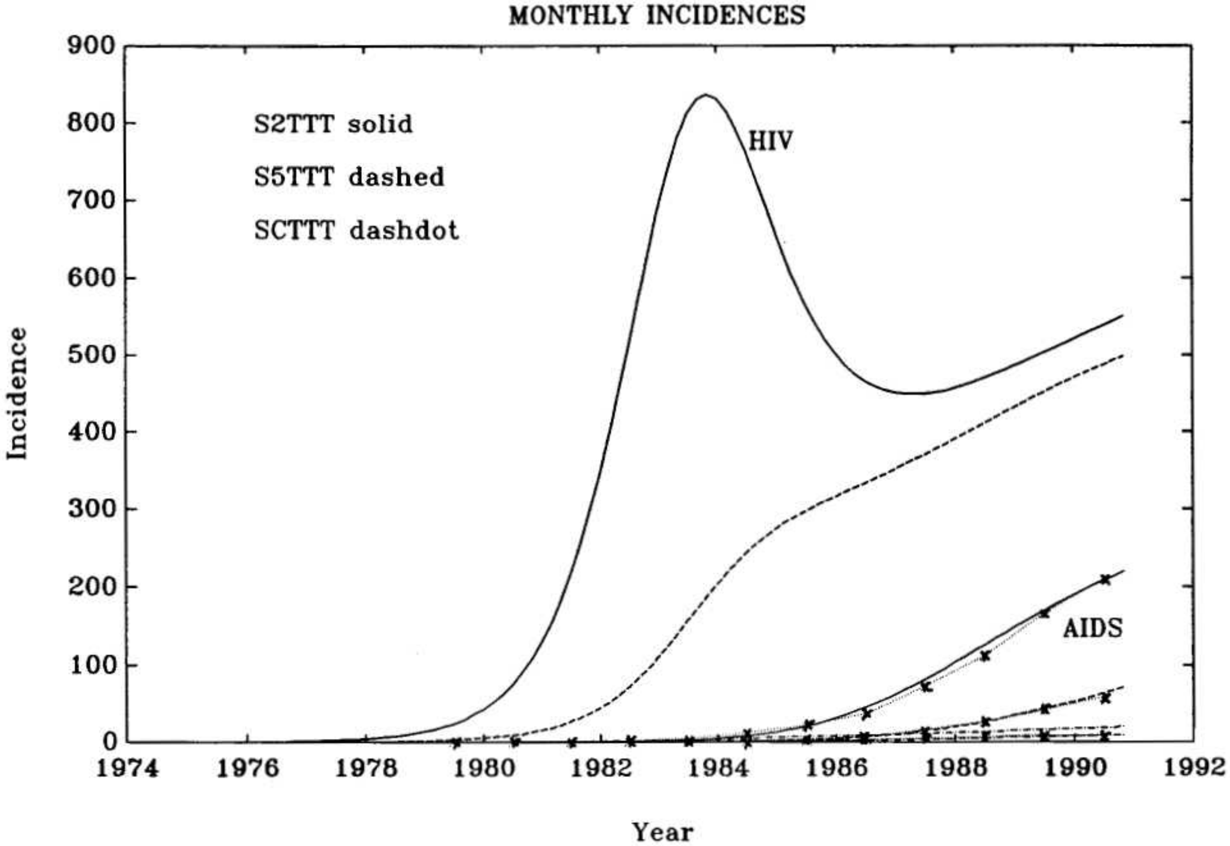

Figure 10.43. Estimated AIDS incidences (*) and simulated HIV and AIDS incidences for IVDUs, their heterosexual partners, and related pediatric cases in the entire South region corresponding to parameter values in Table 10.12.

The AIDS incidences in homosexual men in the three subregions are shown in Figure 10.47. The subregions B and C are similar so they can be combined, but subregion A (San Francisco and Seattle) has a different AIDS incidence pattern so it must be considered separately. In the combined B and C group, 61% are from subregion B and 39% are from subregion C. Figure 10.48 shows the AIDS incidences in homosexual IVDUs in the three subregions; the patterns are similar to those in Figure 10.47 so the subregions B and C can be combined, but subregion A has slower growth after 1986. Figure 10.49 shows AIDS incidences in homosexual men in the four aggregated groups in the South and West regions. It looks like the all other South group has the fastest growing incidence with slower growth in the all other West group and the San Francisco and Seattle group. The epidemic seems to start later and grow slower in the Washington DC and Baltimore group.

The general time trends for r/e groups of male IVDUs in each subregion are similar so they can be combined in each region. Moreover, the general patterns are similar for male IVDUs and female IVDUs in each subregion so they are combined. Figure 10.50 shows the AIDS incidences for the combined male and female IVDUs in the three West subregions. The growth rates in the three subregions are roughly the same since the AIDS incidence curves are approximately parallel. Thus the three subregions can be combined. Figure 10.51 for heterosexual partners of IVDUs also shows that the patterns are similar so the three subregions can be aggregated.

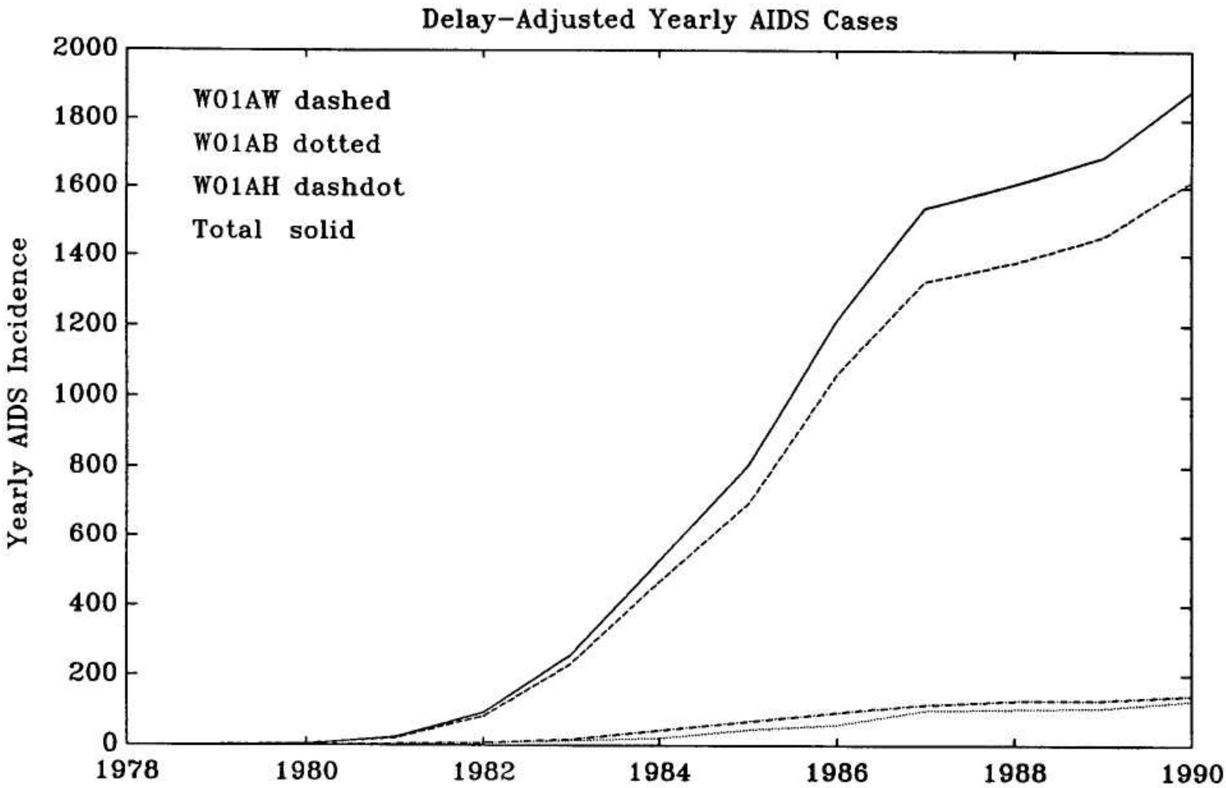

Figure 10.44. AIDS incidence in racial/ethnic groups of homosexual men in West subregion A (San Francisco and Seattle).

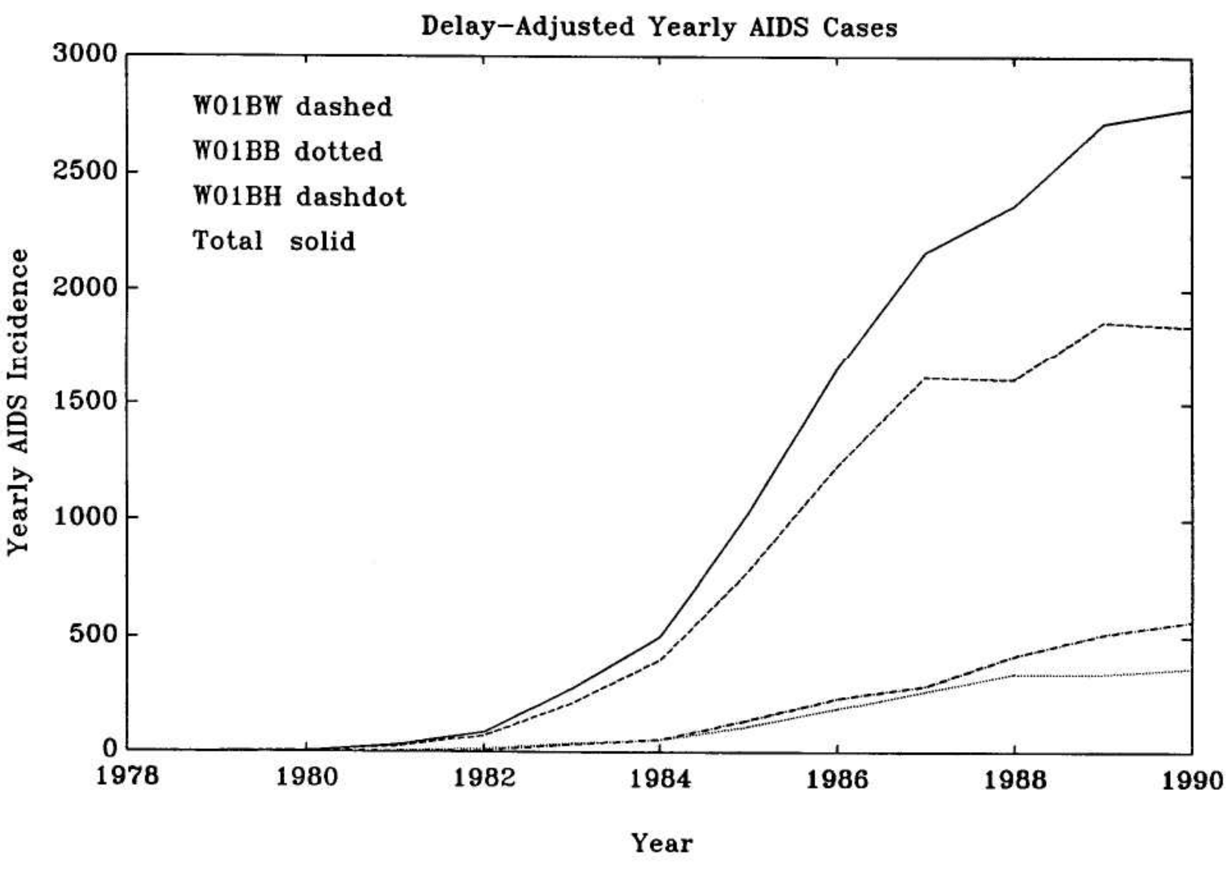

Figure 10.45. AIDS incidence in racial/ethnic groups of homosexual men in West subregion B (Los Angeles, Oakland, Anaheim, Riverside, and San Jose).

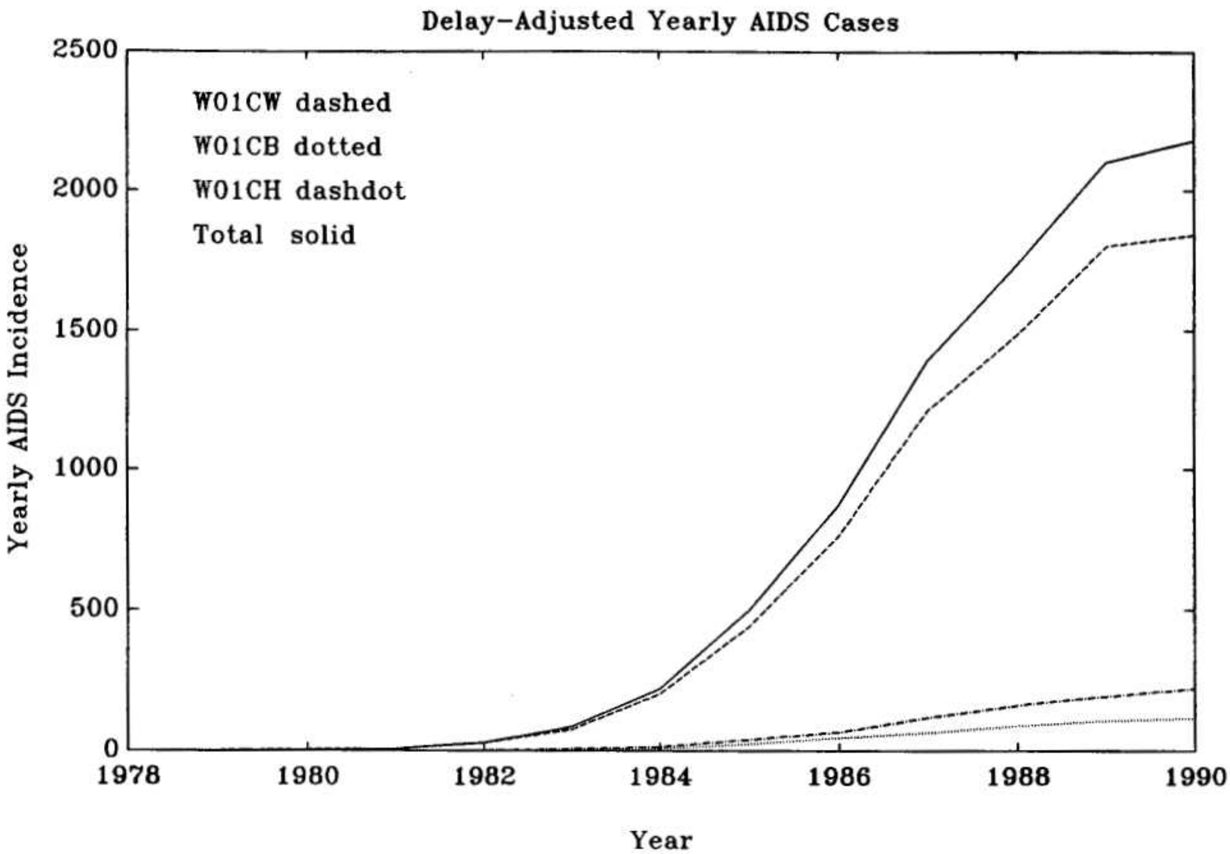

Figure 10.46. AIDS incidence in racial/ethnic groups of homosexual men in West subregion C (all other areas).

10.9. The West Region: Computer Simulations of the Aggregated Groups

Recall that the aggregated groups are homosexual men in subregion A (SF and Seattle), homosexual men in other West subregions and all IVDUs in the West. The simulated HIV and AIDS incidences in homosexual men in subregion A are given in Table 10.13 and Figure 10.52; the simulation for homosexual men in combined subregions B and C are given in Table 10.14 and Figure 10.53. The estimated population size for regions B and C is five times that of region A. The epidemic starting dates are both near the beginning of 1975. The average numbers of new sexual partners per month are similar and the external mixing fractions are both 1. Moreover, the yearly reduction factors and reduction starting dates are very similar. Although the best fit in region A has behavior change stopping in 1983 and the best fit in regions B and C has this change continuing through 1990, this difference is not significant since the actual behavior change in recent years cannot be determined reliably from current AIDS incidence data. Thus there seem to have been similar changes in sexual behavior in SF and Seattle and elsewhere in the West.

The simulations for the IVDUs in the West region are given in Table 10.15 and Figure 10.54. The best fit occurs when there is a yearly decrease in needle–sharing with a factor of 0.8 starting in July 1978. Although changes starting in 1978 would not have been motivated by AIDS, the decrease in needle–sharing is different than in several other regions. It is not possible to fit the AIDS incidence data without changes in needle–sharing behavior. The population size estimate of 200,000 is an educated guess, but is adequate for the data so far since the epidemic starting date of August 1977 is late. The average number 0.72 of new needle–sharing partners

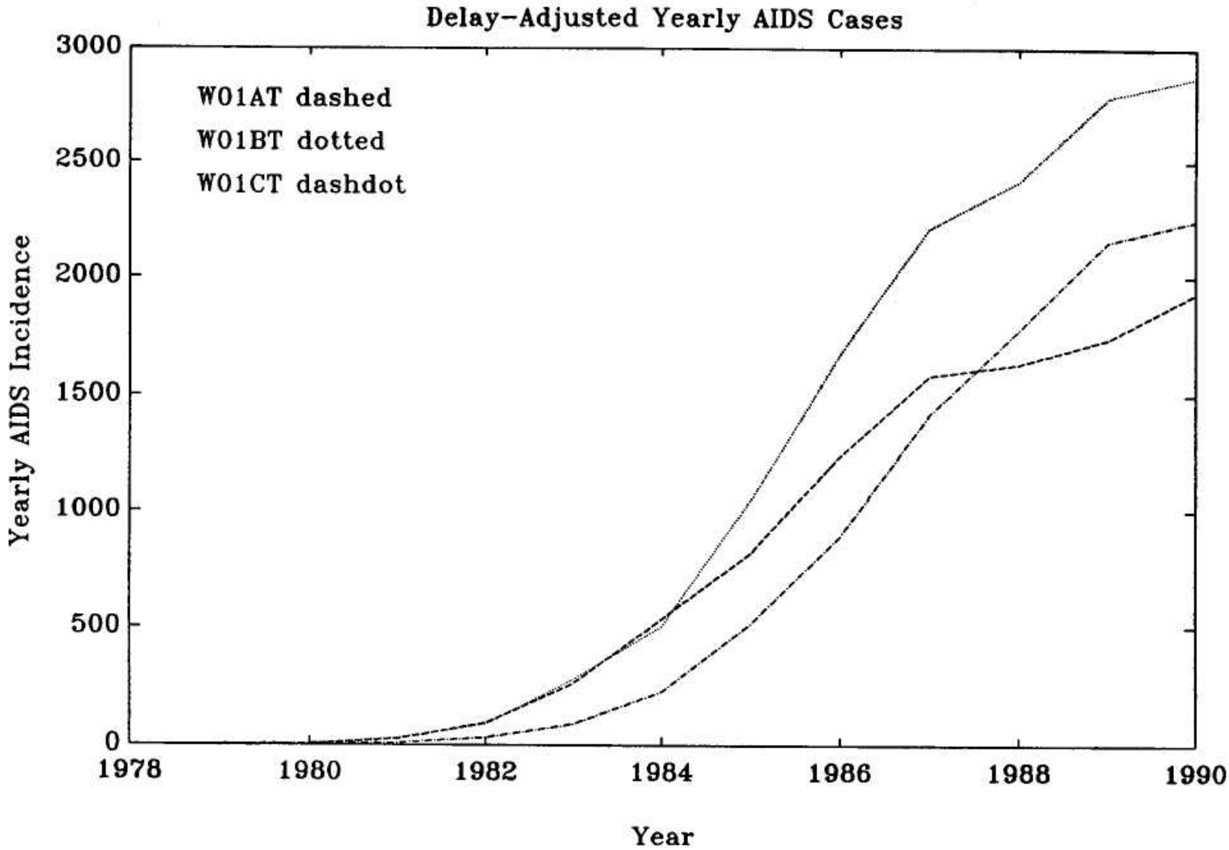

Figure 10.47. AIDS incidence in homosexual men in the three West subregions.

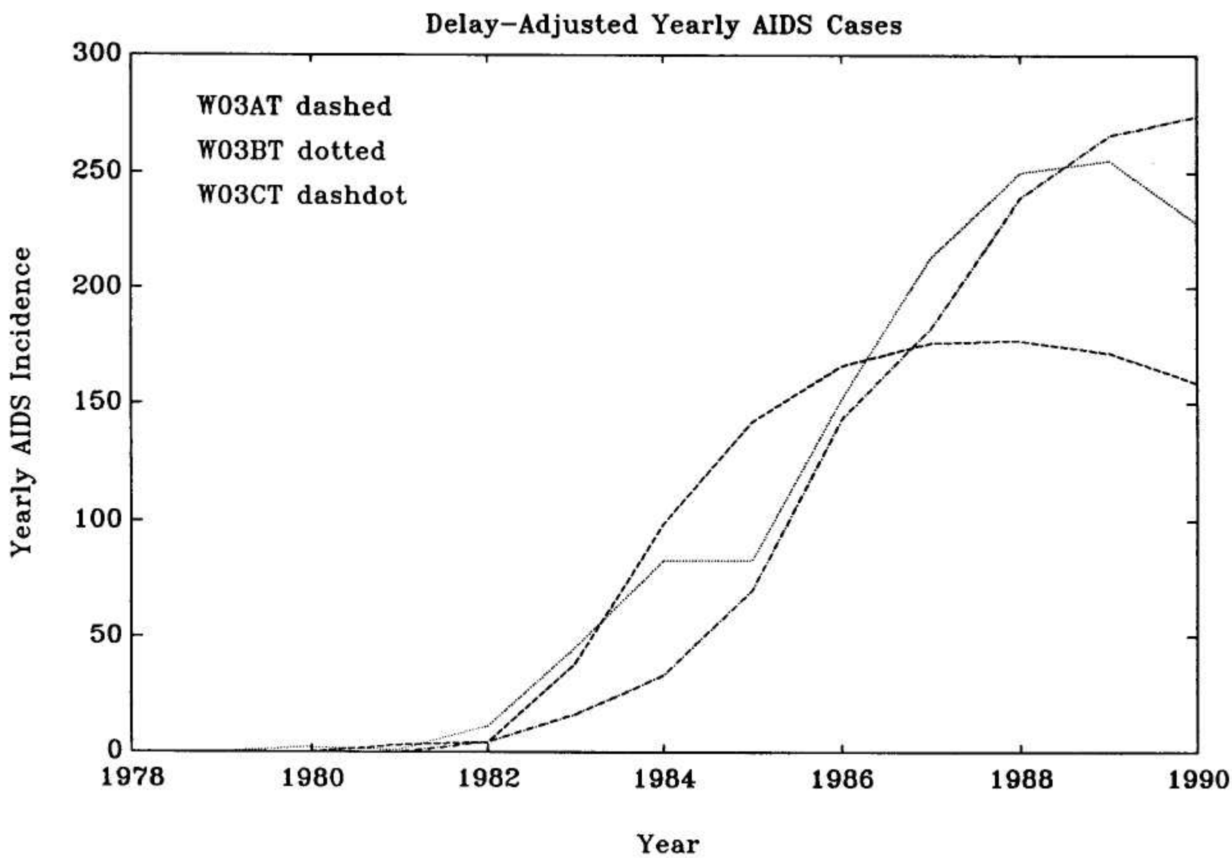

Figure 10.48. AIDS incidence in homosexual IVDUs in the three West subregions.

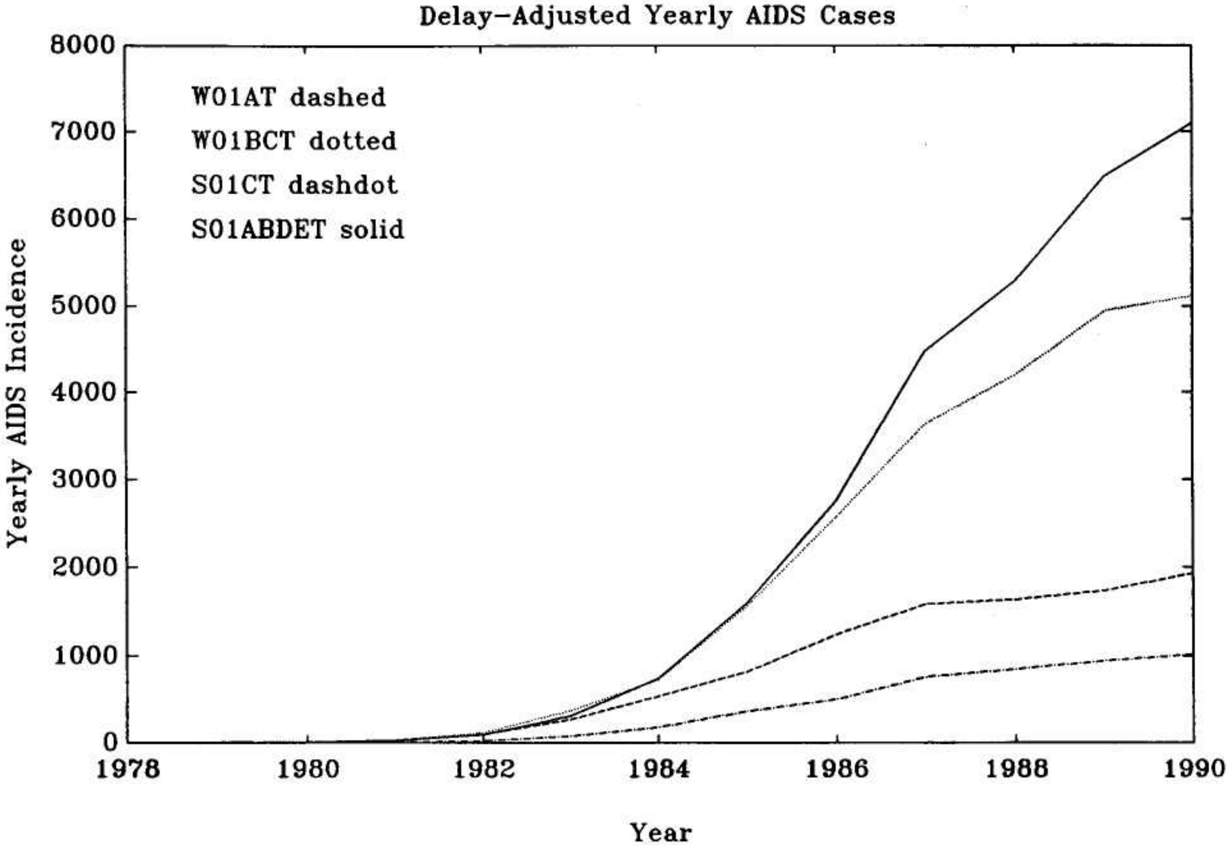

Figure 10.49. AIDS incidence in homosexual men in the four aggregated groups in the South and West regions.

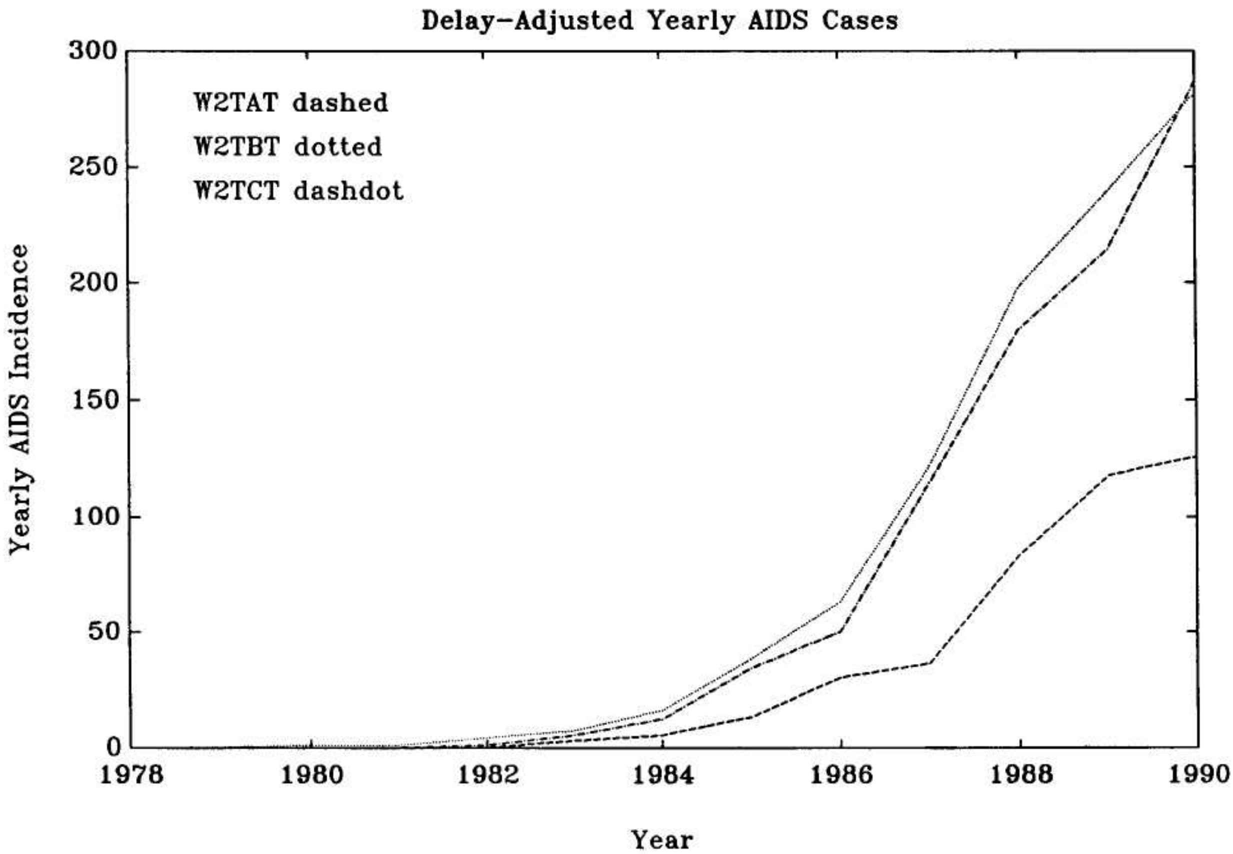

Figure 10.50. AIDS incidence in racial/ethnic groups of the combined male (heterosexual) and female IVDUs in the three West subregions.

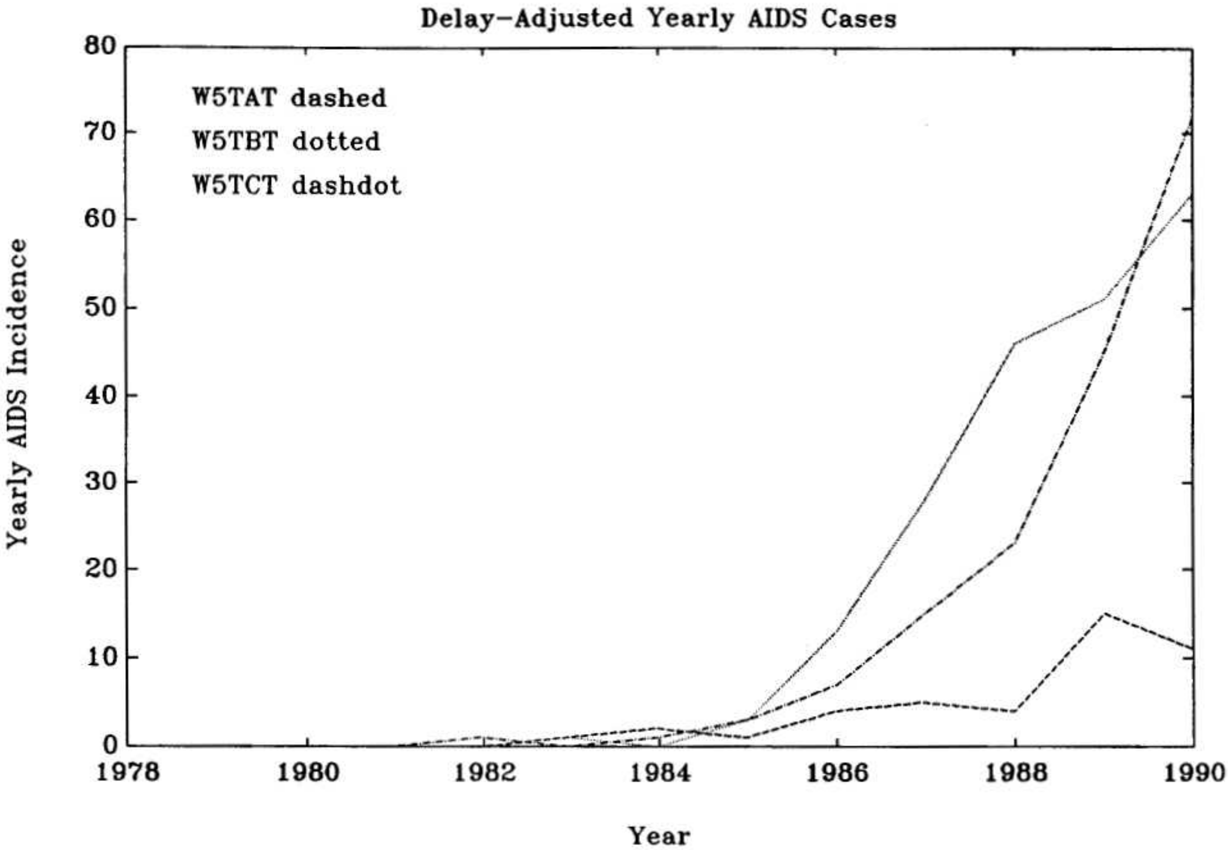

Figure 10.51. AIDS incidence in heterosexual partners of IVDUs in the three West subregions.

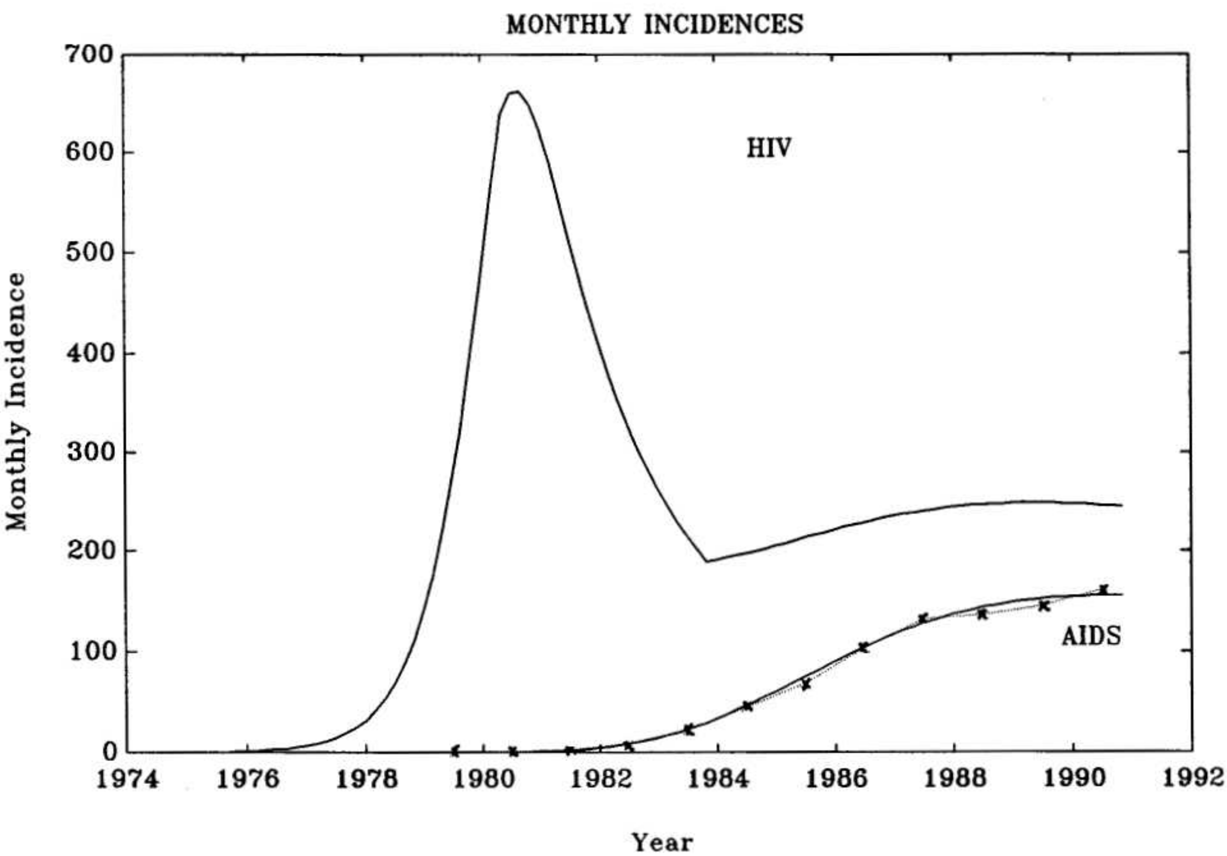

Figure 10.52. Estimated AIDS incidences (*) and simulated HIV and AIDS incidences for homosexual men in West subregion A corresponding to parameter values in Table 10.13.

Table 10.13 Parameter values and corresponding simulation values for homosexual men in West subregion A (San Francisco and Seattle).

```
THE POPULATION SIZE IS       80000, THE VERY ACTIVE FRACTION IS
  1.000000E-01 AND THE ACTIVITY RATIO IS       10.000000
THE NATURAL MORTALITY RATE XMU IS   5.320000E-04
THE INTERCHANGE RATE  FROM THE VERY ACTIVE CLASS TO THE ACTIVE CLASS IS
   4.166667E-03  AND THE TURNOVER RATE IS DLT =    4.166667E-03
THE NUMBER OF INFECTIOUS STAGES IS  M =          7
THE G PARAMETERS FOR THE TRANSFER BETWEEN STAGES ARE    7.355444E-02
   6.433708E-02    4.867545E-02    4.199281E-02    3.997889E-02
   5.152515E-02    5.398798E-02
THE WEIGHTS OF TRANSMISSION PER INFECTIOUS PARTNER TIMES THE FRACTION STILL
SEXUALLY ACTIVE FOR THE STAGES ARE WRH(I) =      2.000000       1.000000
       1.000000       1.500000        1.500000        1.500000
       7.500000
THE PROBABILITY OF TRANSMISSION IS QH =    5.000000E-02
THE EXTERNAL MIXING FRACTION IS ETA =       1.000000
THE AVERAGE NUMBER OF PARTNERS PER MONTH IS    5.829000E-01 BEFORE       1980
          7, THEN IT IS REDUCED EACH YEAR BY A FACTOR OF    6.602000E-01UNTIL
DEC,       1983
THE STARTING YEAR AND MONTH ARE        1975          2
THE STARTING NUMBER OF VERY ACTIVE INFECTIVES IS      1.000000
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YEAR	HIV INC	HIV	FRACTNAL_PREV			YR AIDS	INC	AIDS(SIMULATION)		
	SIM	PREV	ALL	V_A	ACT	DATA	SIM	PREV	DTHS	OUTSF
1975	7.	8.	.00	.00	.00	*****	0.	0.	0.	0.
1976	34.	40.	.00	.00	.00	*****	0.	0.	0.	0.
1977	160.	195.	.00	.01	.00	*****	0.	0.	0.	0.
1978	741.	912.	.01	.06	.01	*****	0.	0.	0.	0.
1979	2982.	3785.	.05	.23	.03	0.	1.	1.	0.	0.
1980	7199.	10603.	.13	.56	.08	2.	6.	5.	2.	1.
1981	6515.	16351.	.20	.74	.14	24.	25.	23.	8.	4.
1982	4190.	19499.	.24	.79	.18	94.	92.	85.	30.	15.
1983	2737.	20999.	.26	.79	.20	259.	252.	241.	96.	48.
1984	2353.	21918.	.27	.77	.22	533.	522.	527.	236.	118.
1985	2536.	22755.	.28	.76	.23	818.	866.	932.	461.	235.
1986	2724.	23465.	.29	.74	.24	1242.	1215.	1399.	748.	388.
1987	2870.	24001.	.30	.72	.25	1583.	1506.	1851.	1053.	557.
1988	2954.	24342.	.30	.70	.26	1633.	1707.	2228.	1329.	717.
1989	2978.	24497.	.31	.68	.27	1737.	1818.	2501.	1545.	849.
1990	2956.	24495.	.31	.65	.27	1931.	1861.	2670.	1692.	947.

CHISQ =   21.086610

Table 10.14 Parameter values and corresponding simulation values for homosexual men in West subregions B and C.

```
THE POPULATION SIZE IS      400000, THE VERY ACTIVE FRACTION IS
  1.000000E-01 AND THE ACTIVITY RATIO IS        10.000000
THE NATURAL MORTALITY RATE XMU IS   5.320000E-04
THE INTERCHANGE RATE  FROM THE VERY ACTIVE CLASS TO THE ACTIVE CLASS IS
   4.166667E-03  AND THE TURNOVER RATE IS DLT =    4.166667E-03
THE NUMBER OF INFECTIOUS STAGES IS  M =          7
THE G PARAMETERS FOR THE TRANSFER BETWEEN STAGES ARE    7.355444E-02
   6.433708E-02    4.867545E-02    4.199281E-02    3.997889E-02
   5.152515E-02    5.398798E-02
THE WEIGHTS OF TRANSMISSION PER INFECTIOUS PARTNER TIMES THE FRACTION STILL
SEXUALLY ACTIVE FOR THE STAGES ARE WRH(I) =       2.000000        1.000000
       1.000000        1.500000        1.500000        1.500000
       7.500000
THE PROBABILITY OF TRANSMISSION IS QH =    5.000000E-02
THE EXTERNAL MIXING FRACTION IS ETA =       1.000000
THE AVERAGE NUMBER OF PARTNERS PER MONTH IS    5.494000E-01 BEFORE        1980
          7, THEN IT IS REDUCED EACH YEAR BY A FACTOR OF    6.916000E-01UNTIL
DEC,        1990
THE STARTING YEAR AND MONTH ARE        1974         11
THE STARTING NUMBER OF VERY ACTIVE INFECTIVES IS      1.000000

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YEAR	HIV INC SIM	HIV PREV	FRACTNAL_PREV ALL	V_A	ACT	YR AIDS DATA	INC SIM	AIDS(SIMULATION) PREV	DTHS	OUTSF
1974	1.	2.	.00	.00	.00	*****	0.	0.	0.	0.
1975	9.	10.	.00	.00	.00	*****	0.	0.	0.	0.
1976	39.	48.	.00	.00	.00	*****	0.	0.	0.	0.
1977	170.	212.	.00	.00	.00	*****	0.	0.	0.	0.
1978	735.	921.	.00	.01	.00	*****	0.	0.	0.	0.
1979	3094.	3905.	.01	.05	.01	0.	1.	1.	0.	0.
1980	10718.	14180.	.04	.17	.02	8.	6.	6.	2.	1.
1981	17670.	30627.	.08	.35	.05	35.	27.	24.	8.	4.
1982	17052.	45516.	.11	.48	.07	114.	105.	97.	33.	16.
1983	13066.	55618.	.14	.55	.09	363.	334.	313.	117.	58.
1984	9454.	61448.	.15	.57	.11	729.	816.	797.	333.	166.
1985	6859.	64042.	.16	.57	.11	1560.	1581.	1627.	751.	379.
1986	5025.	64114.	.16	.55	.12	2568.	2536.	2770.	1393.	714.
1987	3680.	62131.	.16	.51	.12	3631.	3511.	4080.	2201.	1147.
1988	2663.	58488.	.15	.47	.11	4195.	4334.	5355.	3059.	1622.
1989	1888.	53595.	.13	.41	.10	4939.	4887.	6407.	3835.	2072.
1990	1304.	47886.	.12	.36	.09	5118.	5127.	7111.	4424.	2436.

CHISQ =   27.206620

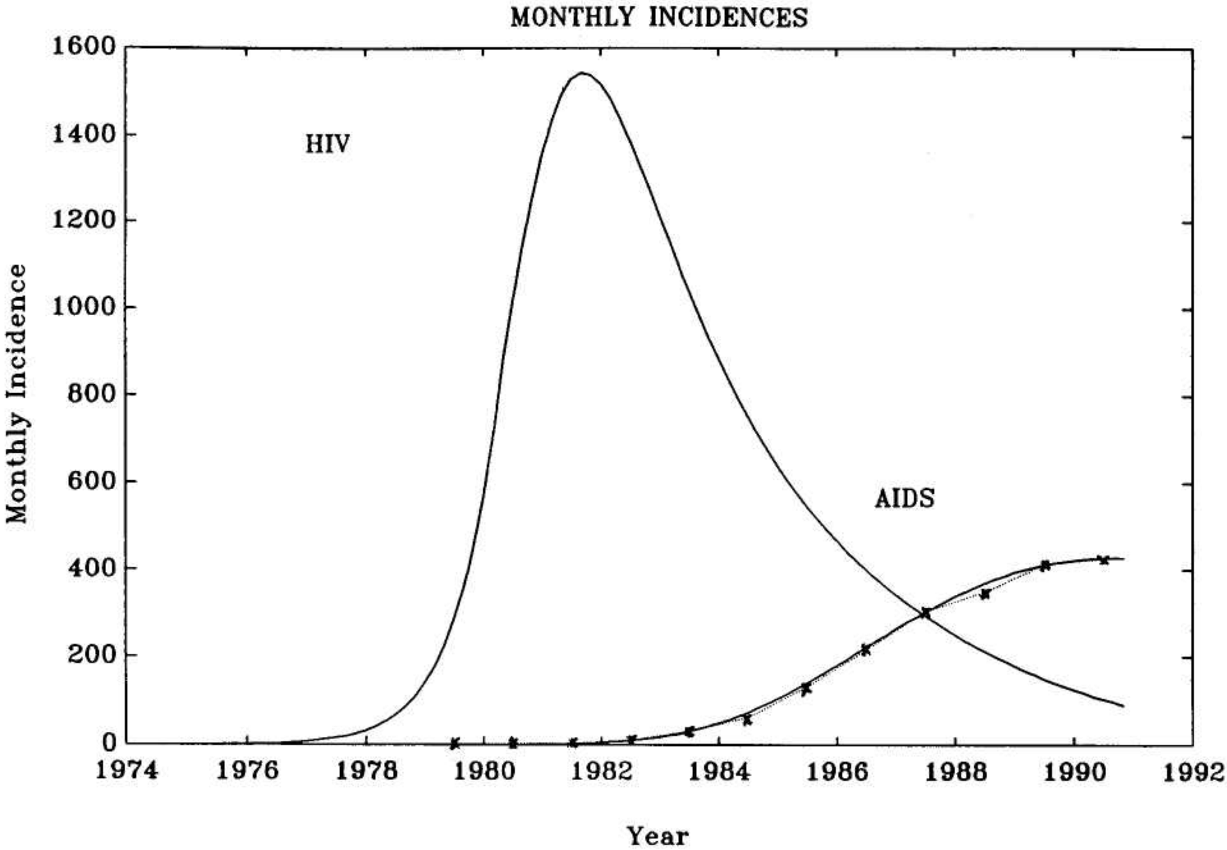

Figure 10.53. Estimated AIDS incidences (*) and simulated HIV and AIDS incidences for homosexual men in combined West subregions B and C corresponding to parameter values in Table 10.14.

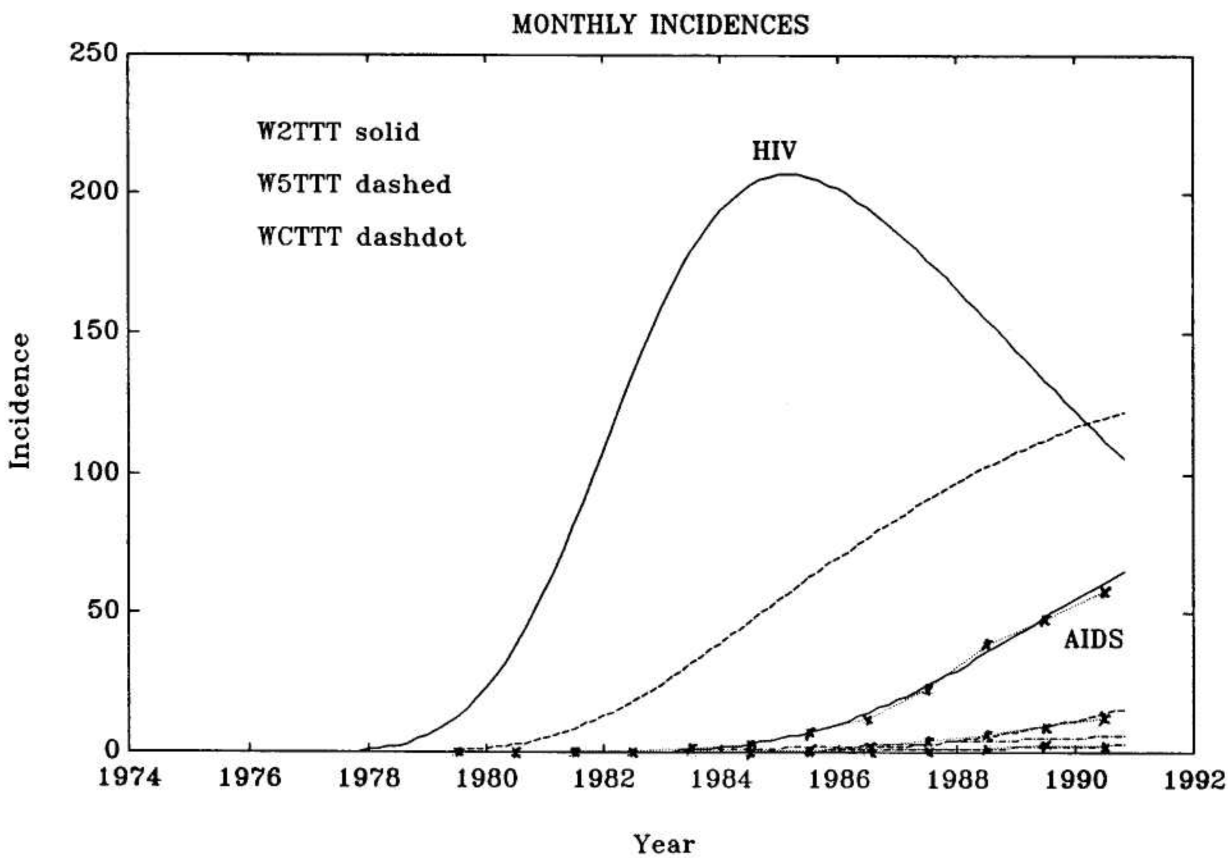

Figure 10.54. Estimated AIDS incidences (*) and simulated HIV and AIDS incidences for IVDUs, their heterosexual partners, and related pediatric cases in the entire West region corresponding to parameter values in Table 10.15.

Table 10.15 Parameter values and corresponding simulation values for IVDUs, heterosexual partners and related pediatric cases in the West region.

```
THE IVDU & HTRO POPULATION SIZES ARE       200000       100000
THE VERY ACTIVE FRACTION IS    1.000000E-01
THE ACTIVITY RATIO IS       10.000000
THE NATURAL MORTALITY RATE XMU IS   5.320000E-04
THE INTERCHANGE RATE  FROM THE VERY ACTIVE CLASS TO THE ACTIVE CLASS IS
   4.166667E-03  AND THE TURNOVER RATE IS DLT =    4.166667E-03
THE NUMBER OF INFECTIOUS STAGES IS  M =          7
THE G PARAMETERS FOR THE TRANSFER BETWEEN ADULT STAGES ARE   7.355444E-02
   6.433708E-02    4.867545E-02    4.199281E-02    3.997889E-02
   5.152515E-02    5.398798E-02
THE WEIGHTS OF TRANSMISSION PER INFECTIOUS PARTNER TIMES THE FRACTION STILL
SEXUALLY ACTIVE FOR THE STAGES ARE WRH(I) =       2.000000        1.000000
       1.000000        1.500000        1.500000        1.500000
       7.500000
THE PROBABILITIES OF TRANSMISSION ARE QH, QHP & QC =    5.000000E-02
   1.000000E-01    1.000000E-01
THE EXTERNAL MIXING FRACTION IS ETA =        1.000000
THE AVERAGE NUMBER OF NEEDLE-SHARING PARTNERS PER MONTH IS   7.177000E-01
BEFORE        1978            7, THEN IT IS REDUCED EACH YEAR BY A FACTOR OF
  8.012000E-01 UNTIL DEC,        1990
THE FRACTION OF IVDU WHO ARE WOMEN IS   2.200000E-01
THE FRACTION OF HETEROSEXUALS WHO ARE WOMEN IS   5.500000E-01
THE AVERAGE NUMBER OF IVDU PARTNERS OF HETEROSEXUALS PER MONTH IS
  5.500000E-02
THE FRACTION   3.400000E-01 OF CHILDREN PROGRESS RAPIDLY TO AIDS WITH RATE
CONSTANT   8.000000E-02. OTHERS MOVE THROUGH M STAGES WITH SPEED FACTOR
      1.550000
THE FECUNDITY FC (CHILDREN/MONTH) IS   6.000000E-03
THE STARTING YEAR AND MONTH ARE       1977          7
THE STARTING NUMBER OF VERY ACTIVE INFECTIVES IS      1.000000
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THE SIMULATED INCIDENCES ARE GIVEN ON THE NEXT PAGE
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w2ttt.m w2ttt.m w2ttt.m w2ttt.m w2ttt.m

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YEAR	CLASS	HIV INC	HIV PREV	FRACTNAL_PREV ALL	V_A	ACT	YR AIDS INC DATA	SIM	AIDS(SIMULATION) PREV	DTHS	OUTSF
1977	IVDU	4.	4.	.00	.00	.00	****	0.	0.	0.	0.
	HTRO	0.	0.	.00	-	-	****	0.	0.	0.	0.
	PED	0.	0.	-	-	-	0.	0.	0.	0.	
1978	IVDU	32.	35.	.00	.00	.00	0.	0.	0.	0.	0.
	HTRO	2.	2.	.00	-	-	****	0.	0.	0.	0.
	PED	0.	0.	-	-	-	0.	0.	0.	0.	
1979	IVDU	140.	171.	.00	.00	.00	0.	0.	0.	0.	0.
	HTRO	9.	11.	.00	-	-	0.	0.	0.	0.	0.
	PED	0.	0.	-	-	-	0.	0.	0.	0.	
1980	IVDU	419.	572.	.00	.01	.00	1.	0.	0.	0.	0.
	HTRO	35.	45.	.00	-	-	0.	0.	0.	0.	0.
	PED	1.	1.	-	-	-	2.	0.	0.	0.	
1981	IVDU	917.	1436.	.01	.04	.00	1.	1.	0.	0.	0.
	HTRO	97.	137.	.00	-	-	0.	0.	0.	0.	0.
	PED	3.	4.	-	-	-	0.	0.	0.	0.	
1982	IVDU	1539.	2859.	.01	.07	.01	5.	4.	1.	1.	1.
	HTRO	208.	332.	.00	-	-	1.	0.	1.	0.	0.
	PED	6.	10.	-	-	-	1.	1.	1.	1.	
1983	IVDU	2087.	4733.	.02	.11	.01	15.	14.	2.	5.	2.
	HTRO	364.	669.	.01	-	-	2.	1.	2.	0.	0.
	PED	12.	20.	-	-	-	2.	2.	3.	1.	
1984	IVDU	2406.	6805.	.03	.16	.02	33.	38.	4.	15.	7.
	HTRO	546.	1164.	.01	-	-	3.	3.	4.	1.	1.
	PED	19.	36.	-	-	-	5.	4.	5.	3.	
1985	IVDU	2475.	8809.	.04	.20	.03	85.	86.	6.	37.	19.
	HTRO	733.	1812.	.02	-	-	7.	9.	6.	4.	2.
	PED	26.	57.	-	-	-	4.	6.	7.	5.	
1986	IVDU	2363.	10553.	.05	.23	.03	143.	164.	10.	79.	40.
	HTRO	911.	2593.	.03	-	-	24.	20.	10.	9.	4.
	PED	35.	84.	-	-	-	5.	10.	11.	8.	
1987	IVDU	2153.	11932.	.06	.26	.04	273.	276.	14.	148.	76.
	HTRO	1074.	3480.	.03	-	-	48.	40.	14.	19.	10.
	PED	44.	117.	-	-	-	14.	14.	16.	11.	
1988	IVDU	1901.	12901.	.06	.27	.04	461.	415.	19.	245.	127.
	HTRO	1219.	4443.	.04	-	-	73.	70.	19.	36.	18.
	PED	54.	155.	-	-	-	16.	19.	21.	16.	
1989	IVDU	1640.	13449.	.07	.27	.04	571.	569.	25.	367.	193.
	HTRO	1341.	5448.	.05	-	-	111.	111.	25.	62.	32.
	PED	63.	196.	-	-	-	32.	25.	27.	21.	
1990	IVDU	1386.	13595.	.07	.27	.05	695.	720.	31.	504.	269.
	HTRO	1435.	6456.	.06	-	-	146.	164.	31.	99.	52.
	PED	73.	242.	-	-	-	28.	31.	34.	28.	

CHISQD = 14.197060
CHISQP = 7.680979
CHISQC = 33.935920
SUM OF CHISQ-D,P,C = 55.813960

before changes start is similar to values in other regions; also similar are the average number 0.055 of new heterosexual partners per month of IVDUs and the fecundity 0.006. In the West 22% of AIDS cases in IVDUs are women and 55% of AIDS cases in heterosexual partners of IVDUs are women.

10.10. Discussion of Regional Comparisons

One major advantage of simulation modeling of AIDS incidence in risk groups in different regions is that the parameter values in the simulations can be compared. The simulation model fits for homosexual men in the subregions are summarized in Table 10.16. The theoretical epidemic starting dates give some insight into the relative possible starting times. Good estimates are usually obtained from the rule of thumb that the epidemic in the simulation model started approximately seven years before the date when the cumulative AIDS cases reached 40. The starting dates range from April 1974 for white homosexual men in New York City to March 1976 for homosexual men in Washington, D.C. and Baltimore. In Table 10.16 note that the HIV incidence increased in all groups until 1980 to 1982 before plateauing or declining. Thus the time trend patterns in the groups of homosexual men are quite similar; the starting dates are in a two year period, all of the HIV incidences increase until about 1980 to 1982 and then they all level off or decrease. Comparing population size estimates is not very enlightening since they are only crude approximations. Recall from Section 6.4.1 that the simulations are not sensitive to the population size estimates.

In the simulations the average numbers of new homosexual partners per month (before reduction if any occurs) range from a high of 0.58 in homosexual men in SF and Seattle to a low of 0.33 in the NE region outside NYC. Although these estimates are somewhat different, the similarity of these parameter values suggests that the growth of HIV infections in homosexual populations throughout the U.S. has been similar. Of course, the HIV epidemic seems to have started earlier in some locations than in others. Recent decreases in the growth rate of AIDS incidences in some locations and r/e groups suggests that there has been a reduction in risky homosexual behavior in these places and groups.

A major difference between simulations of AIDS incidence in homosexual men in regions is that some can be fit without any changes over time in sexual behavior while others require reductions in sexual partnership rates. In Table 10.16 only two groups could be fit without any reduction in sexual partnership rates; namely, black and Hispanic homosexual men in NYC and homosexual men in the South outside Washington, D.C. and Baltimore. It is possible that changes in behavior have occurred in these regions, but that these changes have not yet led to a slowing down of the AIDS incidence.

When the population size is very large and the AIDS incidence has been relatively low, the best fitting simulations can have a low initial monthly partnership rate, reductions in this partnership rate and a weak connection between the high risk group of sexually very active homosexual men and the lower risk group of active homosexual men. This type of fit occurs for the large populations of homosexual men in the NE outside NYC and in the South outside Washington, D.C. and Baltimore. In the two large homosexual populations in the NC region and

Table 10.16 Summary of Simulation Model Fits for Homosexual Men in Subregions of the US

region	size	epidemic starting date	initial partners per month	reduction starting date	reduction factor	external mixing fraction	first HIV incidence peak (year)	HIV prevalence in 1990
NYC (whites)	60,000	4/74	.56	1/81	.34	1	7,400 (1980)	8,100
NYC (nonwhites)	40,000	12/74	.46	none	none	.42	2,800 (1980)	22,000
Other NE	250,000	1/75	.33	7/84	.38	.30	10,000 (1981)	18,000
North Central	500,000	12/75	.55	1/81	.63	1	10,000 (1982)	26,900
Wash DC & Balt.	50,000	3/76	.46	1/82	.73	.53	4,000 (1981)	11,500
Other South	500,000	2/75	.37	none	none	.16	22,600 (1982)	142,000
SF & Seattle	80,000	2/75	.58	7/80	.66	1	7,200 (1980)	24,500
Other West	400,000	11/74	.55	7/80	.69	1	17,700 (1981)	48,000
Total	1,880,000							301,000

in the West outside SF and Seattle, the best fitting simulations have typical initial monthly partnership rates (0.55) and strongly connected very active and active risk groups, but they have reduction in the partnership rates starting very early (1/81 and 7/80).

The external mixing fractions in Table 10.16 are often near 1 corresponding to proportionate mixing, but lower values are obtained in two NE groups and in the South. External mixing fractions near 1 correspond to more mixing between high and low risk groups while lower values correspond to more internal mixing within the low and high risk groups.

It is important to recognize the limitations of the results in Table 10.16, since they reflect the best fits, but do not show nearby parameter sets for which the fit is almost as good. In particular the amount and stopping year for the reduction in sexual behavior are not reliable since changes in recent years have almost no impact on current AIDS incidence. This is consistent with the principle observed in Chapter 6 that HIV incidences in the last approximately six years cannot be estimated from current AIDS incidence data. Thus the HIV prevalences in 1990 in Table 10.16 must be viewed as possibilities instead of predictions. The value 142,000 for 1990 HIV prevalence in the South region outside Washington, D.C. and Baltimore is particularly suspect since it assumes that no changes of behavior occurred, but there may have been undetectable behavior changes in recent years in this region. Indeed, a careful examination of Figures 10.28 to 10.31 suggests that changes in behavior may have started to occur in white homosexual men in several subregions.

A summary of the results for AIDS in homosexual men in the regions follows. The three aggregated groups in the NE region really are different from each other. The epidemic started early in white homosexual men in NYC and the growth rate has slowed recently. The growth rate in black and Hispanic men in NYC was later and slower, but steady. The growth in the rest of the NE region was later and slowest. The growth pattern is the same throughout the NC region and is similar to that in white homosexual men in NYC, but it started later. The growth in AIDS incidence in homosexual men in Washington, D.C. and Baltimore seems to have slowed down, but there is not much evidence so far of behavior changes in other parts of the South. In the West the early rapid growth in homosexual men in San Francisco and Seattle has decreased recently; the pattern in the rest of the West is quite similar.

In Section 8.8 it is described how the simulation modeling in NYC of homosexual men, homosexual–IVDUs and IVDUs led to the conclusion that the homosexual–IVDUs do not constitute a crucial link between the epidemics in homosexual men and IVDUs. Since the epidemic in one population is not feeding or driving the epidemic in the other population, the homosexual men and IVDUs can be simulated separately. The AIDS incidence in homosexual–IVDUs is always less than 10% of that in homosexual men and the time trends are usually similar. Since simulation modeling of homosexual–IVDUs would not lead to new insights, these simulations have not been done.

For IVDUs the theoretical epidemic starting dates range from 1975 in the NE region to 1978 in subregions B and C of the NC region. The estimated population sizes of IVDUs at risk are only educated guesses. These population sizes may differ from actual at–risk population sizes, but it is shown in Section 6.4.1 that the simulation fits are not sensitive to the population size

Table 10.17 Summary of Simulation Model Fits for IVDUs in Subregions of the US

region	size	epidemic starting date	initial partners per month	reduction starting date	reduction factor	external mixing fraction	1990 HIV prevalence	heterosexual partners per month	fecundity per month
NY,NJ,CT,RI	300,000	1/75	.38	none	none	.15	90,200	.027	.0059
Other NE	100,000	1/77	.49	7/81	.72	1	8,000	.046	.0062
Chicago + small cities	100,000	7/77	.48	7/81	.72	1	4,400	.056	.0058
other NC	50,000	1/78	.50	7/81	.70	1	2,500	.059	.0054
South	300,000	1/75	.26	none	none	.63	44,900	.076	.0045
West	200,000	7/77	.72	7/78	.80	1	13,600	.055	.0060
Total	1,050,000						163,600		

estimates.

When the AIDS incidence in a population has slowed down in recent years, the simulation modeling can fit this by either a reduction in the needle–sharing partnership rate or a weak linkage between the risk groups so the HIV epidemic in the very active risk group goes up and down before the HIV epidemic in the active risk group starts to go up. Since it is possible to fit an AIDS incidence curve with either of the two patterns above, the type of pattern which gives the best fit may depend on minor differences and may not reflect major differences in behavior. In Table 10.17 the four groups with smaller population sizes have the former pattern and the two groups with the largest population sizes (300,000) have the latter pattern.

In the best fits for three of the groups with changes in needle–sharing behavior, the initial number of needle–sharing partners per month is 0.48 to 0.50 with a yearly reduction factor of 0.70 to 0.72 which starts in July 1981. In the West the initial partnership rate is 0.72, but the yearly reduction factor starts early (in July 1978) so that the partnership rate in mid–1980 is 0.46 which is similar to the value in the three groups above. In all four groups the very active and active risk groups mix randomly so they are strongly connected.

In the two groups with population sizes of 300,000 located in NE subregions A and B and in the South, the best fitting simulations have low monthly partnership rates of 0.38 and 0.27, respectively, but there are no changes in these partnership rates. The very active and active risk groups are weakly connected since the external mixing fractions are less than one. For these two regions it is clear from Figures 10.18 and 10.43 that the HIV epidemic on the very active risk group goes up and down before the HIV epidemic starts to increase in the active risk group. The downside of the HIV epidemic in the very active risk group leads to a slowdown in the AIDS incidence, but this is temporary since the HIV epidemic is biphasic so the AIDS incidence will also be biphasic with a later higher AIDS incidence peak. If this simulation fitting corresponds to what is actually happening in these regions, then the slowing down or leveling in the AIDS incidence is only temporary since it will soon start increasing again.

The net result of the simulation modeling fits to the AIDS incidence in IVDUs in different regions is that there are many more similarities in the parameter sets and patterns than differences. Although the HIV epidemic starting dates range over three years in the simulations, the growth in the AIDS incidences in IVDUs in these subregions are similar. Although the simulation modeling suggests that reduction in needle–sharing partnerships have occurred, it is not possible to determine the magnitude and extent of these changes from the current AIDS incidence data. It is important to recognize the limitations of the values in Table 10.17. These values correspond to the best fits to the AIDS data, but they do not reflect the nearby parameter values for fits which are almost as good.

Nationally, 23% of the AIDS cases in IVDUs are women. This percentage is between 19% and 26% in the aggregated groups. Nationally, 71% of the AIDS cases in heterosexual partners of IVDUs are women. This percentage is 86% in the NE, 59% in NC subregions A and D, 68% in NC subregions B and C, 57% in the South and 55% in the West. These differences from the national average may reflect regional reporting differences or actual differences.

The one parameter which is varied to fit the AIDS incidences in heterosexual partners of

IVDUs is the average number of new heterosexual partners per month. This value is usually about 0.06, but is 0.076 in the South and 0.027 in the NE subregions A and B. These differences may be due to regional reporting differences or may reflect more heterosexual transmission by IVDUs in the South and less in the NE subregions A and B. The very low value of 0.027 new heterosexual partners per month in NE subregions A and B may be due to their reluctance to categorize men as heterosexual partners of female IVDUs. The high value of 0.076 in the South suggests that relatively more people are categorized as heterosexual partners of IVDUs in the South than in the other regions. Because the heterosexual partnership rate is multiplied by the probability of transmission per new partner in the simulation modeling and good estimates of this probability of transmission are not available, reliable estimates of turnover rates in heterosexual partners of IVDUs cannot be made.

The one parameter which is varied to fit the AIDS incidences in perinatal transmissions to children from IVDU females and female heterosexual partners of IVDUs is the fecundity, *i.e.*, the average number of children per female per month. The values of this parameter are .0059, .0067, .0058, .0054, .0045 and .0060. These values are all reasonably close together and are reasonably close to the national average of 0.0057 which corresponds to the reported value of 68.6 births per 1000 women between ages 18 and 44 per year (World Almanac, 1988). The fecundity rate of 0.0045 in the South is significantly lower than in the other regions. Thus the actual fecundity rate may be lower there or some perinatal AIDS cases may be missed by the reporting system in the South. It is noteworthy that in the South the heterosexual partnership rate is unusually high and the fecundity rate is unusually low. This suggests that some people may be misclassified as heterosexual partners.

The fits in Table 10.16 and 10.17 yield a total HIV prevalence in 1990 of 301,000 homosexual men and 163,600 IVDUs. Of course, these are only crude approximations based on fitting reported AIDS incidence data in the subregions. Since homosexual men and IVDUs constitute about 80% of the reported AIDS cases in the U.S., it is plausible that the 464,600 HIV–positive homosexual men and IVDUs constitute 80% of about 580,000 HIV–positive people in the U.S. Since all of the data used is based on reported cases and underreporting may be between 10% and 20%, the estimate above suggests that the actual number of HIV–positive people in the U.S. might have been about 700,000 in 1990. This estimate is at the low end of estimates obtained by back calculation in Table B1 in the CDC workshop report (CDC, 1990c). This estimate is somewhat less than the CDC estimate that there were approximately 800,000 to 1.2 million HIV–positive people in the U.S. in 1990. Thus our estimate is lower, but is roughly consistent with other estimates; we are not claiming that our crude estimate is more accurate than the CDC estimate of about 1 million HIV–positive people in the U.S. in 1990.

The fitting of the model to geographically aggregated data carried out in this Chapter should be regarded as a first attempt. Although the aggregations used seem reasonable, fits with more r/e subgroups in more subregions might be better. Other factors such as interactions between subregions and nonuniformity within subregions have been ignored in the modeling here, but could be important. A better geographical analysis of data should be possible after more AIDS data have accumulated.