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ABSTRACT

A new method for analyzing data from two surveys, applied to questions on smoking in the Current Population Survey and the Health Interview Survey, shows that the net rate at which adults have been quitting smoking has increased in the last three decades. Two periods, the late 1960s and the late 1970s, had especially high rates. Quit rates are higher for older people and males but not markedly so for whites. The number of light and moderate smokers has been decreasing, but the number of heavy smokers has been increasing.

CHANGES IN ADULT SMOKING BEHAVIOR IN THE UNITED STATES: 1955 TO 1983

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In the last three decades, smoking habits in the United States have changed to a remarkable extent. Nearly everyone is now aware in a general way of the hazards of smoking, and the proportion of adults who smoke regularly dropped from 38 percent in 1955 to 32 percent in 1983. But behind these summary statistics lurk vast differences between young and old, men and women, black and white, and many other demographic and socioeconomic groups. For instance, while the proportion of men who smoke declined sharply from 52 to 35 percent, the proportion of females increased from 25 to 34 percent in 1965 and has declined only slightly in recent years to 30 percent. In 1980, 52 percent of black men between 25 and 35 smoked, compared to only 42 percent of white men (DHEW, 1979, DHHS, 1984).

We know with little certainty about the demographic characteristics of smoking change in the United States or other countries, because, except for very select experimental populations, few studies have followed individuals over time and recorded changes in their smoking behavior. Similarly few population-based studies have retrospectively reported changes in individual smoking behavior within a fixed reference period. The best information that we have about cohort changes in smoking behavior comes from a single study based on a retrospective smoking history taken in a 1978-80 survey (Harris, 1983).

The most consistent, nationally representative data on smoking change in the United States is of sample-based estimates, in various years, of the proportion of the population in various age, sex, race, and sometimes socioeconomic subgroups that smokes. The National Center for Health Statistics' regular Health Interview Survey, which provides estimates of the proportion of the population in various age groups at four points in time between 1965 and 1983 (DHHS, 1984) is the longest series of this kind. Given the paucity of other data, these data provide valu-

able information about a period of dramatic changes in smoking behavior. These data, however, present a difficult analytical challenge because of the problem of cohort progression: the proportion of the population aged 25 to 34 that smokes in 1980 cannot simply be compared to whose 25 to 34 in 1976. The two population groups represent different cohorts, which have different histories of smoking behavior, and the difference between 1976 and 1980 reflects these different histories as well as actual change that occurred during that time.

Using a new method developed to deal with this kind of estimation problem, this paper presents a new analysis of national survey data on smoking habits in the United States between 1955 and 1983. The focus is on estimating net rates at which new smokers begin, current smokers switch to former smokers, and at which smokers switch among light, moderate, and heavy amounts. The paper presents data for five discrete time periods from 1955 to 1983, for males and females, blacks and whites, and for various age groups in the population.

DATA AND METHODS

Two series of surveys with questions about current and former cigarette smoking behavior provide the data for this study. The first is the Current Population Survey (CPS), carried out by the Bureau of the Census, which included questions an smoking behavior in 1955 and 1966. In each year, about 75,000 respondents were interviewed in person. In both surveys, a smoker was defined as someone who has ever smoked more than 100 cigarettes and who currently smokes. The proportion of the population who are current or former smokers was tabulated by sex and the following age groups: 18-24, 25-34, 35-44, 45-54, 55-64, and 65+ (DHEW, 1970).

A series of smoking supplements to the National Center for Health Statistic's Health Interview Survey (HIS) in 1965, 1976, 1978-80, and 1983 is the second source of data. In each of these years, between 50,000 and 75,000 individuals were interviewed in person about a large number of health related factors. Except as noted below, I aggregated the data from relatively small samples in 1978-80 into one series of proportions representing 1979. The questions varied from year to year, but all of the supplements asked about current and former smoking status and used the same definition of smoking as in the CPS. In various sources, the data are tabulated by sex and the following age groups: 20-24, 25-34, 35-44, 45-64, and 65+. For 1965, 1976, and 1978-80, the data were also tabulated by race. For 1965,

1976, and 1980 (not 1978-80), the data were tabulated by the average number of cigarettes smoked per day in the following groups: <15, 15-24, and 25+ (DHEW, 1979, 1980, DHHS, 1984).

If there were data on smoking behavior for n-year population age groups in two surveys taken n years apart, the demographic problem of estimating rates of change would be relatively simple. The commonly available data, however, present two analytical difficulties. First, the data have been tabulated for irregular age groups. In the HIS data, for instance, there is one 5-year, two 10-year, one 20-year, and an open-ended age group. The data were tabulated in this way as a compromise between adequate sample sizes and the need for information about particular population groups. Second, in most cases, the surveys have been taken at irregular intervals. Even when the data are available for 5- or 10-year groups, the surveys are 3, 4, 6, or 11 years apart.

The following approach is derived and tested by Stoto (1985). It uses data of the form ${}_nP_{a,1}$, the proportion of the population aged a to $a+n$ that smokes at time t_1, and ${}_nP_{a,2}$ be the same proportion at time t_2, for various ages a and intervals n. Let

$$ {}_nP_a = \frac{1}{2}({}_nP_{a,1} + {}_nP_{a,2}) $$

represent the average proportion of smokers in the age interval a to $a+n$ and the time interval t_1 to t_2. After correcting for differential mortality of smokers compared to non-smokers and for cohort progression as shown below, I use the relative proportions of smokers in the adjacent intervals a to $a+n$ and b to $b+m$ to estimate the relative net rate of change in the number of smokers.

I first calculate a factor to correct for differential mortality of cigarette smokers. Let ${}_nL_a$ be the life table function representing the number of person years lived by the general population in the age interval a to $a+n$. Similarly, let ${}_nL_a^s$ be the same function for the smoking population. Then, to compare the proportions in two adjacent intervals a to $a+n$ and b to $b+n$, we calculate

$$ {}_nD_{a,b} = \left[\frac{{}_nL_b^s}{{}_nL_a^s} \cdot \frac{{}_nL_a}{{}_nL_b} \right] . \qquad (1) $$

For the calculations here, I assumed that the relative mortality of smokers compared to non-smokers was as given by Hammond (1966, cited in DHEW, 1979, 1980). I used age and sex specific mortality rates from Coale and Demeny (1966) model

life tables with the appropriate level of mortality to calculate the differential mortality correction.

The simplest case in when two adjacent intervals are of the same width, that is $m = n$. In this case, the average rate of change in the population of smokers in the interval a to $b+n$ is

$$\lambda = \frac{1}{(t_2 - t_1)} \ln \left[\frac{{}_nP_b}{{}_nP_a} \left[\frac{{}_nP_{a,2} \cdot {}_nP_{b,2}}{{}_nP_{a,1} \cdot {}_nP_{b,1}} \right]^{\frac{(b-a)}{2(t_2-t_1)}} {}_nD_{a,b} \right] . \quad (2)$$

The net rate of change when the second interval is wider than the first ($m > n$) is

$$\lambda = \frac{1}{(t_2 - t_1)} \ln \left[\frac{(m+n){}_mP_b}{2n{}_nP_a + (m-n){}_mP_b} \left[\frac{{}_nP_{a,2} \cdot {}_mP_{b,2}}{{}_nP_{a,1} \cdot {}_mP_{b,1}} \right]^{\frac{(b-a)}{2(t_2-t_1)}} {}_mD_{a,b} \right] . \quad (3)$$

Finally, when one interval is open, such as for the population aged 65 and over, define P_{a+} as the proportion of the population aged a and over, and so on, then

$$\lambda = \frac{1}{(t_2 - t_1)} \ln \left[\frac{P_{b+}}{P_{a+}} \left[\frac{{}_nP_{a,2} \cdot P_{b+,2}}{{}_nP_{a,1} \cdot P_{b+,1}} \right]^{\frac{(b-a)}{2(t_2-t_1)}} {}_nD_{a,b} \right] . \quad (4)$$

In each case, λ represents the average annual rate of change for the period t_1 to t_2 in the number of smokers between ages a and $b+m$.

When applied to the population of current smokers, C, formulas (1) to (4) yield estimates of the net rate of change in the number of current smokers, in each age group λ_C. This net rate reflects a combination of smoking initiation, smoking cessation, and recidivism. After correction for mortality, however, the population of ever smokers (current plus former), E, can grow only by smoking initiation. When applied to the population of ever smokers, the same formulas yield estimates of the rate of smoking initiation, λ_E. Putting these together, we can estimate a net rate of transition from the smoker to former smoker categories is each age group as follows:

$$\lambda = \lambda_C - \frac{E}{C} \lambda_E . \quad (5)$$

The resulting "adjusted quit rates", λ, do not reflect differential mortality or cohort history. Instead, they represent changes in the smoking habits of a cohort of individuals at a particular time.

RESULTS

Table 1 shows the estimated net rates of change of the current and ever smoking populations for three periods of time: 1955 to 1966, 1965 to 1976, and 1976 to 1983. The estimates for the first period come from the CPS data, and have estimates corresponding to ages 26.5, 35, 45, 55, and 65, the midpoints of the age groups on which they are based. The estimates for the other two periods come from the HIS data, in which there is one less age group, so there are estimates for ages 27.5, 35, 50, and 65. Except for the youngest ages (26.5 or 27.5), the rates of change of the ever smoking population are close to zero, confirming that people rarely begin to smoke after their mid twenties. The only exception we find refers to women in their thirties and forties from 1955 to 1966, as Harris (1983) also found. In the remainder of this analysis, adjusted quit rates are calculated using equation (5) for men and women aged 26.5 and 27.5 in all three periods, and for women aged 35 and 45 in 1955-1966. For all other intervals and age groups, I assume that λ_E is zero and set the adjusted quit rate equal to λ_C.

Figures 1 and 2 show the adjusted quit rates for men and women in each of the three time periods. For both sexes in every period, quit rates increase sharply with age. Men in their sixties, for instance, are quitting at about 5 percent per year, whereas men in their twenties are quitting at about 2 percent per year. Women in their sixties have adjusted quit rates of about 2 to 3 percent, whereas younger women have rates of 1 to 2 percent.

Substantial progress against smoking is evident--with few exceptions the rates increase monotonically with time. The major exception is for older men in the latest period, whose rate decreased. In each time period, however, female quit rates have been substantially lower than those for men. Only in the latest period have female quit rates matched those of men in the first period, and at age 65, they have still not done so.

Table 2 and Figures 3 and 4 present more time detail, based on additional HIS data for 1970 and 1978-80. These results are less reliable for two reasons. First, since equations (3)-(5) all involve division by $t_2 - t_1$, a fixed amount of sampling variability has a bigger absolute effect in shorter intervals. Second, the data for 1970 was available only for the 25 to 44 age group, rather than for the 25 to 34 and 35 to 44 groups, and I assumed that the proportions in both groups were the same.

The results, however, are very suggestive. For both men and women, adjusted quit rates were substantially higher in both the late 1960's and late 1970's than in surrounding periods. In the late 1960's, the Federal Communications Commission (FCC) required television stations that carried cigarette commercials to devote a significant amount of time to anti-smoking advertisements. Warner (1977) found a similar decrease at this time in aggregate data on tobacco consumption, and attributed it to the effects of the FCC ruling. The reason for the increase in the quit rates in the late 1970's, and their subsequent decline in recent years, is not so clear. These changes could possibly reflect an increased reluctance to report smoking behavior in the 1978-80 survey and a return to normal in the 1983 survey. But given the consistency of the pattern across all ages, and the similarity to the earlier increase, this seems unlikely.

Table 3 presents results from the HIS data by race. Figure 5, for 1965 to 1976, shows higher rates for males than females for each race. Black males lag slightly behind white males, and the same for females, but the difference is generally not large. Figure 6, for 1976 to 1979, shows that black quit rates generally exceeded those of whites, but the data are less reliable because of smaller sample sizes and the shorter time interval. In 1980, a larger fraction of blacks than whites in every male age group smoked, and in almost every female age group. These figures suggest that those differences arise not because whites are more successful in quitting, but that a larger fraction of black cohorts were smoking in the 1960's and even though their quit rates have not been substantially different than those for whites, they have not yet caught up.

Table 4 provides data on the net rate of change in the number of light smokers (less than 15 cigarettes per day on average), moderate smokers (15 to 24 cigarettes), and heavy smokers (25 or more cigarettes), based on the 1965, 1976, and 1980 HIS smoking supplements. The data show that the number of light smokers is decreasing at every age, and that the rates are slightly higher at the younger ages. The number of moderate smokers is also decreasing, but rates tend to be higher for older ages. Heavy smokers show negative rates at most ages which imply that numbers of heavy smokers are increasing. In both periods, the number of heavy smokers among men in their twenties and thirties increased, but the number among older men decreased. The number of female heavy smokers, on the other hand, has continued to increases until women were in their fifties.

These data do not distinguish, though, between moderate smokers who quit and moderate smokers who become heavy smokers. The lack of data on the number of transitions among these groups, from the non-smoker group, or to the former smoker group makes it impossible to calculate more specific transition rates. In order to gain some insight into the possible explanations, Figures 7 to 10 display the same rates which have been rescaled so that they represent the number of transitions per year divided by the total population of smokers. In the new scale, the sum of the rates of change of the light, moderate, and heavy smokers is equal to the rate of change of the smoking population.

Comparing Figures 7 and 8, the rates of change of the moderate and heavy smokers are about the same in the first and second periods. The number of moderate smokers decreases at all ages, and the number of heavy smokers increases at the younger ages but decreases at older ages. Most likely, part of the ddecrease in the number of moderate smokers at the younger ages represents shifts to the heavy smoking catagory, so the quit rate of both groups increases with age. The rate of change of the light smokers, however, is very different in the two periods. In 1976-80, when overall quit rates were relatively high, light smokers were decreasing in number much faster than in the earlier period. Because of the relative stability of the rates for the other groups, the simplest explanation is that the light smokers provided the "swing group" that led to the higher overall quit rates in the second period.

The results for women in Figures 9 and 10 show a different pattern. In both periods the numbers of both light and moderate smokers decrease at all ages, and the number of heavy smokers increases at all but the oldest age. The difference between the first and second period, though, is striking. In 1976-80, when overall quit rates were higher, the rates of decrease for both the light and moderate smokers were higher than in the earlier period. But the rate of increase in the heavy smokers also increased. Thus, it seems that two things happened in the late 1970's: overall quit rates for women increased, but more women were becoming heavy smokers. The biggest increase in the growth rate of heavy smokers came for women in their thirties.

DISCUSSION

From a public health perspective, reliable national estimates of changes in smoking behavior, with adequate demographic detail, serve two purposes. First, since many of the factors that effect smoking behavior--government warnings, advertising bans, tax policy, and social norms, for instance--are national in scale, we need nationally representative estimates of changes in smoking behavior to assess their effects. And since government actions may differentially affect demographic and socio-economic groups, policy analysts need the data in sufficient demographic detail. Second, in order to locate and target groups in the population that are either susceptible to anti-smoking interventions or in need of such programs, we need reliable and demographically detailed on both current smoking status and transitions.

The results in this paper show that changes in adult smoking behavior in the United States in the last three decades have been far from uniform. At any given time, men have been more likely to quit smoking than women, and older people more likely than younger people. All of the population groups, though, are susceptible to change. These results suggest that public health experts must work harder to develop intervention programs that are more effective for young people and women.

Furthermore, there have been substantial differences in the rates of change of light, moderate, and heavy smokers. Between 1965 and 1980, the number of light and moderate smokers has declined, but the numbers of heavy smokers at all but the highest ages have increased. The rates of change for the light and moderate smokers have varied with time, but the rates for the heavy smokers have been relatively constant. At all but the oldest ages, the number of heavy smokers has increased not only as a proportion of all smokers, but also as a proportion of the population at large. At one level, this suggests the need for more effective intervention programs for heavy smokers. It may be, however, that the cost of intervening with heavy smokers is so high, and the health benefits so low, that our resources would be used more effectively on other population subgroups.

The data reveal more similarity between blacks and whites in quit rates than in levels of current smokers. Although more blacks than whites smoked in the 1960's, their net quit rates between 1966 and 1979 were not markedly different than those of whites. Whatever caused some whites to stop smoking seems to have had a similar effect on blacks, but blacks have farther to go.

The rate of decline in cigarette smoking has not been uniform in the last three decades. In the late 1960's, probably due to the FCC's rulings on television advertising, net quit rates for all ages and both sexes increased relative to earlier and later periods. In the late 1970's, there was a similar uniform increase in quit rates, but the cause is less evident. Understanding why this occurred should be a high priority for public health experts.

Another interpretation of these data is that each major increase in net quit rates was followed by a decrease a few years later. This could be due to recidivism, or because in the later period the smoking population contained a higher proportion of people who found it difficult to quit. Better data on transitions, especially individual-level longitudinal data, is needed to understand the dynamics of these changes.

Table 1. Quit rates, start rates, and adjusted quit rates United States, 1955 to 1983

	CPS data			HIS data				
	1955-1966			1965-1976			1976-1983	
	Age	Male	Female	Age	Male	Female	Male	Female
Quit rate	26.5	-1.67	-3.08	27.5	1.69	0.76	2.72	0.78
	35.0	1.05	-0.33	35.0	2.29	1.23	2.86	1.70
	45.0	1.64	-0.22	50.0	3.14	1.71	3.46	2.56
	55.0	2.69	1.89	65.0	5.36	2.85	4.85	4.23
	65.0	4.94	2.76					
Start rate	26.5	2.45	2.90	27.5	0.27	0.63	-0.26	0.23
	35.0	0.03	0.48	35.0	-0.00	0.09	-0.10	-0.33
	45.0	-0.27	0.81	50.0	-0.06	-0.04	-0.44	-1.12
	55.0	-0.27	-0.16	65.0	0.19	0.33	-0.34	-0.53
	65.0	-0.41	-0.08					
Adjusted quit rate	26.5	1.30	0.45	27.5	2.03	1.55	2.36	1.09
	35.0	1.05	0.26	35.0	2.29	1.23	2.86	1.70
	45.0	1.64	0.77	50.0	3.14	1.71	3.46	2.56
	55.0	2.69	1.89	65.0	5.36	2.85	4.85	4.23
	65.0	4.94	2.76					

Table 2. Adjusted quit rates for five time periods, 1955-1983

	Male					Female				
Age	55-66	65-70	70-76	76-79	79-83	55-66	65-70	70-76	76-79	79-83
27.5	1.30	3.76	2.63	3.04	2.12	0.45	2.63	2.39	2.51	0.73
35.0	1.05	3.49	1.00	4.11	2.20	0.26	2.49	0.25	2.17	0.92
50.0	2.17	4.04	2.42	3.62	2.94	1.33	2.76	0.57	3.35	2.25
65.0	4.94	7.15	4.19	6.13	4.31	2.76	3.44	2.60	3.87	4.06

Table 3. Adjusted quit rates for Blacks and Whites, 1965-1979

	Black				White			
	Male		Female		Male		Female	
Age	65-76	76-79	65-76	76-79	65-76	76-79	65-76	76-79
27.5	1.48	3.63	3.34	1.79	2.05	2.75	1.56	2.39
35.0	1.44	6.24	1.42	3.85	2.35	4.06	1.18	1.58
50.0	2.72	4.59	0.40	4.05	3.11	3.54	1.78	3.12
65.0	5.20	2.71	3.02	10.69	5.15	6.53	2.71	3.42

Table 4. Net rates of change for light, moderate, and heavy smokers

	Male			Female		
	1965-1976			1965-1976		
Age	Light	Moderate	Heavy	Light	Moderate	Heavy
27.5	3.94	2.53	-5.29	4.68	-0.09	-7.25
35.0	1.28	4.20	-2.20	3.14	0.95	-1.94
50.0	0.33	3.66	2.26	3.05	1.57	-0.72
60.0	0.96	5.96	8.08	3.55	2.48	1.27
	1976-1980			1976-1980		
Age	Light	Moderate	Heavy	Light	Moderate	Heavy
27.5	6.71	3.55	-4.18	5.88	3.02	-6.00
35.0	9.96	3.57	-1.45	6.37	5.59	-6.68
50.0	2.48	5.04	1.00	7.36	4.04	-1.87
60.0	6.29	8.43	6.25	1.43	1.88	1.06

Fig. 1 – Adjusted quit rates

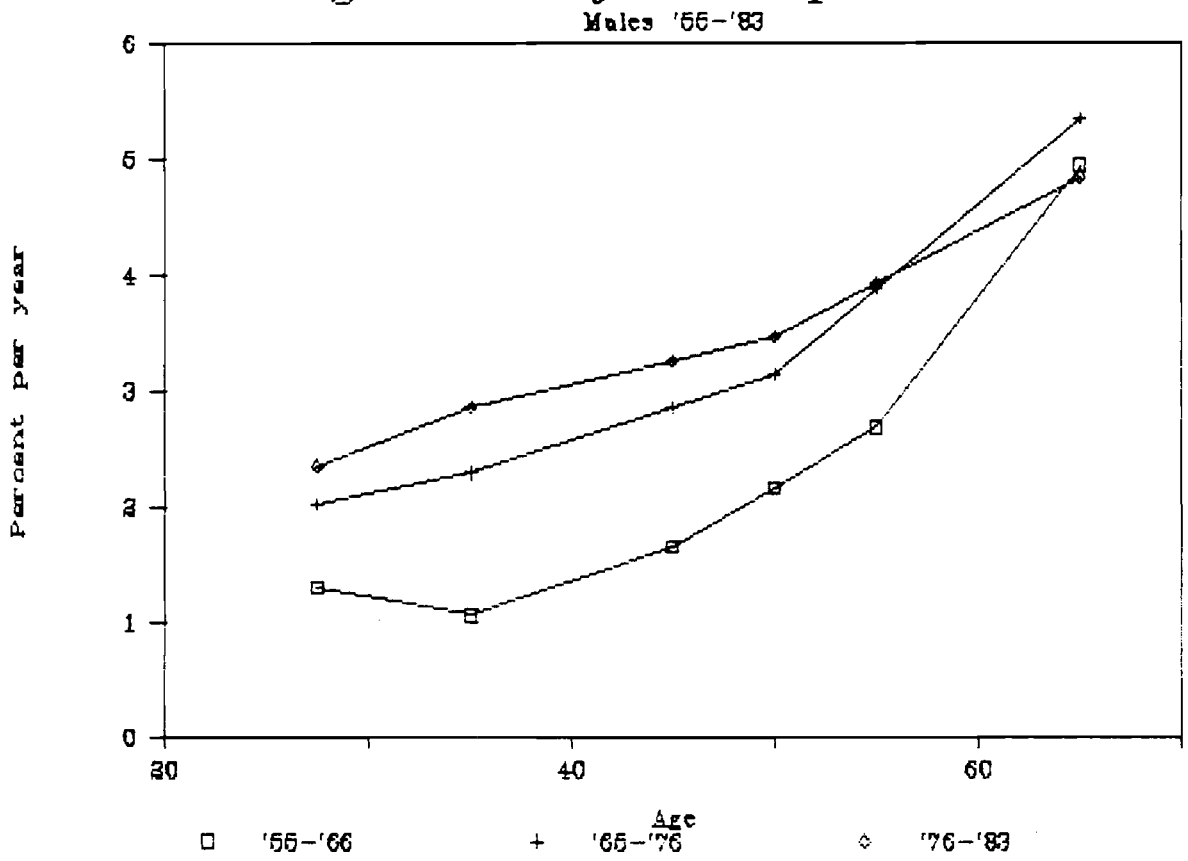


Fig. 2 – Adjusted quit rates

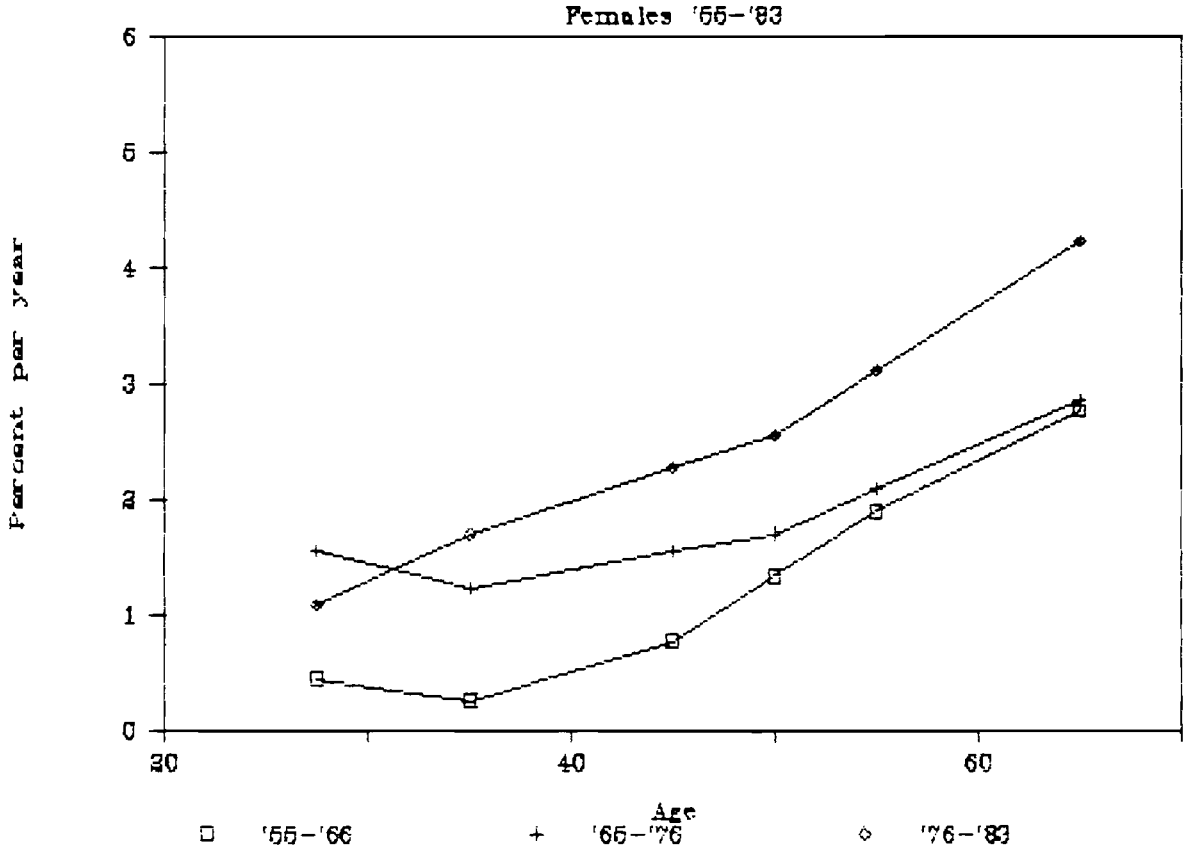


Fig. 3 – Adjusted quit rates

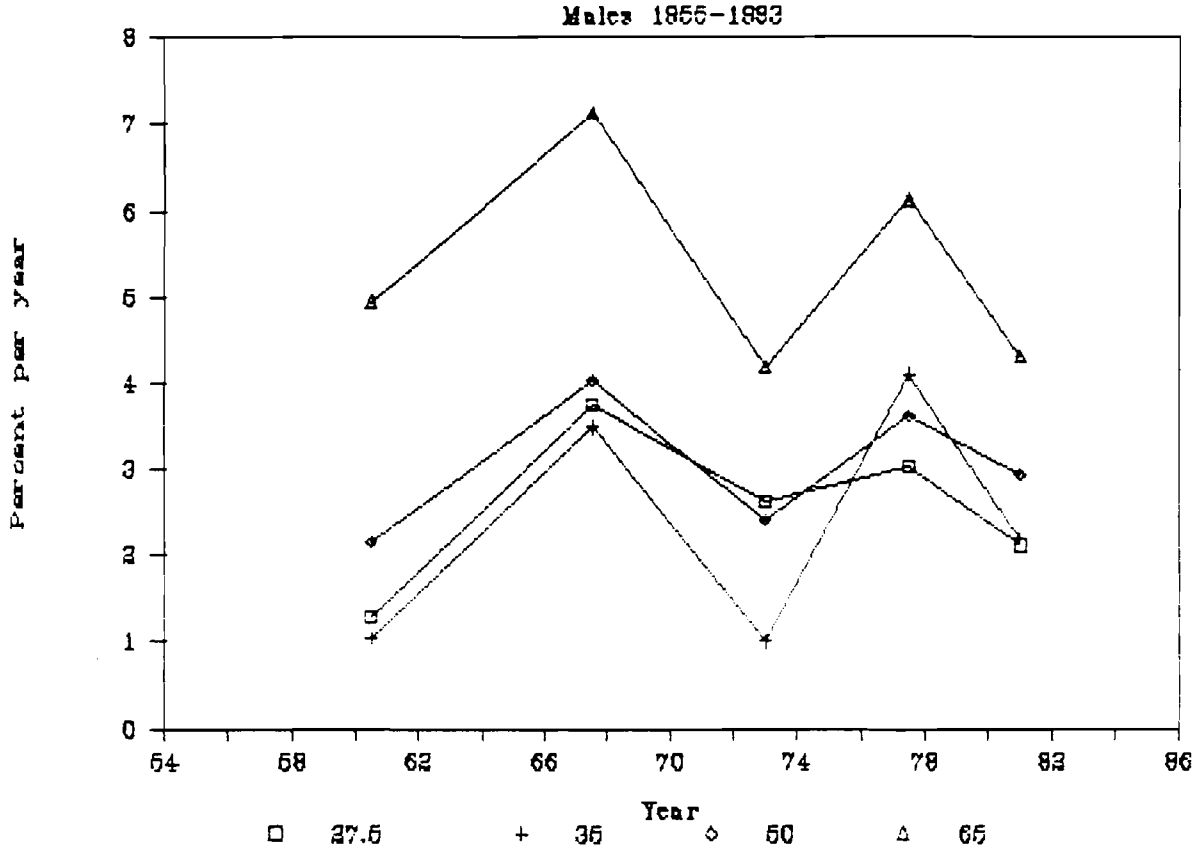


Fig. 4 – Adjusted quit rates

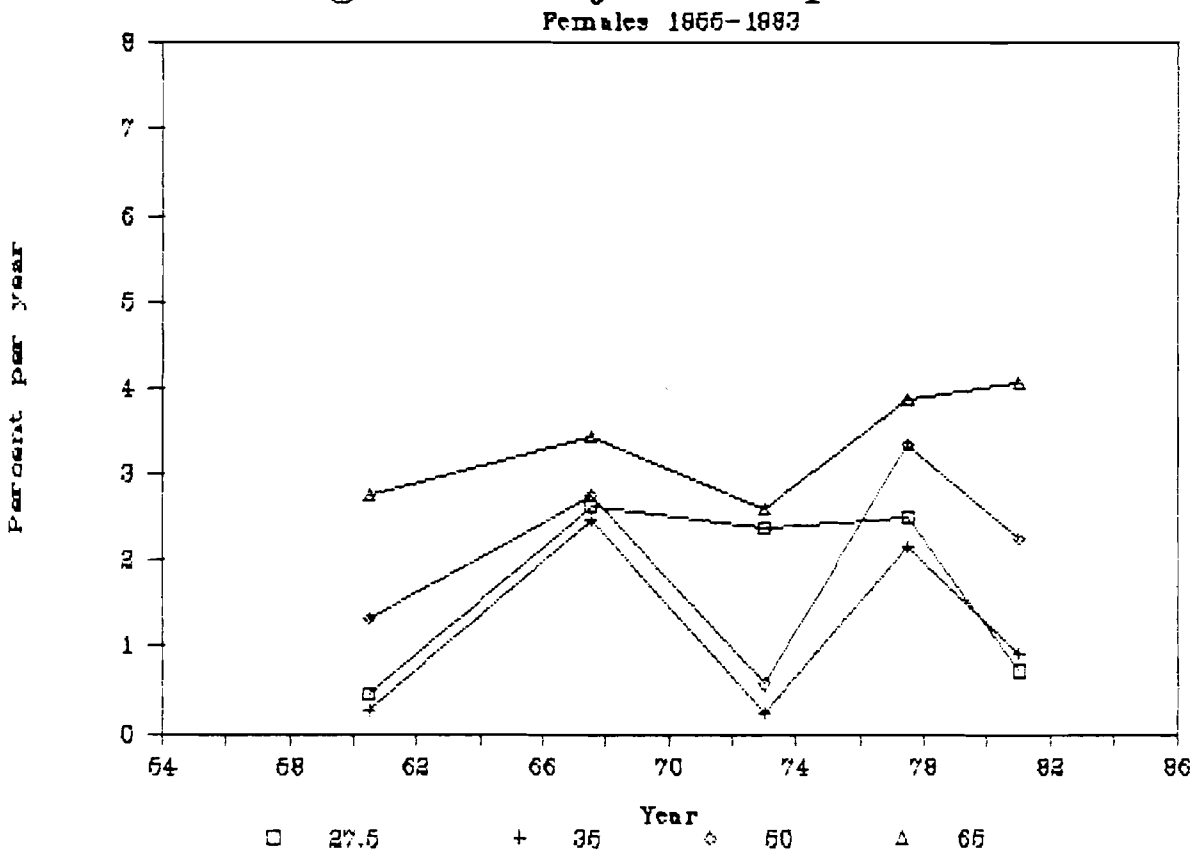


Fig. 5 – Adjusted quit rates 1965–1976

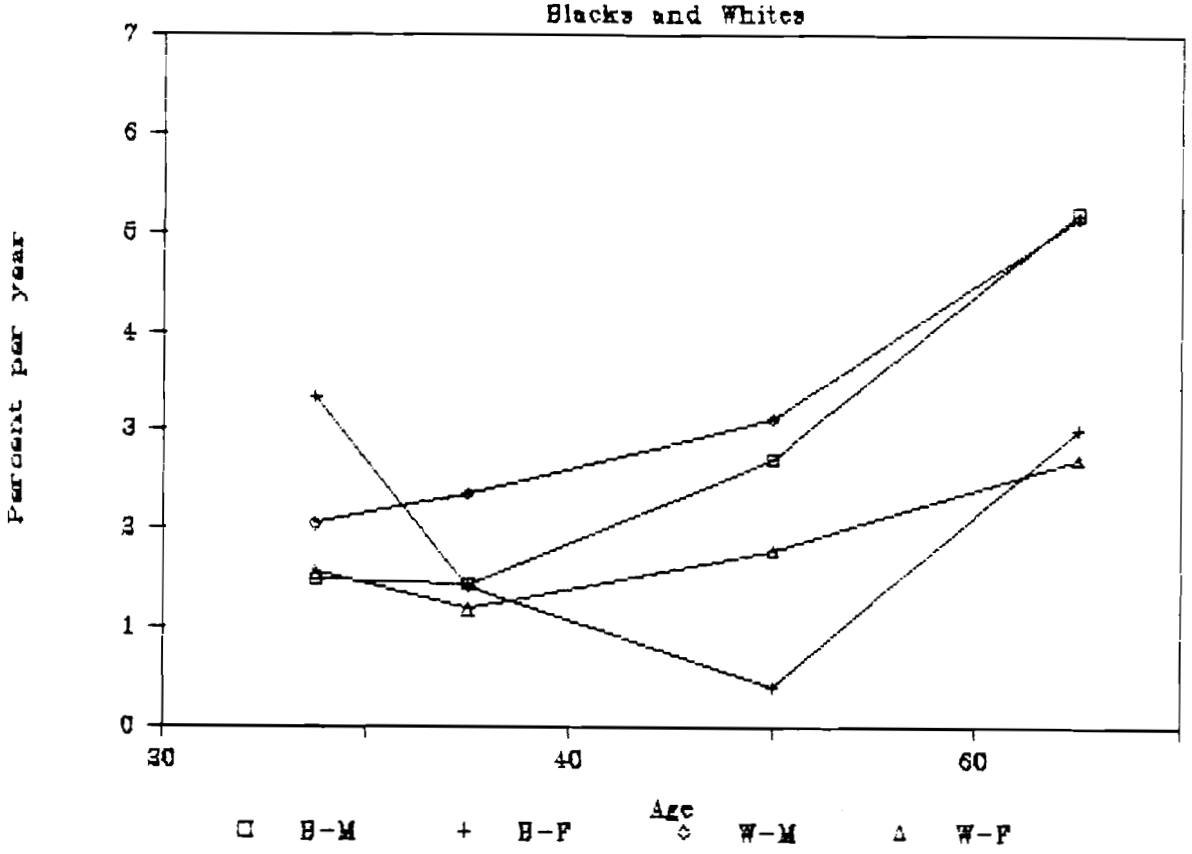


Fig. 6 – Adjusted quit rates 1976–1979

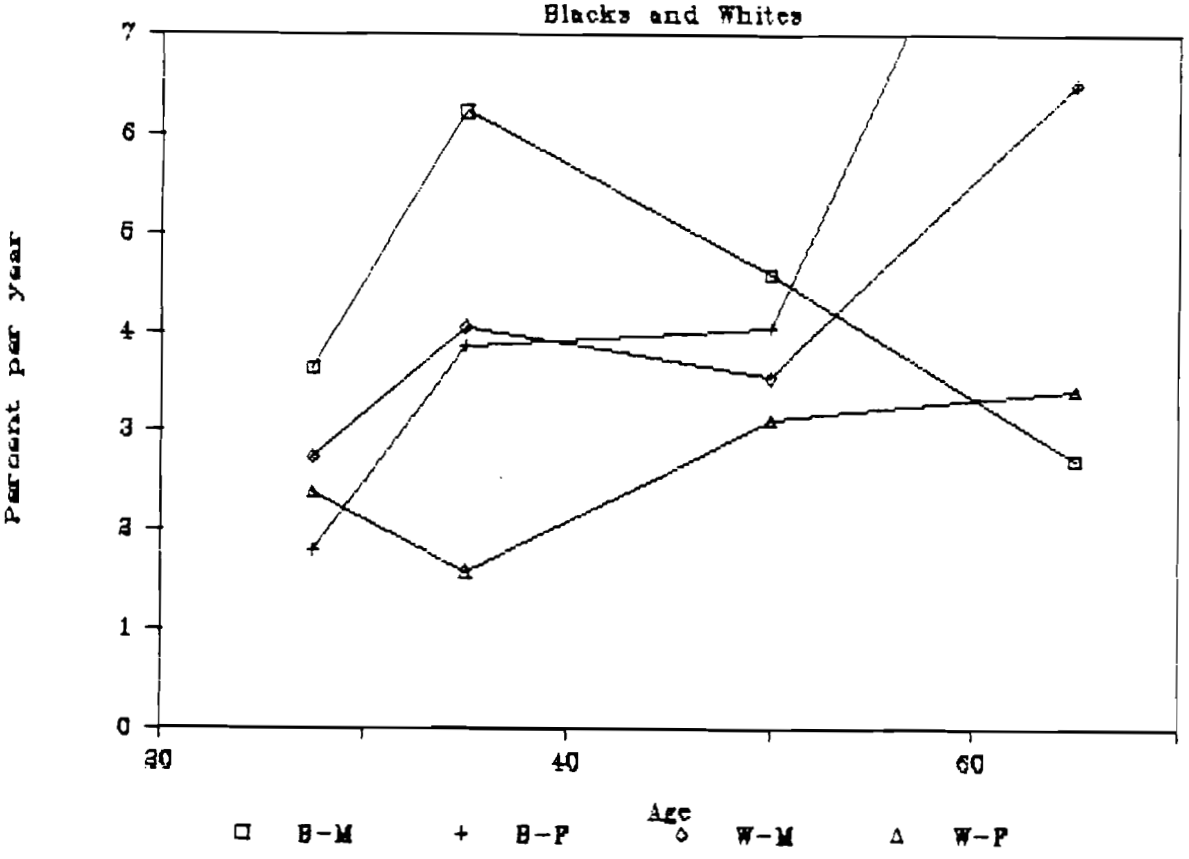


Fig. 7 – Males '65–'76

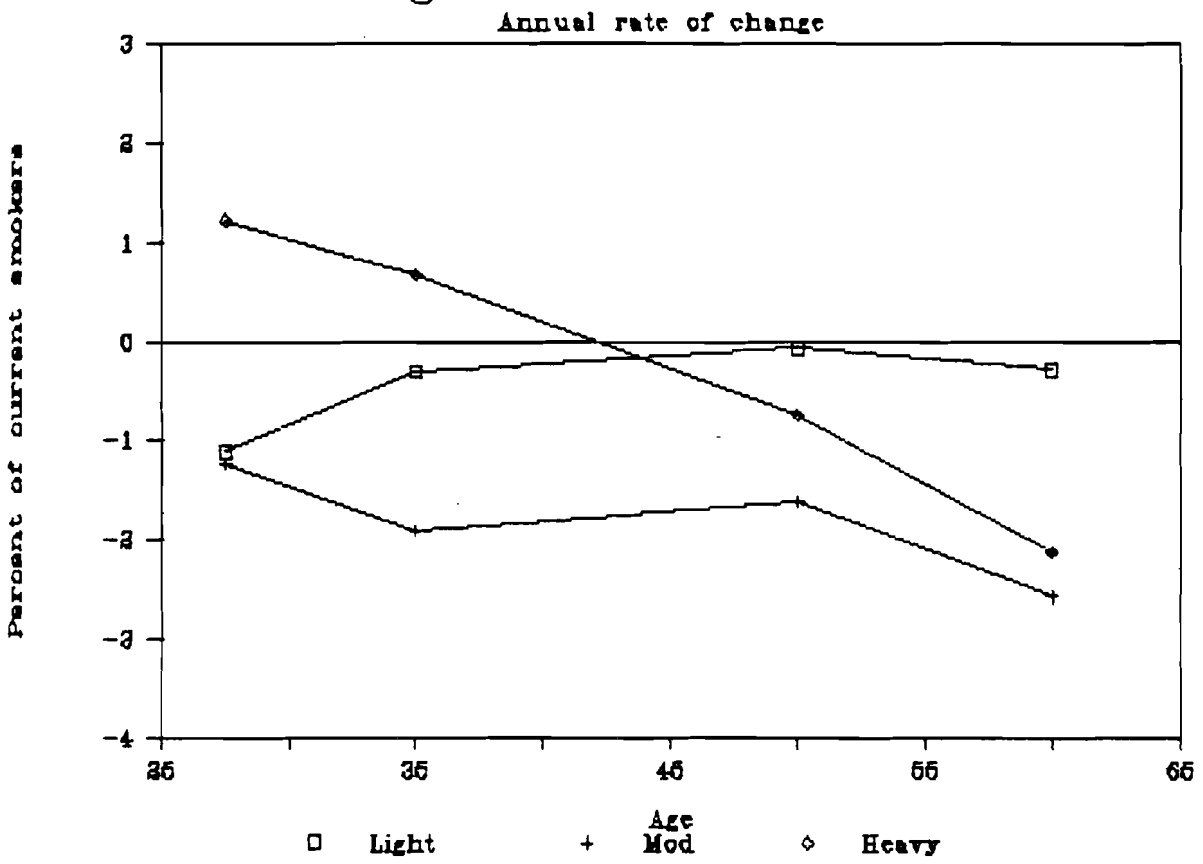


Fig. 8 – Males '76–'80

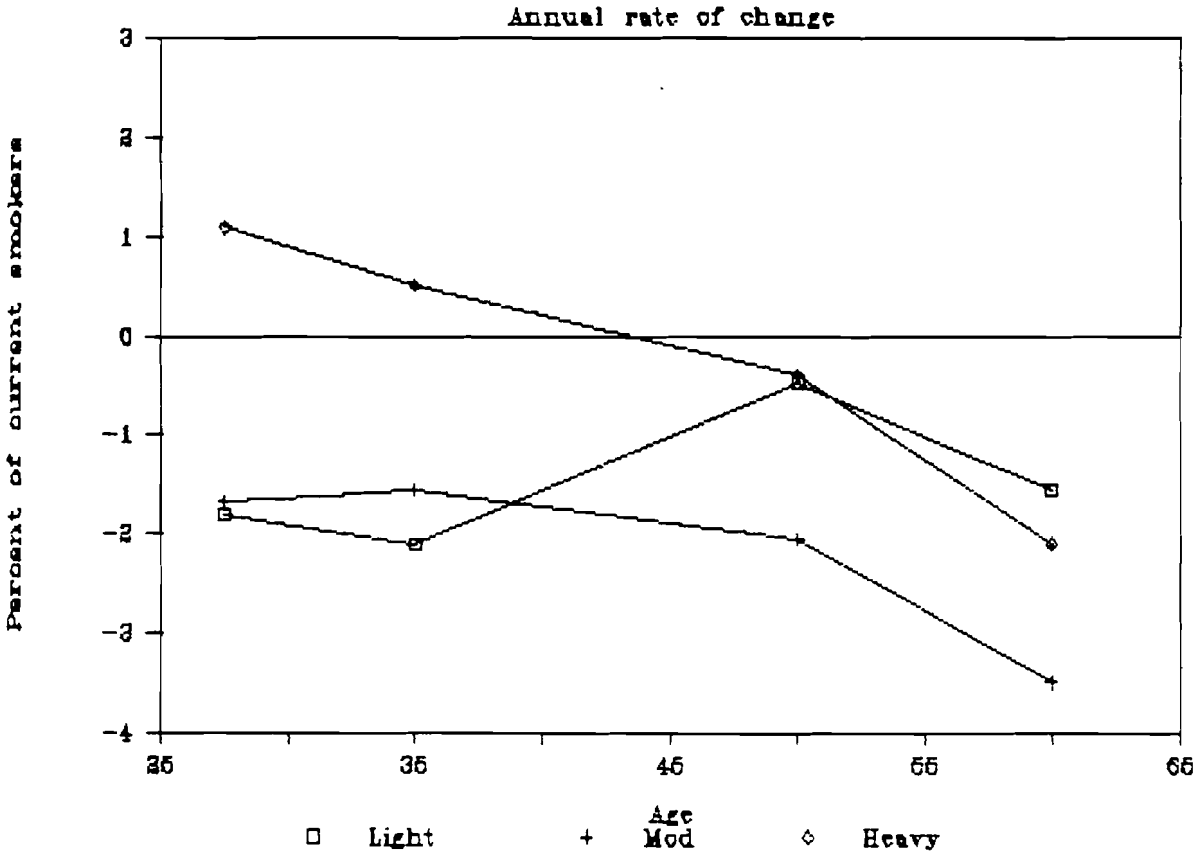


Fig. 9 – Females '65–'76

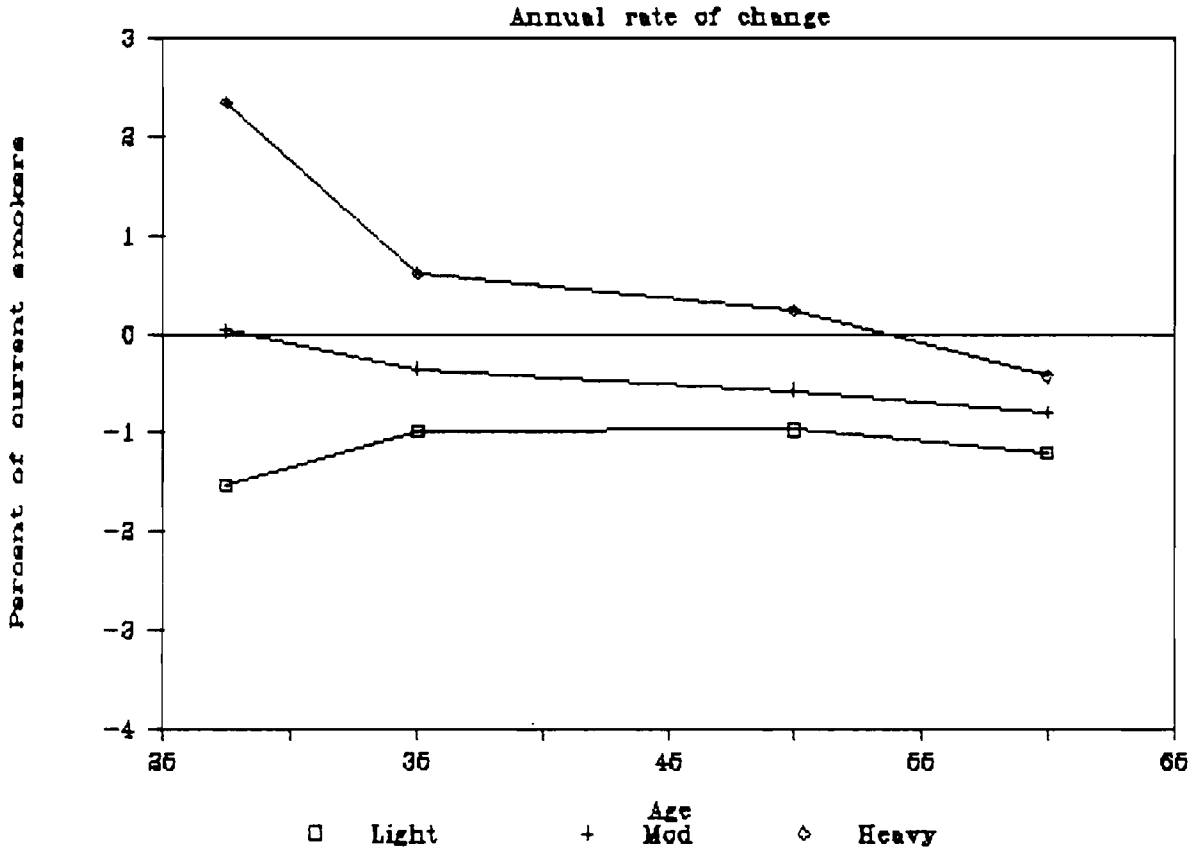
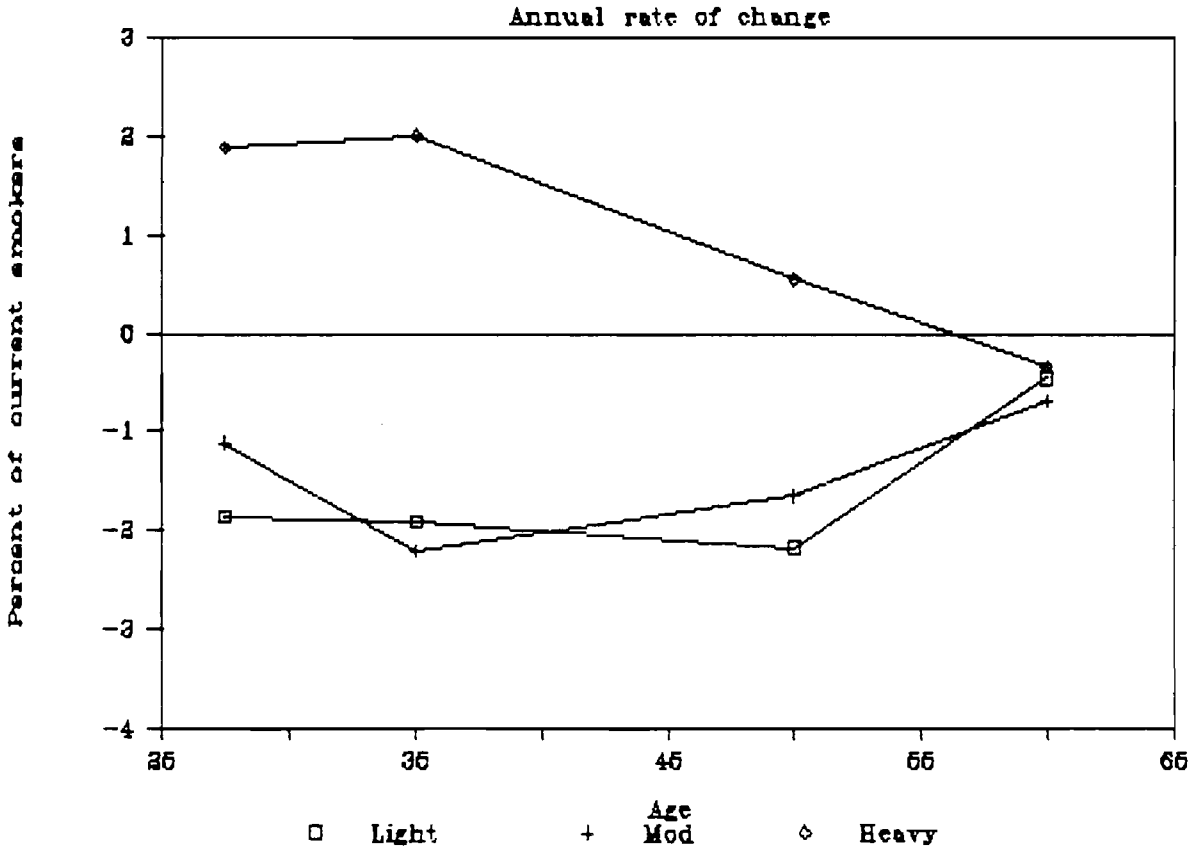


Fig. 10 – Females '76–'80



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