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Human Immunodeficiency Virus Infections in Teenagers

Seroprevalence Among Applicants for US Military Service

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Between October 15, 1985, and March 31, 1989, serum specimens from 1 141 164 teenaged youths (aged <20 years) who applied for entry into the US military were tested for antibodies to the human immunodeficiency virus. Overall, 393 teenaged applicants were found to be seropositive (prevalence, 0.34 per 1000). Prevalences varied markedly in different geographic locales: less than 0.1 per 1000 throughout the north-central states, compared with greater than 2 per 1000 in urban counties in Maryland, Texas, New York, and the District of Columbia. Overall, rates among teenaged males (345/991 445; prevalence, 0.35 per 1000) and teenaged females (48/150 013; prevalence, 0.32 per 1000) were comparable. The prevalence among black teenaged applicants (1.06 per 1000) was greater than that among white (0.18 per 1000) or Hispanic (0.31 per 1000) teenaged applicants. Infections with the human immunodeficiency virus are not rare among teenaged Americans.

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THE ACQUIRED immunodeficiency syndrome (AIDS) is relatively rare among teenagers in the United States.[1] Of the total of 109 167 AIDS cases reported to the Centers for Disease Control, only 421 (0.4%) have been in the 13-year-old to 19-year-old age group.[2] However, clinically overt AIDS represents only the end-stage manifestation of a prolonged infection with the human immunodeficiency virus (HIV). The total number of HIV-infected teenagers in the United States who have not yet developed overt illness remains unknown.

Since October 1985, all civilian applicants for US military service have been tested for serologic evidence of HIV infection during the medical screening examination.[3] We previously reported data on the prevalence of HIV infection among the entire applicant population.[4] In this study, we focus the data analysis exclusively on HIV infection among youths younger than 20 years.

PATIENTS AND METHODS

The procedures used in the HIV testing program and data analysis have previously been reported.[4] They are reviewed herein only briefly.

All civilian applicants for military service who undergo the medical screening examination for entry into service are tested for evidence of HIV infection. Applicants are examined at 72 Military Entrance Processing Command facilities across the United States. Applicants who are HIV positive are counseled by a physician as to their infected status and are provided with a listing of AIDS/HIV specialists and counseling services in their home community. The current analysis includes applicants whose blood was obtained during the 42 months between October 1985 and March 1989.

Serum specimens obtained at each military entrance processing station are sent by overnight express courier to a central laboratory testing facility. Specimens that are repeatedly reactive when tested by enzyme-linked immunosorbent assay are immediately tested further using the Western blot method. Between October 1985 and May 1987, the definition of a positive blot was as follows: presence of viral specific bands gp41 and/or p24 plus p55 bands. In May 1987, the blot technique was modified so as to more clearly detect the gp160 and gp120 bands, and the definition of a positive blot was changed to the following: two of three of p24, gp41, or gp160/120 bands. This change in blot interpretive criteria rarely affected final diagnosis.[5] All applicants found to be positive on the first specimen are advised to submit a second "verification" sample for testing. Applicants found to be antibody positive by Western blot on both first and second serum samples, along with those who declined to submit a second blood sample, were considered antibody positive.

Prevalences were calculated as the number of antibody-positive applicants per 1000 applicants screened. Confidence intervals for prevalence estimates were calculated based on the Poisson distribution. To assess independent relationships to infection risk of various demographic and geographic characteristics, a logistic regression analysis was conducted using the catalytic modeling (CATMOD) procedure provided under Version 5 of the

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SAS statistical package (SAS Institute, Inc, Cary, NC). The results of the analysis were summarized using adjusted odds ratios. For categorical variables (eg, race/ethnicity), adjusted odds ratios documented the relative increase or decrease in infection risk associated with particular characteristics while simultaneously controlling the effects of other determinants. For continuous variables, adjusted odds ratios documented the relative change in risk per unit change in the value of the characteristic (eg, for county population density, the relative increase in infection risk per change in density of 1000 people per square mile). Confidence intervals for and estimates of the statistical significance of odds ratios were based on SEs of logistic regression parameter estimates.

RESULTS

During the 42-month period between October 15, 1985, and March 31, 1989, 1 141 164 teenaged applicants for military service from across the United States were tested for HIV infection (Table 1). A total of 393 teenaged applicants were found to be infected (crude prevalence, 0.34 per 1000). Among teenaged female applicants, 48 of 150 043 (0.32 per 1000) were seropositive. Among teenaged male applicants, 345 of 991 455 (0.35 per 1000) were seropositive. The overall ratio of male-to-female prevalences was 1.09:1. A higher prevalence of infection among males was observed in 19-year-olds; however, among 17- and 18-year-olds the prevalence among females (28/112 604, or 0.25 per 1000) exceeded that among males (177/763 872, or 0.23 per 1000). The ratio of male-to-female prevalences among 17- and 18-year-olds was 0.9:1.

The crude prevalences of HIV infection per 1000 applicants from different race/ethnicity groups were as follows: white, 0.17; black, 1.00; Hispanic, 0.29; other, 0.52 (Table 2). The prevalence among black teenaged females (0.77 per 1000) was fourfold higher than that among white teenaged males (0.18 per 1000).

Teenagers infected with HIV were found in 200 counties in 41 states and the District of Columbia. Table 3 presents HIV prevalence data for the 11 states with the greatest number of HIV-infected teenagers. The most populous states had the greatest number of infected teenagers (California, 52; New York, 45; and Texas, 38). State-specific prevalences ranged from 0 to 1.06 per 1000, with the highest prevalences recorded in Delaware (3/2821, or 1.06 per 1000) and Maryland (18/20 026, or 0.90 per 1000). Among applicants from 9 states, no HIV-positive teenagers were found (Alaska, 2436; Colorado, 16 006; Maine, 7396; Montana, 6304; North Dakota, 4344; New Hampshire, 4838; Rhode Island, 3599; South Dakota, 5107; and Wyoming, 3129). From 8 contiguous states in the north-central region of the country (Idaho, Wyoming, Montana, North Dakota, South Dakota, Minnesota, Iowa, and Wisconsin), only 4 of 91 802 teenaged applicants were seropositive (prevalence, 0.04 per 1000; or 1 per 25 000).

Of the 200 counties with at least one HIV-positive teenaged applicant, 134 had only a single positive applicant, while 66 counties had numerous HIV-positive teenaged applicants. Table presents the counties with four or n positive applicants. Prevalences in these 19 counties ranged from 0.70 to 5.32 per 1000; in 6 counties the prevalence of HIV was greater than 2.00 per 1000 teenaged applicants (District of Columbia; Travis County, Texas; Kings, Bronx, and New York counties; New York City; and Baltimore city, Md). Prevalences of HIV infection among teenagers were, in general, proportional to prevalences of infection among older applicants from corresponding counties.

An analysis of individual parameters in a maximum likelihood analysis demonstrated that several variables were associated with an increased probability of seropositivity (Table 5): namely, age, sex, race/ethnicity, population density per 1000 per square mile, and AIDS endemicity of county in which home of record was located. When the maximum likelihood analysis was confined to subpopulations of white males, black males, or black females, the terms age, population density, and AIDS remained as statistically significant predictors of seropositivity. In the analysis of data from other subpopulations, the likelihood d not converge, and reliable predictor seropositivity could not be identified.

The crude prevalence among teenagers decreased over the 42-month period analyzed (Table 6). Addition of a temporal term to the maximum likelihood analysis (Table 5) for the entire population of teenaged applicants demonstrated that the year in which the applicant was tested independently predicted risk of seropositivity (adjusted odds ratio, 0.83; 95% confidence interval, 0.72 to 0.92) per year for the entire population. Temporal trends varied in different sex- and race-defined subgroups. For males, the risk of seropositivity decreased over time, but less so among blacks than whites (adjusted odds ratio per year: black males, 0.89 [0.77 to 1.03]; and white males, 0.67

Table 1.—Prevalence of Human Immunodeficiency Virus (HIV) Infection Among Teenaged Applicants for Military Service, by Age and Sex

	Age, y			
Sex	17	18	19	Total*
F	12/53 773 (0.22; 0.12-0.39)	16/58 803 (0.27; 0.16-0.44)	20/37 467 (0.53; 0.33-0.82)	48/150 043† (0.32; 0.24-0.42)
M	55/393 782 (0.14; 0.11-0.18)	122/370 090 (0.33; 0.27-0.40)	168/227 583 (0.74; 0.63-0.86)	345/991 455 (0.35; 0.31-0.39)

*Totals include 10 female and 95 male applicants younger than 17 years, none of whom were HIV seropositive.
†Number HIV positive/number tested. The prevalence per 1000 persons tested is shown in parentheses, followed by the 95% confidence interval of this prevalence.

Table 2.—Prevalence of Human Immunodeficiency Virus (HIV) Infection Among Teenaged Applicants for Military Service, by Race/Ethnicity and Sex

	Race/Ethnicity				
Sex	White	Black	Hispanic	Other	All*
F	12/97 467 (0.12; 0.06-0.22)	32/41 574 (0.77; 0.53-1.09)	1/6437 (0.16; 0.00-0.87)	3/4569 (0.66; 0.14-1.92)	48/150 047† (0.32; 0.24-0.42)
M	132/740 077 (0.18; 0.15-0.21)	184/174 295 (1.06; 0.91-1.22)	15/49 193 (0.31; 0.17-0.50)	14/27 945 (0.50; 0.27-0.84)	345/991 510 (0.35; 0.31-0.39)
Total	144/837 544 (0.17; 0.15-0.20)	216/215 869 (1.00; 0.87-1.14)	16/55 630 (0.29; 0.16-0.47)	17/32 514 (0.52; 0.31-0.84)	393/1 141 5 (0.34; 0.31-0.

*Totals include 10 female and 95 male applicants younger than 17 years, none of whom were HIV seropositive.
†Number HIV positive/number tested. The prevalence per 1000 persons tested is shown in parentheses, followed by the 95% confidence interval of this prevalence.

Table 3.—States With the Greatest Number of Human Immunodeficiency Virus–Infected Teenaged Applicants for Military Service

State	No. Positive	No. Tested	Prevalence*
California	52	90 821	0.57
New York	45	62 244	0.72
Texas	38	73 789	0.51
Florida	21	52 778	0.40
Maryland	18	20 026	0.90
Georgia	17	32 018	0.53
Pennsylvania	16	59 142	0.27
Illinois	14	51 250	0.27
North Carolina	13	29 222	0.44
South Carolina	12	19 267	0.62
Michigan	12	47 721	0.25

*Prevalence per 1000 teenaged applicants tested.

Table 4.—Counties With Four or More Human Immunodeficiency Virus–Infected Teenaged Applicants for Military Service

County	State	No. Positive	No. Tested	Prevalence*
Los Angeles	California	21	24 598	0.85
Cook (Chicago)	Illinois	13	18 587	0.70
Kings	New York	13	5510	2.36
Philadelphia	Pennsylvania	11	5892	1.87
Harris (Houston)	Texas	10	10 187	0.98
District of Columbia	...	9	1692	5.32
Baltimore city	Maryland	8	3655	2.19
Wayne (Detroit)	Michigan	8	10 536	0.76
Bronx	New York	8	3741	2.14
Dade (Miami)	Florida	7	5571	1.26
Queens	New York	7	4481	1.56
Sacramento	California	5	3862	1.29
San Jose	California	5	4476	1.12
Marion (Indianapolis)	Indiana	5	4012	1.25
Alameda (Oakland)	California	4	3946	1.01
Prince Georges	Maryland	4	3595	1.11
New York	New York	4	2004	1.99
Tarrant (Fort Worth)	Texas	4	4000	1.00
Travis (Austin)	Texas	4	1749	2.29

*Prevalence per 1000 teenaged applicants tested.

Table 5.—Maximum Likelihood Analysis

Term	Adjusted Odds Ratio	95% Confidence Interval
Age (per year)	2.04	1.78-2.32
Sex (M vs F)	1.39	1.03-1.88
Race ethnicity (vs white)		
Black	4.93	3.97-6.13
Hispanic	1.13	0.64-2.00
Other	2.04	1.20-3.48
Population density (per 1000/square mile)	1.04*	1.03-1.05
Acquired immunodeficiency syndrome endemicity (high vs low)	2.19	1.74-2.75
Date of test (per year)	0.83	0.75-0.92

*Adjusted odds ratio is per 1000 per square mile.

[0.56 to 0.81]). However, for black females there was an upward temporal trend (adjusted odds ratio, 1.32; 95% confidence interval, 0.82 to 1.9). Insufficient data were available for white females to allow for a reliable estimate of temporal trend.

COMMENT

Although clinically overt disease due to HIV infection is relatively rare among teenagers in the United States, the results of the screening process of civilian applicants for military service presented herein indicate that subclinical HIV infections are not rare in this age group. On a national level, approximately 1 of every 3000 teenaged applicants was seropositive. The population sampled and presented herein may not be perfectly representative of the entire US population. Nonetheless, these data can be used as one source to aid in estimation of HIV prevalences in various geographically and demographically defined subgroups of the US civilian population.

As was noted in a previous study that included applicants for military service of all ages, HIV prevalences among teenaged applicants were greater among those who were nonwhite, who lived in densely populated counties, and who lived in metropolitan areas with high incidences of reported cases of AIDS.[4] Urban blacks are known to be disproportionately represented among teenaged overt AIDS cases reported to the Centers for Disease Control: 35% of adolescent AIDS cases are among blacks.[6] Human immunodeficiency virus prevalences among teenaged applicants from several urban centers exceeded 1 per 1000. In contrast, HIV prevalences among applicants from the north-central United States were only 1 in 25 000.

Information regarding individual applicant behavior was not collected during the routine operations of the military entrance HIV screening program, so it is not possible to determine the contribution of intravenous drug abuse, heterosexual activity, or homosexual activity to the prevalence of HIV infection among teenagers. Illicit drug use is common among US high school students: 57% of high school seniors report at least one instance of illicit drug use.[7] However, the proportion who have ever used illicit intravenous drugs is substantially lower than this: 1% to 2% report ever having used heroin.[7] Heterosexual activity is the rule among teens: 70% of adolescents report having engaged in sexual intercourse by age 19 years.[8] Homosexual behavior is also probably not infrequent among adoles-

Table 6.—Human Immunodeficiency Virus Prevalence Among Teenaged Applicants for Military Service, According to Date of Examination

Date	No. Negative	No. Positive	Total	Prevalence*
October-December 1985	77 983	32	78 015	0.41 (0.28-
January-March 1986	90 047	35	90 082	0.38 (0.27-0
April-June 1986	84 644	38	84 682	0.44 (0.32-0.62)
July-September 1986	92 442	40	92 482	0.43 (0.31-0.59)
October-December 1986	84 374	22	84 396	0.26 (0.16-0.39)
January-March 1987	90 114	36	90 150	0.39 (0.28-0.55)
April-June 1987	80 143	38	80 181	0.47 (0.34-0.65)
July-September 1987	82 024	31	82 055	0.37 (0.26-0.54)
October-December 1987	73 573	22	73 595	0.29 (0.19-0.45)
January-March 1988	80 821	26	80 847	0.32 (0.21-0.47)
April-June 1988	73 080	21	73 101	0.28 (0.18-0.44)
July-September 1988	79 105	22	79 127	0.27 (0.17-0.42)
October-December 1988	73 057	10	73 067	0.13 (0.07-0.25)
January-March 1989	79 757	20	79 777	0.25 (0.15-0.39)
Total	1 141 164	393	1 141 557	0.34 (0.31-0.39)

*Prevalence per 1000 teenaged applicants tested; 95% confidence interval shown in parentheses.

cents: 17% of males and 6% of females between the ages of 16 and 19 report at least one homosexual experience.[8,9] It is probable that all of these forms of behavior contribute to the prevalences of HIV observed.

In this population of applicants for military service, we found that the prevalence of HIV among teenaged females was similar to that among teenaged males. Indeed, among 17- and 18-year-olds the prevalence among females was greater than that among males. These figures are in sharp contrast to the 9.3:1 ratio of males to females among adult AIDS cases, and to the 4:1 ratio among reported adolescent AIDS cases.[2] One possible reason for the discrepancy between the male-to-female ratio among teenagers infected with HIV (1:1) and the ratio among teenagers with clinically diagnosed AIDS (4:1) may be that AIDS is less suspected and therefore relatively underdiagnosed and underreported among adolescent females. Another explanation is that HIV-infected males may be underrepresented in the population of military applicants due to self-deferral. If this is the case, then the prevalence of HIV infection among US teenagers in the civilian population at large may be substantially greater than 1 in 3000. However, the most likely reason for the higher prevalences among 17- and 18-year-old females is that they are more likely to have older, infected sexual partners than are males.

The overall prevalence of HIV infection among teenagers appeared to decrease over the 42-month period (October 1985 through March 1989) covered in this analysis. However, substantial additional data are required before firm conclusions can be drawn about first and second time derivatives of the prevalence data presented herein. Indeed, trend analysis suggests that the epidemic may be accelerating among some gender- and race/ethnicity-defined subgroups while simultaneously decelerating in others. Some of these differences may be artifactual due to different rates of self-deferral selection bias according to race/ethnicity, rather than reflect differences in true HIV incidence rates. However, the comparative data presented herein on prevalent infections among various age-, race/ethnicity-, and gender-defined subgroups of civilian applicants for military service are supported by quite similar observations on prevalent and incident infections among active-duty soldiers.[10,11]

It is widely appreciated that education is a cornerstone to the prevention HIV infections.[12] However, the intensity of the effort and the resources required to impart effective education about HIV remain as points of considerable debate. Preliminary surveys suggest that adolescents typically have little understanding regarding risks of infection with HIV.[13-18] The data presented in this study suggest that HIV is a real and immediate threat to teenagers throughout the United States. Intense yet appropriately targeted educational efforts may play an important role in limiting HIV transmission among teenagers.

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