

# Determinants of Human Immunodeficiency Virus (HIV) Prevalence in Homosexual and Bisexual Men Screened for Admission to a Cohort Study of HIV Negatives in Belo Horizonte, Brazil: Project Horizonte

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*Project Horizonte, an open cohort of homosexual and bisexual human immunodeficiency virus (HIV-1) negative men, is a component of the AIDS Vaccine Program, in Belo Horizonte, Minas Gerais, Brazil. The objective of this study was to compare volunteers testing HIV positive at cohort entry with a sample of those who tested HIV negative in order to identify risk factors for prevalent HIV infection, in a population being screened for enrollment at Project Horizonte. A nested case-control study was conducted. HIV positive volunteers at entry (cases) were matched by age and admission date to three HIV negative controls each. Selected variables used for the current analysis included demographic factors, sexual behavior and other risk factors for HIV infection. During the study period (1994-2001), among the 621 volunteers screened, 61 tested positive for HIV. Cases were matched to 183 HIV negative control subjects. After adjustments, the main risk factors associated with HIV infection were unprotected sex with an occasional partners, OR = 3.7 (CI 95% 1.3-10.6), receptive anal intercourse with an occasional partner, OR = 2.8 (95% CI 0.9-8.9) and belonging to the negro racial group, OR = 3.4 (CI 95% 1.1-11.9). These variables were associated with an increase in the risk of HIV infection among men who have sex with men at the screening for admission to an open HIV negative cohort.*

Key words: human immunodeficiency virus prevalence - risk factors - homosexual and bisexual men - open cohort - Minas Gerais - Brazil

Prevalent and incident epidemiological studies on the transmission of human immunodeficiency virus (HIV-1) conducted with homosexual and bisexual men have provided reasonable knowledge of male-to-male HIV sexual transmission determinants. Different risk factors, including individual, social and behavioral characteristics, have been found to be associated with HIV infection. Regarding sexual behavior risk factors, receptive anal intercourse, high number of male sexual partners, and sex without condoms were, among others, reported as major determinants in HIV transmission (Kingsley et al. 1987, Moss et al. 1987, Winkelstein et al. 1987, Van Griensven et al. 1987, Chmiel et al. 1987, Kuiken et al. 1990, Ostrow et al. 1995). HIV infection risk has also been associated with the use of recreational and illicit drugs, particularly amyl nitrites, amphetamines, cannabis, and cocaine (Van Griensven et

al. 1987, Burcham et al. 1989, Seage et al. 1992, Page-Shafer et al. 1997). Prevailing thought is that these associations are primarily due to confounding between high-risk sexual activity and drug use behavior (Seage et al. 1992, Ostrow et al. 1993, Leigh & Stall, 1993, Caceres & Van Griensven 1994, Page-Shafer et al. 1997).

Several studies have identified factors, at individual level, as contributors to HIV infection and progression to AIDS. The most frequent demographic characteristics associated to HIV/AIDS in a cohort of homosexual/bisexual men (MACS) were age, race and ethnicity: being under 35 years of age and either black or being of Hispanic Latin American ethnicity (compared to non-Hispanic white men), were significantly associated to increased seroconversion (Kingsley et al. 1991). A cross sectional study conducted among young men who have sex with men in the USA, showed that HIV infection prevalence was higher among blacks, among youngsters of mixed race and among Hispanics when compared to non-Hispanic whites, Asian Americans and Pacific Islanders (Valleroy et al. 2000). Higher rate of HIV infection was found among African Americans, among men who have sex with men who used injection drugs and among less educated men (Catania et al. 2001).

The Project Horizonte, an open cohort of homosexual and bisexual HIV negative men, is one of the components of the Minas Gerais AIDS Vaccine Center, established at

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the Universidade Federal de Minas Gerais (CNPq/UFGM) and sponsored by the Brazilian Ministry of Health in collaboration with the United Nations AIDS Control Program (UNAIDS). Its main objectives are to evaluate the feasibility of following such a cohort for an extended period of time, to determine HIV infection incidence rate and to investigate risk factors for HIV infection (Carneiro et al. 2000). Eligibility criteria for enrollment included having a negative result for HIV-1 infection and it is here assumed that the volunteers who came to the project probably believed themselves not to be HIV-infected. The objective of the present study is to compare volunteers testing HIV positive at cohort entry with a sample of those who tested HIV negative, in order to identify risk factors for prevalent HIV infection among the population screened for admission to the Project Horizonte.

### PATIENTS AND METHODS

*Study population* - A detailed description of Project Horizonte design and methods has been published elsewhere (Carneiro et al. 2000). Briefly, the study protocol has two phases: the selection process (recruitment and enrollment) and the follow-up. The objective of the recruitment stage is to identify HIV-1 negative homosexual or bisexual males, which would consent to participate in a cohort study. The objective of the follow-up is to evaluate the participants semiannually to detect HIV incidence, to counsel and to investigate risk factors for infection. Eligibility criteria for enrollment include age between 18 and 59 years, being homosexual or bisexual, consenting to HIV testing and testing negative for HIV-1.

The Project Horizonte proposal was approved by the Committee on Human Research of the Federal University of Minas Gerais.

*Data collection* - All volunteers who agreed to participate in the study and signed the informed consent form were face-to-face interviewed by a member of the psycho-social staff regarding their sexual practices, their risk behavior for HIV infection and their knowledge about HIV/AIDS and HIV vaccines. Serum samples were assayed for HIV-1 antibodies by a commercial enzyme-linked-immunoabsorbent (ELISA) kit and, if positive, confirmed by Western-blot. The volunteers go through a complete physical examination at each clinical visit. Those testing HIV positive are referred to the University Infections Disease Outpatient Clinic.

*Study design and data analysis* - A nested case-control study was conducted to identify risk factors for prevalent HIV infection. Volunteers who were evaluated for enrollment to the Project Horizonte and tested positive for HIV-1 infection were compared to those who were HIV negative at entry.

Cases were identified from 1994 to 2001. All volunteers who tested positive for HIV infection at enrollment were defined as a case. For each case, three controls from the pool of HIV negative volunteers admitted to the Project were randomly selected, matched by admission time ( $\pm 6$  months) and age ( $\pm 3$  years).

Variables used for the current analysis included demographic characteristics such as age, race, employment status, income relative to the monthly Brazilian minimum

wage (equivalent to 80 US dollars), educational level and marital status; sexual behavior including practices in the last 6 months with a steady and/or occasional partner, insertive and receptive anal intercourse, sex without protection, having a partner with AIDS and number of partners; other risk factors for HIV infection such as sexual identity, attending gay saunas and bars, use of illicit drugs and type of drugs. Race/ethnicity was determined by asking the participant "Which of these groups best describes your racial or ethnic background?" The available answers were: negro, white, mulatto, and others.

A bivariate analysis was performed using matched odds ratio (OR) and 95% confidence interval to quantify the association between single putative risk factors for HIV infection. The independent contribution of risk factors was assessed using the conditional logistic regression, stepwise technique. The initial model included all the variables with p-values less than 0.10 (bivariate comparison), and those known to have biological importance for HIV infection. New models were built using the backward process and statistical significance was determined by the likelihood ratio tests (Hosmer & Lemeshow 1989). The statistical analyses were conducted using STATA statistic software (Stata Corporation, College Station, TX, USA, 2001).

### RESULTS

During the study period, 621 homosexual and bisexual men were screened for admission to the Project; among them, 61 (11.7%) tested positive for HIV and comprised the cases. The comparison of social and demographic characteristics among cases (61) and matched controls (183) did not reveal any statistically significant difference regarding age (mean 28 years old) and monthly income (mean 7.0 Brazilian minimum wages). Similar proportions regarding years of education, marital status, current employment and sexual identity were also found between cases and controls. However, cases had a higher proportion of negro race compared to controls (20 vs 6.7%).

In the bivariate matched analysis, the odds of belonging the negro racial group among cases was almost four times higher (OR = 3.9, 95% CI 1.6-9.7) when compared to the controls (Table I).

Comparison of selected behavioral characteristics among cases and controls subjects using a bivariate matched analysis is shown in Table II. Sexual identity, unprotected sex with steady partner, insertive anal intercourse with an occasional or steady partner, paying or receiving for having sex, frequenting gay saunas, having a HIV positive sexual partner, and reporting being a drug user (cocaine and marijuana) did not show differences between cases and controls. The odds of receptive anal intercourse with steady partners (OR = 2.7, 95% CI 1.1-6.5), receptive anal intercourse with an occasional partners (OR = 3.1, 95% CI 1.6-6.2) and unprotected sex with an occasional partners (OR = 4.9, 95% CI 1.9-12.8) were higher among cases when compared to controls.

The full model in the multivariate analyses included all variables that reached a p-value less than 0.10 in the bivariate comparisons (negro or white, sexual identity, having insertive anal intercourse with steady partner, hav-

TABLE I

Univariate matched analyses of demographics and behavior characteristics among human immunodeficiency virus (HIV) positives (cases) and HIV negatives (controls), Project Horizonte, 1994-2001

Characteristics	OR	95% CI	p-value
Race			
Negro vs Other	3.9	1.6-9.7	0.003
Mulatto vs Other	0.9	0.6-1.7	0.922
White vs Other	0.6	0.3-1.0	0.072
Civil status			
Single vs Married	0.4	0.1-1.3	0.130
Have children (yes/no)	2.5	0.8-8.0	0.116
Currently employed (yes/no)	0.7	0.3-1.7	0.469
Education			
Elementary vs Other	1.4	0.8-2.7	0.206
Secondary vs Other	0.8	0.4-1.6	0.547
College vs Other	0.7	0.3-1.5	0.325

OR: Odds ratios; CI 95%: 95% confidence intervals

ing receptive anal intercourse with an occasional or steady partners, and having unprotected sex with occasional partner). Being reactive in the VDRL (Venereal Disease Research Laboratories test) was also included, because it is considered an important marker of having a higher risk for HIV infection. The final model (Table III) included variables that were independently associated with the risk of being HIV positive. Remained in the model: having unprotected sex with an occasional partners (OR = 3.7, 95% CI 1.3-10.6), having receptive anal intercourse with an occasional partner (OR = 2.8, 95% CI 0.9-8.9) and belonging to the negro racial group (OR = 3.4, 95% CI 1.1-11.9).

TABLE III

Final multiple conditional logistic regression model among human immunodeficiency virus (HIV) positives (cases) and HIV negatives (controls), Project Horizonte, 1994-2001

Characteristics	AdjOR	CI 95%
Unprotected sex with an occasional partner	3.7	1.1-11.9
Receptive anal intercourse with an occasional partner	2.8	0.9-8.9
Belonging to the negro racial group	3.4	1.3-10.6

AdjOR: Odds ratios adjusted by conditional multiple logistic regression analysis for the variables listed on the table; 95% CI: 95% confidence intervals

## DISCUSSION

This study comparing homosexual/bisexual men being screened for admission to the Project Horizonte shows that unprotected sex with an occasional partner, receptive anal intercourse with an occasional partner and belonging to the negro racial group, were the risk factors, after adjustment, associated to prevalent HIV infection in this population.

These sexual practices are known to carry the highest risk for HIV infection, as reported by several authors (Kingsley et al. 1987, Van Griensven et al. 1987, Chmiel et al. 1987, Kuiken et al. 1990). Our results reveal adjusted relative odds of 3.4 for unprotected sex with an occasional partner, and of 2.8 for receptive anal intercourse with an occasional partner. Results of similar magnitude were reported by other authors (Kingsley et al. 1987, Ostrow et al. 1993).

Controlling for race, the relative odds for those belonging to the negro racial group being HIV positive was

TABLE II

Univariate matched analyses of behavioral characteristics among human immunodeficiency virus (HIV), positives (cases), and HIV negatives (controls), Project Horizonte, 1994-2001

Characteristics	OR	95% CI	p-value
Sexual identity			
Homosexual vs Bisexual	0.5	0.3-1.0	0.064
Insertive anal intercourse with steady partner (yes/no)	0.5	0.3-1.2	0.098
Receptive anal intercourse with steady partner (yes/no)	2.7	1.1-6.5	0.024
Unprotected sex with a steady partner (yes/no)	0.9	0.4-2.1	0.896
Insertive anal intercourse with an occasional partner (yes/no)	1.2	0.6-2.2	0.641
Receptive anal intercourse with an occasional partner (yes/no)	3.1	1.6-6.2	0.001
Unprotected sex with an occasional partner (yes/no)	4.9	1.9-12.8	0.001
Usually pay to have sex (yes/no)	0.8	0.3-2.5	0.827
Usually receive to have sex (yes/no)	3.1	0.3-28.9	0.307
Frequenting gay saunas (yes/no)	1.4	0.7-2.9	0.290
HIV positive partner (yes/no)	0.8	0.2-4.3	0.842
Drug Use			
Cocaine (yes/no)	1.3	0.4-4.3	0.632
Marijuana (yes/no)	1.6	0.7-4.3	0.237
Reactive VDRL	2.1	0.7-6.4	0.188

OR: Odds ratios; CI 95%: 95% confidence intervals; VDRL (Venereal Disease Research Laboratories test)

four-fold higher compared to whites. The proportion of negroes men in the study population was 0.20 and 0.07 among cases and controls, respectively. Similar results from the MACS cohort of homosexual/bisexual men were reported where race was an important marker for increased HIV seropositivity observed among black men. Relative risks of 3.4 and of 2.4 were found in the Baltimore/Washington and in the Chicago areas respectively, when they were compared to non-Hispanic white men (Kingsley et al. 1991). A cross-sectional study conducted to investigate the current status of the HIV epidemic among adolescent and young adult homosexuals in the US has shown that the factors more strongly associated with HIV infection in the multivariate-adjusted analysis were being black (OR = 6.3), mixed race (OR = 4.8) or Hispanic (OR = 2.3) when compared to non-Hispanic white men (Valleroy et al. 2000). Assessing the independent predictive value of racial groups with respect to HIV antibody status, after controlling for demographic characteristics, drug use and sexual behavior, another study showed that the relative odds for being black was 2.1 when compared to non-Hispanic white men (Klobin et al. 1990). However, in the above cited investigations, the definition of race and ethnicity are not in accordance with US Census Bureau (Grieco & Cassidy 2001): the question on Hispanic origin asked respondents if they were Spanish, Hispanic or Latino; it is also stated that Hispanics can be of any race.

There are various possible explanations for the observed association between race (belonging to the negroes racial group) and HIV infection. First, ethnicity and HIV infection association could be related to differences in sexual practices but comparing these practices between negro and white or mulatto participants revealed few differences in this study. On one hand, percentages of unprotected sex with an occasional partner were 31.6, 23.7 and 9.9% for negroes, mulattos and whites, respectively. On the other hand the proportion of those admitting insertive anal intercourse with steady partners showed that whites and mulattos reported this practice more frequently than negroes participants did. Despite these differences, after adjustment, belonging to the negro racial group was still independently associated to prevalent HIV infection in this population. A study conducted in the US to evaluate HIV risk differences between African-American and non-Hispanic white men found that African-American were less open about their sexual orientation, scored lower in HIV risk behavior knowledge and had more female sexual partners (Heckman et al. 1999).

It can also be hypothesized that negroes participants did not have immediate access to HIV diagnostic tests compared to the other racial groups; this difficulty in having access to HIV tests could be one of the explanations for the higher proportion of HIV positive negroes volunteers reaching the Project Horizonte. Unfortunately, the structured interview in our study did not have enough sensitivity to identify this and other possible sexual or social behavior among these groups.

A second possibility was a higher exposure to situations where HIV was more prevalent and it was found that the percentages of reactive VDRL test were 3.3, 6.1 and 16% for whites, mulattos and negroes (qui-square for

trends was significative,  $p$ -value < 0.003). This finding, even with the differences not being significant in the multivariate analysis, could be an indirect marker of higher risk for HIV infection.

A third hypothesis would be the possible differential occurrence of an immunological facilitator of infection, like the CCR5-Δ32 mutation, a 32-base-pair deletion in the coding region of CCR5 (Dean et al. 1996, Liu et al. 1996, Samson et al. 1996). Although this mutation is relatively common in Caucasian population and rare or absent in other racial and ethnic groups (black population from Western and Central African, African America and Japanese populations) (Zimmerman et al. 1997, Libert et al. 1998, Stephens et al. 1998), the presence of such a high proportion of black individuals infected because of its absence is highly unlikely.

In conclusion, the sexual practices found associated with HIV infection in this population are known as important determinants of infection. This case-control study was conducted in an open cohort where prevalent cases are arriving to be admitted since the establishment of the Project Horizonte in the year of 1994. It is probable that these risk factors did not have temporal changes during this period of time and can be considered as the most important risks for HIV infection in this population. The reason or reasons for the association of being negroes and the HIV infection when compared with white and mulattos still elude us and will be further studied as we have started a thorough evaluation of clinical, social, immunological and virological data of these individuals which are being followed at our outpatient clinic.

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#### REFERENCES

- Burcham JL, Tindall B, Marmor M, Cooper DA, Berry G, Penny R 1989. Incidence and risk factors for human immunodeficiency virus seroconversion in a cohort of Sydney homosexual men. *Med J Austl* 50: 634-639.
- Caceres CF, Van Griensven GPJ 1994. Male homosexual transmission of HIV-1. *AIDS* 8: 1051-1061.
- Carneiro M, Antunes CMF, Greco M, Oliveira E, Andrade J, Lignani Jr L, Greco DB 2000. Design, implementation, an evaluation at entry of a prospective cohort study of homosexual and bisexual HIV-1 negative men in Belo Horizonte, Brazil: Project Horizonte. *JAIDS* 25: 182-187.
- Catania JA, Osmond D, Stall RD, Pollack L, Paul JP, Blower S, Binson D, Canchola JA, Mills TC, Fisher L, Choi KH, Porco T, Turner C, Blair J, Henne J, Bye LL, Coates TJ 2001. The continuing HIV epidemic among men who have sex with men. *Am J Public Health* 91: 907-914.
- Chmiel JS, Detels R, Kaslow RA, Van Raden M, Kingsley LA, Brookmeyer R 1987. Factors associated with prevalent human immunodeficiency virus (HIV) infection in Multicenter AIDS Cohort Study. *Am J Epidemiol* 126: 568-577.
- Dean M, Carrington M, Winkler C, Huttley GA, Smith MW, Allikmets R, Goedert JJ, Buchbinder SP, Vittinghoff E, Gomperts E, Donfield S, Vlahov D, Kaslow R, Saah A, Rinaldo C, Detels R 1996. Genetic restriction of HIV-1



- infection and progression to AIDS by deletion allele of the CCR5 structural gene. *Science* 273: 1856-1862.
- Grieco E, Cassidy RC 2001. Overview of Race and Hispanic Origin: Census 2000 Brief. Department of Commerce, Economics and Statistics Administration, U.S Census Bureau, 11 pp. <http://www.census.gov>.
- Heckman TG, Kelly JA, Bogart LM, Kalichman SC, Rompa D 1999. HIV risk differences between African-American and white men who have sex with men. *J Natl Med Assoc* 91: 92-100.
- Hosmer DW, Lemeshow S 1989. *Applied Logistic Regression*, John Wiley & Sons, New York, 386 pp.
- Kingsley LA, Kaslow R, Rinaldo Jr CR, Detre K, Odaka N, VanRaden M, Detels R, Polk BF, Chmiel J, Kelsley SF, Ostrow D, Visscher B 1987. Risk factors for seroconversion to human immunodeficiency virus among male homosexuals. *The Lancet* 14: 345-348.
- Kingsley LA, Zhou SYJ, Bacellar H, Rinaldo Jr. CR, Chmiel J, Detels R, Saah A, VanRaden M, Ho M, Munoz A 1991. Temporal trends in human immunodeficiency virus type 1 seroconversion 1984-1989. *Am J Epidemiol* 134: 331-339.
- Klobin BA, McCusker J, Lewis BF, Sullivan JL 1990. Racial/ethnic differences in HIV-1 seroprevalence and risky behaviors among intravenous drug users in a multisite study. *Am J Epidemiol* 132: 837-846.
- Kuiken CL, Van Griensven GPJ, de Vroome EMM, Coutinho RA 1990. Risks factors and changes in sexual behavior in male homosexuals who seroconverted for human immunodeficiency virus antibodies. *Am J Epidemiol* 132: 523-530.
- Leigh BC, Stall R 1993. Substance use and risk sexually for exposure to HIV: issues in methodology, interpretation and prevention. *Am Psychol* 48: 1035-1045.
- Libert F, Cochaux P, Beckman G, Samson M, Aksenova M, Cao A, Czeizel A, Claustres M, de La Rua C, Ferrari M, Ferrec C, Glover G, Grinde B, Guran S, Kucinskas V, Lavinha J, Mercier B, Ogur G, Peltonen L, Rosatelli C, Schwartz M, Spitsyn V, Timar L, Beckman L, Vassart G 1998. The delta-CCR5 mutation protection against HIV-1 Caucasian populations has a single an recent origin in North-eastern Europe. *Hum Mol Genet* 7: 399-406.
- Liu R, Paxton WA, Choe S, Ceradini D, Martin SR, Horuk R, Macdonald ME, Stuhlmann H, Koup RA, Landau NR 1996. Homozygous defect in HIV-1 coreceptor accounts for resistance of some multiply-exposed individuals to HIV-1 infection. *Cell* 86: 367-377.
- Moss AR, Osmond D, Bacchetti P, Chermann JC, Barre-Sinoussi F, Carlson J 1987. Risk factors for AIDS and HIV seropositivity in homosexual men. *Am J Epidemiol* 125: 1035-1047.
- Ostrow DG, Beltran ED, Joseph JG, Difrancesco W, Wesch J, Chmiel JS 1993. Recreational drugs and sexual behavior in Chicago MACS/CCS cohort of homosexual active men. *J Subst Abuse* 5: 311-325.
- Ostrow GG, Difranceisco WJ, Chmiel JS, Wagstaff DA, Wesch J 1995. A case-control study of human immunodeficiency virus type 1 seroconversion and risk-related behaviors in the Chicago MACS/CCS cohort, 1984-1992. *Am J Epidemiol* 142: 875-883.
- Page-Shafer K, Veugelers PJ, Moss AR, Strathdee S, Kaldor JM, Van Griensven GJP 1997. Sexual risk behavior and risk factors for HIV-1 seroconversion in homosexual men participating in the Tricontinental Seroconverters Study, 1982-1994. *Am J Epidemiol* 146: 531-542.
- Samson M, Libert F, Doranz BJ, Rucker J, Liesnard C, Farber CM, Saragosti S, Lapoumeroulie C, Cogniaux J, Forceille C, Muyldermans G, Verhofstede C, Burtorboy G, Georgers M, Imai T, Rana S, Smyth RJ, Collman RG, Doms RW, Vassart G, Parmentier M 1996. Resistance to HIV-1 infection in Caucasian individuals bearing mutant alleles of the CCR-5 chemokine receptor gene. *Nature* 382: 668.
- Seage GR III, Mayer KH, Horsburg Jr. CR, Holmberg SD, Monn MW, Lamb GA 1992. The relation between nitrite inhalants, unprotected receptive anal intercourse, and risk of human immunodeficiency virus infection. *Am J Epidemiol* 135: 1-11.
- Stata Corporation 2001. Stata Statistical Software: Release 7.0. College Station, TX: Stata Corporation.
- Stephens JC, Reich DE, Goldstein DB, Shin HD, Smith MW, Carrington M, Winkler C, Huttley GA, Allikmets R, Schrim L, Gerrard B, Malasky M, Ramos MD, Morlot S, Tzetis L, Oddoux C, di Giovine FS, Nasioulas G, Chandler D, Aseev M, Hanson M, Kalaydjieva L, Glavac D, Gasparini P, Dean M 1998. Dating the origin of the CCR5-Delta 32 AIDS-resistance allele by the coalescence of haplotypes. *Am J Hum Genet* 62: 1507-1515.
- Valleroy LA, Mackellar DA, Karon JM, Rosen DH, McFarland W, Shehan DA, Stoyanoff SR, Lalota M, Celentano D, Koblin BA, Thiede HDVM, Katz MH, Torian LV, Janssen RS 2000. HIV prevalence and associated risks in young men who have sex with men. *JAMA* 284: 198-204.
- Van Griensven GPJ, Tielman RAP, Goudsmit J, Van Der Noordaa J, Wolf F, Vroome MME, Coutinho RA 1987. Risk factors and prevalence of HIV antibodies in homosexual men in the Netherlands. *Am J Epidemiol* 125: 1048-1057.
- Winkelstein Jr W, Lyman DM, Padian N, Grant R, Samuel M, Wiley JA, Anderson RE, Lang W, Riggs J, Levy JA 1987. Sexual practices and risk of infection by the human immunodeficiency virus: The San Francisco Men's Health Study. *JAMA* 257: 321-325.
- Zimmerman PA, Buckler-White A, Alkhatib G, Spalding T, Kubofcik J, Combadiere C, Weissman D, Cohen O, Rubbert A, Lam G, Vaccarezza M, Kennedy PE, Kumaraswami V, Giorgi JV, Detels R, Hunter J, Chopek M, Berger EA, Fauci AS, Nutman TB, Murphy PM 1997. Inherit resistance to HIV-1 conferred by inactivating mutation in CC chemokine receptor 5: studies in populations with contrasting clinical phenotypes, defined racial background, and quantified risk. *Mol Med* 3: 23-36.