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(Accepted 28 October 1993)

Incidence of HIV-1 infection in a rural region of Uganda

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Abstract

***Objective*—To determine the incidence of infection with HIV-1 and the risk factors associated with seroconversion in three geographical strata of a rural Ugandan district.**

***Design*—Serological, sociodemographic, and behavioural surveys of everyone aged 13 or more in 21 randomly selected communities at baseline and one year later.**

***Setting*—Rural population of Rakai district, southwestern Uganda, residing in main road trading centres, secondary trading villages, and agricultural villages.**

***Subjects*—In 1989, 1292 adults provided a blood sample and interview data; one year later, 778 survivors (77%) who had been seronegative at baseline provided follow up data.**

***Main outcome measures*—Incidence of HIV infection in relation to individual characteristics and risk factors, including place of residence.**

***Results*—Incidence of HIV infection in all adults was 2·1/100 person years of observation (SE 0·5 (95% confidence interval 1·1 to 3·1)); in people aged 15-39 the incidence was 3·2/100 person years. Incidence was highest in men and women aged 20-24 (9·2/100 person years (3·9) and 6·8/100 person years (2·9) respectively). Risk factors significantly associated with seroconversion were age 24 and under and two or more sexual partners. Between the surveys the proportion of all respondents reporting high risk behaviour (two or more partners) significantly increased from 8·9% to 12·3%.**

***Conclusions*—Despite preventive programmes and substantial knowledge about AIDS the incidence of HIV infection remains high in this rural population. Prevention aimed at vulnerable rural communities is urgently needed to contain the HIV epidemic.**

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BMJ 1994;308:171-3

Introduction

We previously reported a high seroprevalence of HIV-1 infection in Rakai district, southwestern Uganda, the prevalence among adults ranging from 38·5% in trading centres on roads servicing international traffic to 8·6% in agricultural villages off main and secondary roads.[1 2] The first national AIDS control programme in Africa was implemented in Uganda, and the Rakai project was initiated in 1989; the project included health rallies, community education through village health workers, access to serological screening and counselling, and distribution of condoms. HIV is transmitted almost exclusively through heterosexual exposure in Rakai,[2] and the degree of knowledge about the virus is high. In 1989, 94% of responding adults knew about AIDS (S D Musgrave *et al*, sixth international conference on AIDS, San Francisco, 1990), and 86% correctly identified sexual intercourse as a risk factor (M Musagara *et al*, sixth international conference on AIDS, San Francisco, 1990). We report the incidence of HIV-1 infection in 1990 in the district.

Subjects and methods

In 1989 we established the study cohort using two stage stratified cluster sampling.[1 2] The population consisted of all consenting people aged 13 and over residing in 21 randomly selected clusters, each of 40 contiguous households. Trading centres on main roads were oversampled to ensure adequate representation of villages with a high prevalence of HIV infection. The distribution of age and sex in the cohort population was typical for rural Africa, with the exception of males aged 15 to 34, who were underrepresented by roughly a quarter. The absent men resided primarily in trading centres and were away from home to work.

Baseline data on sociodemographic variables, knowledge of AIDS and risk behaviours, and health status, as well as a whole blood sample, were collected from all consenting subjects; 1292 adults aged 13 and over (85·6% of those present at the time of the survey) responded, and 1037 were negative for HIV infection.[1 2] Serum specimens were screened at the Uganda Virus Research Institute, a World Health Organisation HIV reference laboratory, with a commercial enzyme linked immunosorbent assay (ELISA) (Recombigen EIS, Cambridge Biosciences, Worcester, Massachusetts). All positive samples were confirmed by western blotting (Biorad, Hercules, California). In 1990 we resurveyed all respondents of the 1989 survey. The mean follow up time was 15 months.

STATISTICAL ANALYSIS

The incidence of HIV infection per 100 person years of observation was estimated from the number of seroconversions and the person months of follow up. Rate ratios of seroconversion and 95% confidence intervals were estimated to assess associations, and Mantel-Haenszel stratified χ^2 tests for trend were used to determine significance. Multivariate logistic regression by SAS[3] was used to estimate the odds ratios for seroconversion after adjustment for potential confounding.[4]

Results

Twenty one of the 1037 subjects (2·0%) who were seronegative at baseline had died by the time of follow up. We obtained follow up data and samples for 778 of the 1016 survivors (76·6%). There were 234 subjects without full follow up data. Of these, 73 completed the follow up questionnaire but declined to provide a blood sample, eight refused both to be interviewed and

to provide a specimen, and 153 had migrated or were temporarily absent because of work. Loss to follow up was highest among males aged 13-39 in the trading centres (65% follow up). Samples from four rural residents aged over 50 were indeterminate on follow up on western blotting and are excluded from the analysis.

Of the 774 remaining subjects who were seronegative at baseline, 21 (2·7%) became seropositive between surveys. Adjusted for period of observation, the incidence of HIV-1 infection was 2·1/100 person years (95% confidence interval 1·1 to 3·1). We estimate the weighted seroincidence for Rakai district, adjusted for our oversampling of the trading centres, to be 1·9% (SE 1·2, design effect=2·4). Seroconversion occurred at younger ages in women than in men, but the peak incidence was in people aged 20-24 (table I). The oldest person to seroconvert was a man aged 55. Other associations between respondent characteristics and incidence did not differ systematically by sex, and overall seroconversion rates in males and females were not significantly different.

Table II shows seroconversion rates by sociodemographic and behavioural characteristics for all subjects aged 15-39, the group encompassing 90% of seroconversions in people of known age. Except when indicated, all further results refer to this age group. The most important risk factor was the number of sexual partners reported in the year before reinterview (table II). Seroconversion among the 71 respondents reporting no partners in the interval was 1·1/100 person years; among the 310 people reporting one partner, 2·8/100 person years; among the 33 people with two partners, 7·3/100 person years; and among the 23 people with three or more reported partners, 9·7/100 person years (χ^2 for trend=7·6, $P<0·01$). Among all respondents, 765 provided data on partners at baseline and reinterview. The prevalence of reported high risk behaviour (two or more partners in the past year) increased from 8·9% at baseline to 12·3% at reinterview ($\chi^2=4·3$, $P<0·05$).

TABLE I—*Incidence of HIV infection per 100 person years by age and sex in all respondents*

Age group (years)	Proportion of subjects who seroconverted	Person years	Incidence/100 person years (SE)
		Males	
13-14	0/25	45·0	0
15-19	0/61	69·8	0
20-24	5/42	54·4	9·2 (3·9)
25-29	1/31	40·5	2·5 (2·4)
30-39	1/50	70·7	1·4 (1·3)
≥40	2/131	159·1	1·3 (0·9)
All ages*	9/366	460·0	2·0 (0·7)
		Females	
13-14	0/31	40·3	0
15-19	4/60	80·8	5·0 (2·4)
20-24	5/56	73·3	6·8 (2·9)
25-29	0/60	74·5	0
30-39	2/72	88·2	2·3 (1·6)
≥40	0/105	130·5	0
All ages*	12/408	518·1	2·3 (0·7)

*Including age unknown.

TABLE II—*Rates of HIV-1 seroconversion by selected sociodemographic and behavioural factors in respondents aged 15-39*

Variable	No of people who seroconverted/No followed up	No of person years	Seroconversion rate/100 person years	Rate ratio (95% confidence interval)
Total	18/442	562·4	3·2	
Place or residence:				
Trading centre	5/77	115·5	4·3	1·6 (0·5 to 4·9)
Trading village	5/112	150·2	3·3	1·2 (0·4 to 3·8)
Rural village	8/253	296·7	2·7	1
Marital status:				
Non-marital relationship	3/49	63·4	4·7	1·7 (0·5 to 6·0)
Widowed, divorced, separated, no relationship	4/84	112·5	3·6	1·3 (0·4 to 4·0)
Married (monogamous or polygamous)	11/305	383·9	2·9	1
Education:				
Primary or secondary	15/311	406·0	3·7	1·9 (0·6 to 6·6)
No schooling	3/130	155·4	1·9	1
Occupation:				
Student and other	4/54	74·9	5·3	2·3 (0·7 to 7·6)
Bar/hotel/driver/vendor	6/104	144·0	4·2	1·8 (0·6 to 5·1)
Agriculture	8/282	342·6	2·3	1
Travel in past year:				
Yes	11/236	307·0	3·6	1·3 (0·5 to 3·2)
No	7/205	245·5	2·8	1
Injections in past year:				
Yes	14/334	420·2	3·3	1·1 (0·4 to 3·4)
No	4/103	134·7	3·0	1
No sexual partners in past year:				
≥2	6/56	71·9	8·3	3·4 (1·3 to 9·0)
0-1	12/381	484·0	2·5	1
History of sexually transmitted diseases in past year:				
Yes	5/61	75·6	6·6	2·4 (0·9 to 6·9)
No	13/376	480·4	2·7	1
Attendance at an AIDS educational rally in past year:				
Yes	14/314	399·8	3·5	1·7 (0·5 to 5·9)
No	3/114	145·2	2·1	1

*Excluding people with incomplete data. Five or fewer cases missing for any variable, with the exception of attendance at an AIDS rally (14 missing); in this group one person seroconverted (seroincidence 5·7/100 person years). No other people with missing data seroconverted.

Bivariate analyses suggested a higher incidence associated with non-marital status, higher education, non-agricultural occupation, and a history of sexually transmitted disease in the previous year, but these associations were not significant (table II). Twenty one discordant marital couples were followed up in both survey rounds; the incidence of HIV-1 infection in the partners who had been seronegative was 7·3/100 person years (SE 4·9). Injections were not associated with seroconversion, and there were no transfusions reported between the two surveys. The associations between seroconversion and reported sexual intercourse for gifts or pay, use of oral contraceptives, use of condoms, and male circumcision were not significant, but analysis was constrained by small numbers (results not shown). Attendance at an AIDS prevention education rally did not beneficially affect seroconversion.

We previously found that place of residence was strongly associated with prevalence of HIV infection.[1,3] The geographical variation in seroincidence was less obvious among persons aged 15-39 (table II) and was not significant (χ^2 for trend=1·7, $P>0·15$).

We used logistic regression to determine which sociodemographic and behavioural factors were predictive of acquiring infection after adjusting for potential confounding factors, including follow up period. Only age and number of partners remained independently associated with seroconversion after adjustment, and in the most simple model (age, sex, and number of partners) the adjusted odds ratios of seroconversion were significantly increased for younger subjects aged 15-24 compared with those aged 25-39 (odds ratio 3·9 (1·2 to 12·2)) and for those reporting two or more sexual partners (odds ratio 6·5 (1·8 to 23·7)).

Discussion

The incidence of HIV infection in the Rakai cohort is high, despite substantial knowledge about AIDS and access to condoms. The overall incidence, 2·1/100 person years in all adults, represents a conservative estimate, given that loss to follow up was greatest in young, mobile males living in trading centres, who would be expected to contribute disproportionately to the seroincidence. The sex and age distribution of seropositive cases, the significant differentials by reported number of sexual partners, the lack of an association between seroconversion and injections, and the absence of transfusions strongly suggest that heterosexual transmission remains the primary mode of transmission of HIV in adults. The risk factors associated with seroconversion, particularly age and number of sexual partners, are compatible with those related to seroprevalence in the Rakai population[2] and elsewhere in Africa.[5,6] Although there may be underreporting of sexual activity, as noted by other researchers in Africa,[7] the data suggest that in this

Public health implications

- An AIDS control programme was established in Uganda in 1989 in response to high rates of HIV infection
- In 1990 most subjects in Rakai district had attended an AIDS rally in the past year and were aware of the risk factors for HIV infection
- The proportion of subjects having two or more sexual partners in the past year increased from 8·9% in 1989 to 12·3% in 1990
- The incidence of HIV infection was 2·1/100 person years
- The control programme has so far not reduced transmission of HIV in Rakai. More priority should be given to educating people in rural areas

population with a high prevalence of HIV infection even moderate sexual activity (one partner reported in the previous year) is associated with substantial risk of seroconversion (2·8/100 person years).

Knowledge of AIDS is almost universal, and most subjects had attended an AIDS education rally during the period of observation. It is therefore disturbing that the proportion of all adults admitting to multiple sexual partners in the previous year increased significantly from 8·9% to 12·3% between 1989 and 1990. Although the increase may reflect greater candour at reinterview, the data do not suggest any reduction in high risk behaviour. Since 1987 Uganda has mounted one of the most extensive AIDS education programmes in Africa, and the Rakai project implemented community interventions in 1989. Although incidence may have been even higher without the educational interventions, existing programmes have not curbed transmission. These findings reflect the difficulties of implementing effective interventions in communities and underline the urgent need for better strategies. Furthermore, the high HIV incidence found in remote rural villages and in people with even moderate reported levels of sexual activity indicate that identification of high risk populations or groups may become increasingly difficult. Because over 70% of the African population lives in rural areas[8] greater priority should be given to these vulnerable communities.

The study was supported by the National Institute of Allergy and Infectious Diseases, National Institutes of Health (RO1-AI29314); The Rockefeller Foundation; and the Research Division, Office of Population, United States Agency for International Development (Cooperative Agreement DPE-3030-A-00-4049). The authors thank Dr S Okware of the Ugandan Ministry of Health; and Drs S Sempala, B Biryawaho and R Downing of the Uganda Virus Research Institute.

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(Accepted 23 August 1993)

Effectiveness of bicycle helmets in preventing head injury in children: case-control study

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BMJ 1994;308:173-6

Abstract

***Objective*—To examine the risk of injury to the head and the effect of wearing helmets in bicycle accidents among children.**

***Design*—Case-control study by questionnaire completed by the children and their carers.**

***Setting*—Two large children's hospitals in Brisbane, Australia.**

***Subjects*—445 children presenting with bicycle related injuries during 15 April 1991 to 30 June 1992. The cases comprised 102 children who had sustained injury to the upper head including the skull, forehead and scalp or loss of consciousness. The controls were 278 cyclists presenting with injuries other than to the head or face. A further 65 children with injuries to the face were considered as an extra comparison group.**

***Main outcome measures*—Cause and type of injury, wearing of helmet.**

***Results*—Most children (230) were injured after losing control and falling from their bicycle. Only 31 had contact with another moving vehicle. Children with head injury were significantly more likely to have made contact with a moving vehicle than control children (19 (19%) *v* 12 (4%), $P<0.001$). Head injuries were more likely to occur on paved surfaces than on grass, gravel, or dirt. Wearing a helmet reduced the risk of head injury by 63% (95% confidence interval 34% to 80%) and of loss of consciousness by 86% (62% to 95%).**

***Conclusions*—The risk of head injury in bicycle accidents is reduced among children wearing a helmet. Current helmet design maximises protection in the type of accident most commonly occurring in this study. Legislation enforcing helmet use among children should be considered.**

Introduction

Childhood bicycle injuries are one of the main reasons for presentation to paediatric emergency departments in Brisbane, Australia. Admission to hospital and death from bicycle related trauma are usually due to head injury.[1] Several studies of bicycle safety helmets report an associated reduction of head injuries,[2,3] and in the only case-control study the risk of head injury was significantly reduced if a helmet was worn.[3] Wearing helmets became mandatory in Queensland, Australia, in July 1991. We examined the risk of upper head injury or loss of consciousness associated with helmet wearing among children.

Subjects and methods

The study was conducted between 15 April 1991 and 30 June 1992 at the Royal Children's and Mater Misericordiae Children's Hospital, the two main children's hospitals in Brisbane. Children attending the emergency departments were ascertained by specific flagging by triage staff. We also carried out