The relationship between male circumcision and HIV infection in African populations

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The relationship between HIV seroprevalence and the proportion of uncircumcised males in African countries is examined to determine whether circumcision practices play a role in explaining the large existing variation in the sizes of African HIV epidemics. A review of the anthropological literature yielded estimates of circumcision practices for 409 African ethnic groups from which corresponding national estimates were derived. HIV seroprevalence rates in the capital cities were used as indicators of the relative level of HIV infection of countries. The correlation between these two variables in 37 African countries was high ($R = 0.9$; $P < 0.001$). This finding is consistent with existing clinic-based studies that indicate a lower risk of HIV infection among circumcised males.

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Introduction

Striking variations in the size of the AIDS epidemic exist among and within different countries in Africa [1,2]. In a few urban areas of central Africa, HIV seroprevalence in the general adult population has reached 20% [3], while in many rural areas, infection levels are very low or not measurable. Among female prostitutes, the group at highest risk of infection, seroprevalence ranges from over 80% in Nairobi [4] to less than 1% in Nigeria [5]. The causes of these large geographic differences have not yet been identified. Contributing factors may include variations in sexual behavior, timing of onset of the epidemic, and prevalence of other sexually transmitted diseases, particularly those that cause genital ulcers [6]. We document here a strong statistical correlation between national estimates of male circumcision status and HIV seroprevalence in the capitals of 37 African countries. This continent-wide result is consistent with that of a case-control study in a Nairobi clinic which found that uncircumcised men were significantly more likely to be infected with HIV than circumcised controls [7]. The absence of male circumcision may therefore be a crucial factor in the spread of HIV in Africa.

Methods

The ethnographic literature on circumcision practices amply documents that in some African ethnic groups, indigenous cultural tradition requires men to be circumcised while in others it does not. Adherence to a world religion is also important: those who profess to follow Islam practise circumcision, but it is not required for Christians. Whichever practice is appropriate, conformity is expected and individual compliance is part of a man's identity as a member of his ethnic and/or religious group. Ethnic group traditions are believed to be culturally durable (except for previously uncircumcised men who convert to Islam), so that available data on past circumcision practices are likely to provide good estimates for the present.

For our analysis, circumcision data were taken from two principal sources. The first is Murdock's *Ethnographic Atlas*, which contains information on circumcision practices for a sample of 282 groups in Africa [8]. These data are coded for the presence or absence of the practice, and, if practiced the time of the operation. Most groups circumcise between ages 6 and 15. The second source is an east African study by Dodge and Kaviti which increased the ethnic group coverage for Kenya from 13 to 36, for Uganda from 11 to 32, and for Tanzania from 23 to 90 [9]. With additional information from related sources [10,11] (G. Murdock, Microfile data), circumcision data are known for 409 ethnic groups in Africa.

Figure 1 presents the geographic distribution of circumcision practices on Murdock's ethnographic map for the continent of Africa [10]. Although the age at circumcision is also known, this information is not used in Fig. 1 and ethnic groups for which data are available are simply identified as either circumcised or uncircumcised. Data are missing for certain ethnic groups (white areas in Fig. 1) because the information in Murdock's *Ethnographic Atlas* consists of a sample of groups and because circumcision data were lacking for 17 of the groups included in the Atlas.

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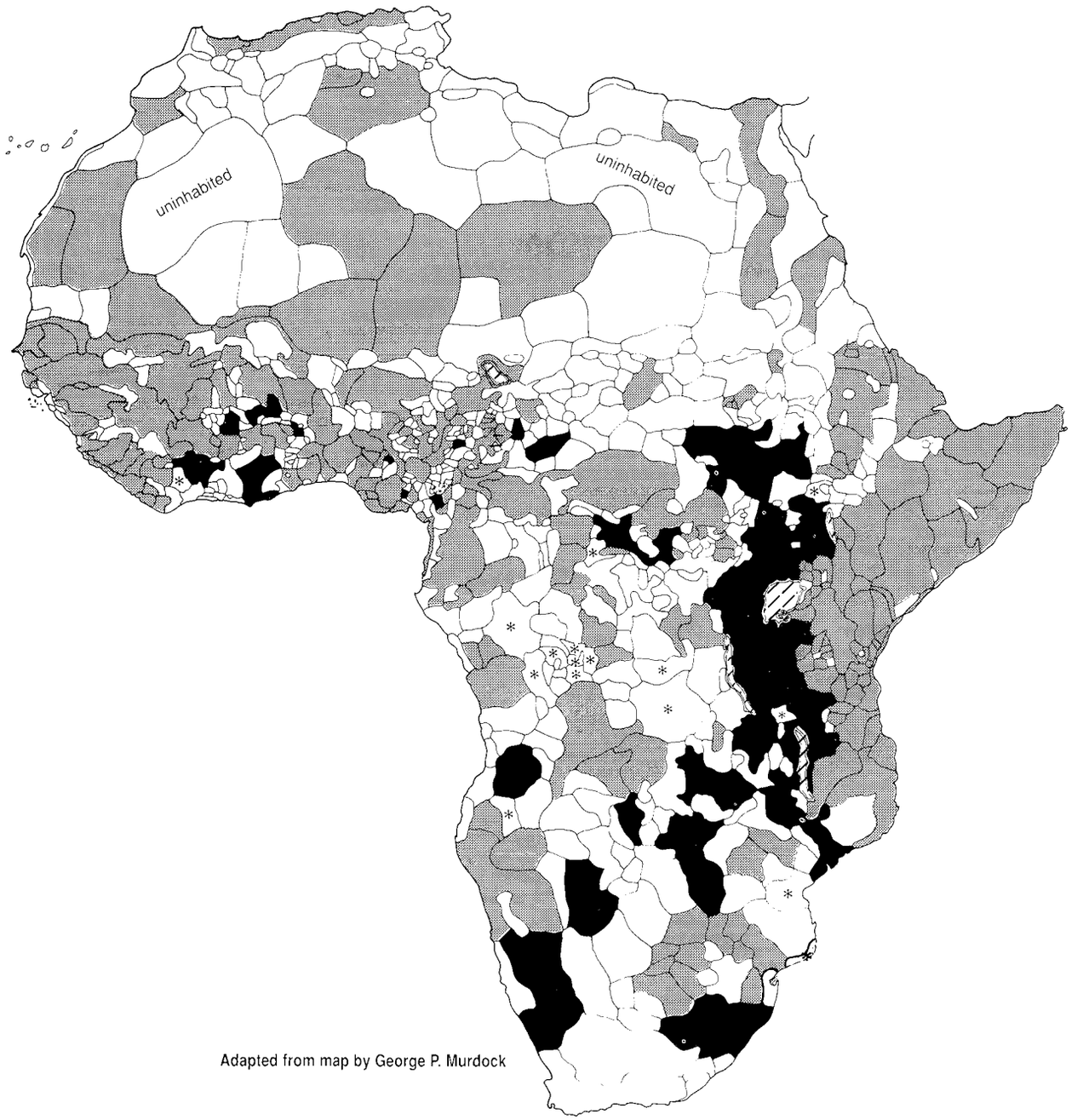

Fig. 1. Distribution of circumcision practice in Africa, by ethnic group. ▨ circumcised, ■ uncircumcised, * no data in a group included in Murdock's World Sample, □ not in sample, ▨ lakes.

Wide regional variation in circumcision practices are evident in Fig. 1. The absence of this practice is particularly notable in central east Africa and in parts of southern Africa. Most groups in west Africa are circumcised and even though information is incomplete for north Africa, most males in this Moslem region are also circumcised.

In order to compare circumcision data with HIV seroprevalence estimates, country-level estimates of the percentage of men who are circumcised were made. Country boundaries were projected onto the ethnographic map and the ethnic groups in each country identified. Within each country the size and location of the different ethnic groups was determined from census data and maps [12–18]. National estimates of the percentage of men circumcised were then calculated as the weighted average of the ethnic group specific circumcision data. (Groups which lacked information on circumcision practices were excluded. South Africa was not included in our coverage.) Column 1 of Table 1 presents the results of this exercise for each of 37 countries.

HIV seroprevalence estimates were drawn from a database on HIV/AIDS statistics developed and maintained

Table 1. Estimated HIV seroprevalence in capital city and percentage of males who are circumcised for 37 African countries.

Country	Percentage of males who are circumcised	HIV seroprevalence (% of adults)
Northern Africa		
Egypt	100.0	0.0
Morocco	100.0	0.3
Sudan (N)	100.0	0.3
Tunisia	100.0	0.0
Western Africa		
Benin	87.0	0.0
Burkina Faso	96.0	1.7
Chad	70.0	0.0
Ivory Coast	43.0	8.1
Gambia	100.0	0.0
Ghana	37.0	4.7
Guinea	100.0	0.5
Guinea Bissau	50.0	8.5
Liberia	100.0	0.0
Mali	100.0	1.6
Mauritania	100.0	0.0
Nigeria	99.0	0.0
Senegal	99.0	0.3
Eastern Africa		
Burundi	0.0	15.0
Djibouti	100.0	0.0
Ethiopia	95.0	0.0
Kenya	85.0	2.6
Malawi	4.6	9.5
Mozambique	93.0	3.4
Rwanda	0.0	20.1
Somalia	100.0	0.0
Tanzania	49.0	3.6
Uganda	9.0	20.0
Zambia	2.5	17.2
Zimbabwe	89.0	3.2
Central Africa		
Angola	75.5	2.3
Cameroon	65.0	0.5
Central African Rep.	100.0	3.5
Congo	95.0	3.9
Equatorial Guinea	100.0	0.3
Gabon	95.0	1.8
Zaire	75.0	4.5
Southern Africa		
Botswana	95.0	0.3

Source: See text.

at the Center for International Research at the US Bureau of the Census. The principal sources of information on seroprevalence for population subgroups in Africa are journal articles and papers or posters presented at international conferences such as the IV International Conference on AIDS in Stockholm, Sweden (June 1988) and at the III International Conference on AIDS and Associated Cancers held in Arusha, Tanzania in September, 1988 [19,20]. Many existing seroprevalence studies are of limited value for our purpose, because they are based on relatively small, nonrandom samples. Often, study populations either may have a known high-risk behavior (for example, prostitutes and their clients) or may deviate from a representative sample of the population in unknown ways (for example, hospital patients). In addition, the geographic coverage of these studies is usually limited to a major city or perhaps a single rural district. Consequently, nationally representative estimates of HIV seroprevalence are virtually nonexistent.

Available estimates indicate that the HIV epidemic in the majority of African countries has not yet spread significantly in rural areas. Thus, the World Health Organization (WHO) typically estimates rural seroprevalence levels at 10% of the level recorded in the capital city (personal communication: Dr James Chin, WHO, 1988). Since so little rural information is available, we have chosen the HIV seroprevalence level of the capital city as our indicator of HIV infection.

Our estimates of HIV seroprevalence in capital cities of different African countries are given in Table 1. Estimates for representative samples of adult males are used when available, because this study focuses on the potential role of male circumcision as a cofactor in the HIV epidemic. However, data on males are not always available even for the capital cities. Estimates for other groups representative of the general adult population (for example, pregnant women, blood donors) were accepted in a number of countries. The use of data on women in these instances is thought to have little influence on our results. Evidence to date suggests that the spread of HIV in Africa is not particularly sex specific. Approximately equal levels of seroprevalence have been found among representative samples of adult males and females in several settings [2,21,22].

Discussion

The estimates of HIV seroprevalence in capital cities and the proportion of circumcised males summarized in Table 1 are plotted in Fig. 2. The two variables are highly correlated ($R = 0.90$; $P < 0.001$). The average HIV prevalence is 16.4% in the five countries where more than three quarters of males are estimated to be uncircumcised, and in none of the capitals of these five countries is seroprevalence less than 9.5%. In contrast, among the twenty countries where more than 90% of males are circumcised, the average seroprevalence is 0.9% and in no case did seroprevalence exceed 4%. A regression line fitted to the data in Fig. 2 yields the following equation for the expected HIV prevalence rate, H, as a function of the level of male circumcision, C, (both variables expressed in percentages):

$$H = 15.1 - 0.151C$$

This simple correlation and regression analysis is flawed because the units of analysis are not the same for the dependent and independent variables: the former is based on estimates for capital cities; the latter on national averages. This procedure would be acceptable if national circumcision data provide accurate estimates for the capitals in each country but that is unlikely to be the case in every country. However, the resulting errors produce an underestimate of the true level of correlation between the proportion of males who are circumcised and the level of HIV infection, because deviations from the regression line in a number

of countries are due to discrepancies between urban and national circumcision practices.

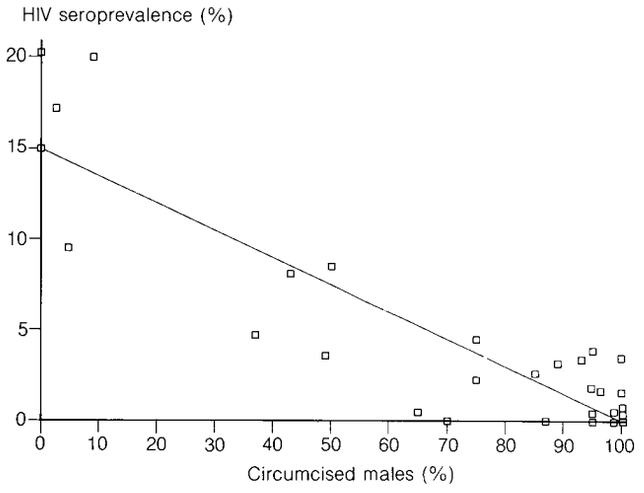

Fig. 2. Estimated HIV seroprevalence in capital city and percentage of males who are circumcised for 37 African countries.

A closer examination of subnational data from Tanzania and Kenya indicates that the lack of circumcision is concentrated in parts of the country distant from the capitals — Nairobi in the south central part of Kenya and Dar es Salaam on the Tanzanian coast. Our national estimates of the percentage circumcised in these countries may therefore not be representative for the capital city.

Kenya and Tanzania both have striking differences in geographic distribution of circumcision practice. Around Kisumu in the west and in the northwest of Kenya and in the western half of Tanzania, the practice is absent and HIV seroprevalence rates for these areas are the highest in each country [7,9,23]. For example, results from a sample survey in Bukoba town in the Kagera region of northwestern Tanzania (900 miles from Dar es Salaam) indicate an HIV seroprevalence rate of 32.8% and in two rural areas outside of Bukoba the rates are 9.7 and 4.6%, respectively [23]. In this part of Tanzania, circumcision is absent except for men who profess Islam. In the only sample from a rural area in eastern Tanzania, where circumcision is practiced, no HIV was found [24]. Similarly, in Kenya, in two rural areas where circumcision is practiced, the rates among males are 0% close to Nairobi [25], and 0.4% in the Rift Valley of Kenya [27]. However, there is an exception to this relationship between the lack of circumcision and HIV infection. In a few major towns in central and eastern Tanzania, where circumcision is practiced by the dominant ethnic groups, a significant degree of infection with HIV has been found [24].

It should be emphasized that the strong population level correlation we find between male circumcision and HIV seroprevalence does not prove a cause and effect relationship. However, our results are consistent with the findings from a previous case-control study in Nairobi [7] and suggest that male circumcision is a cofactor in HIV infection. Uncircumcised African males are apparently at increased risk of developing chancroid and other genital-ulcer disease [26,27]. These diseases in turn facilitate infection with HIV, but lack of circumcision apparently also has an effect that is independent of genital ulcer disease [7]. Perhaps enhanced viral survival under the foreskin and the more frequent occurrence of balanitis are responsible for increased susceptibility to HIV among uncircumcised males [6,28]. Further study of the role of these factors should be given high priority.

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