Patterns and risk factors for HIV infection in children in eastern Zimbabwe

Erica Pufall, Jeffrey Eaton, Albert Takaruza, Laura Robertson, Constance Nyamukapa, Simon Gregson

Background

HIV affects children in sub-Saharan Africa (SSA) disproportionately to the rest of the world. In 2009 there were 2.3 million children (aged 0-14 years) living with HIV in SSA, roughly 92% of the global total. With such high numbers of HIV-positive children, it is critical to understand the sources and impacts of HIV on children. However, currently, there are few data on the prevalence of HIV and associated disease patterns in children under the age of 15 in SSA. Most infected children are believed to have acquired HIV perinatally from their HIV-positive mothers and global and national HIV estimates in children generally are extrapolated from data on pregnant women using mathematical models. Whilst some studies have found evidence of horizontal HIV transmission in children (1-3), these studies often used non-representative samples or were conducted in highly localised areas.

To add to the limited body of knowledge on the epidemiology of HIV in children in SSA, we use data from a population-based study in eastern Zimbabwe to describe the demographic characteristics associated with HIV infection, the source(s) of childhood HIV infection, and the effect of HIV status on child welfare outcomes.

Methods

We analysed data from the Manicaland HIV/STD Prevention Project. Five survey rounds have been completed since 1998. In the fifth round (2009-2011), a random sample of 3,399 children aged 2-14 years was interviewed on their welfare, health and healthcare, with children under 7 years old answering with assistance from their primary caregiver. Questions of a more sensitive nature were asked only to older children and were answered without their primary caregiver present. Dried blood spot samples were collected and tested for HIV in an offsite laboratory.

We tested for associations between demographic characteristics and HIV infection using logistic regression, adjusting for age-group. To determine if HIV prevalence in children was greater than what would be expected from MTCT alone, we compared the age-specific HIV prevalence data
to the survival model proposed by Ferrand et al. (4), modified in R version 2.14.0 (http://www.r-project.org) to include the scale-up of PMTCT in Zimbabwe begun in the mid-2000s. Where available, maternal status (deceased, HIV-negative, HIV-positive, alive with unknown HIV status) is reported by child HIV status. The relative risks of being a maternal orphan and of being a maternal orphan or having an HIV-positive mother amongst infected and uninfected children were evaluated using a one-sided Fisher’s exact test. For children with HIV-negative mothers, we tested the association between hypothesised horizontal risk factors and the child’s HIV status using logistic regression, adjusting for sex, age-group and site type. The impact of HIV on various measures of child welfare was evaluated using linear (continuous outcomes) or logistic (binary outcomes) regression, adjusting for age-group. Z-scores for height- and weight-for-age were calculated using WHO child growth standards, which provide data for children from birth to 19 yrs (5,6). Z-scores below -2 were considered to indicate stunting and wasting, respectively (5,6).

**Results**

Overall, 73/3395 children were HIV positive (2.15%, 95% CI: 1.66-2.64%). We found no significant (p<0.05) associations between demographic characteristics (sex, age group, household socio-economic status, community type, and religion) and HIV prevalence.

When assessing the likelihood that MTCT was the primary source of HIV infection in children we found that HIV prevalence values for all ages were not significantly higher than those predicted by the model (Figure 1). HIV-positive children were significantly more likely to have an HIV-positive mother and/or be a maternal orphan (Table 1). Despite these findings, there were nine children who were HIV-positive but had HIV-negative mothers. Upon testing these children for selected risk factors proposed in the literature, we found no associations with blood transfusions, lifetime number of injections, Caesarean vs. natural birth, single vs. multiple birth, breastfeeding by a non-biological mother, caring for a sick relative, or child abuse.

While being HIV-positive did not have a significant impact on physical or psychological ill-health or on school drop-out, HIV-positive children were more likely to be wasted or stunted (Table 2).

**Discussion**

Although no demographic factors were associated with HIV prevalence, the reported HIV prevalence is similar to reports from other studies from SSA. A large population survey in South Africa found that national HIV prevalence in children 2-14 decreased from 5.6% in 2002 to 2.5% in 2008 (7). In Zimbabwe, a behaviour survey conducted in a purposive sample of children in Chimanimani district in Manicaland province found HIV prevalence rates of 3.3% (95% CI: 2.1-5.0%), 3.0% (95% CI: 1.8-4.7%) and 5.3% (95% CI: 3.1-8.5%) in children aged 2-11 years, 12-14 years, and 15-18 years, respectively (8). As in the current study, no significant differences in HIV prevalence were found with respect to sex or age (8).
The mathematical model projection undertaken in the study indicated that a relatively even pattern of HIV prevalence by age over the age-range 2-14 years is expected now given recent trends in the HIV epidemic in Zimbabwe. Survival data for children infected with HIV through MTCT suggest high mortality – with fast and slow progressors having median survival times of 0.64 years and 16.0 years, respectively (4) – and, in a stable epidemic with little horizontal transmission and no PMTCT intervention, HIV prevalence will decline steadily with age. However, the decline in HIV prevalence in pregnant women since the late 1990s and the scale-up of PMTCT services from the mid-2000s would be expected to have reduced prevalence rates in younger children.

Our findings suggest that MTCT is the primary mode of HIV transmission in eastern Zimbabwe: observed HIV prevalence was not higher than model predictions that assumed MTCT was the only source of HIV, and mothers of HIV-infected children were significantly more likely than mothers of uninfected children to be deceased or HIV-positive. Our finding that nine children did not acquire HIV from their mothers is consistent with a growing body of evidence that some children do acquire HIV horizontally (9). We found no evidence that these infections had occurred through use of contaminated blood products or medical injections or through factors such as breastfeeding by a non-biological mother, caring for a sick relative, or child abuse. Exposure to some of these potential modes of transmission may have been under-reported in the study and data were not collected on some other possible sources of infection such as scarification and hospital and dental visits (1-3).

We found no association between HIV status and reporting of illness. This may be because most infected children aged 2-14 years are slow progressors, infected after birth through breastfeeding, who reach late-stage infection and develop AIDS-related illness mainly when they reach adolescence (10). Stunting and wasting in HIV-positive children has been reported previously in SSA (10-12) and our results add to the evidence that HIV has a significant negative impact on a child’s physical development.

These findings provide evidence that MTCT is the principal source of HIV infection in children and that current initiatives to increase the availability of more efficacious PMTCT regimens should result in reductions in HIV prevalence in children over time. However, horizontal infection during childhood also appears to be occurring and further research is needed to identify the leading causes. Every effort should be made to provide adequate nutritional support to perinatally infected children as they are more likely to suffer from wasting and stunting than their HIV-negative counterparts.
**Figure 1.** Comparison of model-based predictions of child HIV prevalence based on MTCT alone to observed HIV prevalence in the Manicaland HIV/STD Prevention Project.

![Graph showing comparison of model-based predictions and observed HIV prevalence by age.](image)

**Table 1.** Maternal mortality and HIV status in children

<table>
<thead>
<tr>
<th>Mother status</th>
<th>HIV+ (N = 73)</th>
<th>HIV- (N = 3326)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother deceased</td>
<td>28 (38.36%)</td>
<td>322 (9.68%)</td>
</tr>
<tr>
<td>Mother alive HIV+</td>
<td>15 (20.55%)</td>
<td>287 (8.63%)</td>
</tr>
<tr>
<td>Mother alive HIV-</td>
<td>9 (12.34%)</td>
<td>1474 (44.32%)</td>
</tr>
<tr>
<td>Mother alive unknown</td>
<td>21 (28.77%)</td>
<td>1243 (37.37%)</td>
</tr>
</tbody>
</table>

RR of mother being deceased: 6.55 ($p<0.001$)

RR of mother being deceased or HIV+: 6.80 ($p<0.001$)

† excludes children with surviving mothers of unknown HIV status

**Table 2.** Associations between HIV status and child welfare measures

<table>
<thead>
<tr>
<th></th>
<th>% HIV+ (n/N)</th>
<th>% HIV- (n/N)</th>
<th>AOR (95% CI)†</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enrolled in school†</td>
<td>96.15% (50/53)</td>
<td>96.45% (2312/2397)</td>
<td>0.99 (0.24-4.17)</td>
<td>0.99</td>
</tr>
<tr>
<td>Ill in last week</td>
<td>13.70% (10/73)</td>
<td>10.26% (341/3324)</td>
<td>1.38 (0.70-2.72)</td>
<td>0.35</td>
</tr>
<tr>
<td>Low height-for-age</td>
<td>42.03% (29/67)</td>
<td>30.63% (988/3226)</td>
<td>1.73 (1.06-2.84)</td>
<td>0.03</td>
</tr>
<tr>
<td>Low weight-for-agea</td>
<td>21.57% (11/51)</td>
<td>9.93% (221/2226)</td>
<td>2.61 (1.32-5.18)</td>
<td>0.006</td>
</tr>
<tr>
<td>Low BMI-for-age</td>
<td>7.25% (5/69)</td>
<td>7.45% (236/3168)</td>
<td>0.98 (0.39-2.48)</td>
<td>0.97</td>
</tr>
<tr>
<td>Low weight-for-heightb</td>
<td>5.56% (1/18)</td>
<td>11.75% (98/834)</td>
<td>0.46 (0.06-3.52)</td>
<td>0.46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Psychological wellbeing score</th>
<th>Mean score HIV+</th>
<th>Mean score HIV-</th>
<th>Change in score between HIV- and HIV+ (95% CI)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.051</td>
<td>0.009</td>
<td>-0.09 (-0.24-0.07)</td>
<td>0.27</td>
</tr>
</tbody>
</table>

† Adjusted for age group  
Children over the age of 5 only  
‡ Children 2-10 only  
§ Children 2-5 only
References


