## Home-based treatment of children with HIV infection or tuberculous meningitis in South Africa

van Elsland, S.L.

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# Disclosure of HIV status to children in South Africa: a comprehensive analysis

Sabine L. van Elsland
Remco P.H. Peters
Nelis Grobbelaar
Patiswa Ketelo
Maarten O. Kok
Mark F. Cotton
A. Marceline van Furth

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## SUMMARY

**Introduction:** The extent of disclosure of HIV status to children and adolescents and context facilitating their disclosure process has received little attention.

**Methods:** Cross-sectional study to assess disclosure and provide a comprehensive analysis of factors associated with disclosure to children (3-14 years) receiving antiretroviral treatment in a South African semi-urban clinic. Structured interview administered questionnaires were supplemented with medical record data. Predictors included child-, caregiver-, clinical- and socio-economic characteristics, viral suppression, immune response, adherence, health-related quality of life and family functioning.

**Results:** We included 190 children of whom 45 (23.7%) was disclosed to (28 were partial disclosed to 14.7%; 17 were fully disclosed to 8.9%). Older age of the child and higher education of the caregiver were strongly associated with disclosure. Sex of caregivers, suppressed viral load, syrup formulation, PI regimens with stavidune and didanosine, and self-reported non-adherence were strongly associated with non-disclosure.

**Conclusion:** When children do well on treatment, caregivers feel less need to disclose. Well-functioning families, higher educated caregivers and better socio-economic status enabled and promoted disclosure. Non-disclosure can indicate a sub-optimal social structure which could negatively affect adherence and viral suppression. There is an urgent need to address disclosure thoughtfully and proactively in long-term disease management. For the disclosure process to be beneficial, an enabling supportive context is important and provide a great opportunity for future interventions.

## INTRODUCTION

Globally, 36.7 million people live with human immunodeficiency virus (HIV) of whom an estimated 2.1 million are children (0-14 years) [1]. Fifteen percent (320,000) of these children live in South Africa [1,2]. South Africa has more people receiving antiretroviral therapy (ART) than any other country in the world [3]. Coverage of paediatric ART was 55%, reaching 172,000 children in 2016 [2]. Depending on measure and definition, ART adherence ranges between 20.5% and 89.1% [4]. Poor adherence to medication is common, contributing to substantial worsening of disease, death, and increased healthcare costs [5]. Factors associated with ART adherence were the impact the condition on daily life, household functioning, socio-economic status, problems administering medication and disclosure [4]. Non-disclosure of HIV status to the child can lead to a delay in access to treatment, non-adherence and consequent treatment failure [6-9]. Although studies suggest both positive and negative effects of disclosure for children [10], the lack of disclosure of HIV status to children and adolescents ultimately adversely affects their well-being [7].

The availability and roll-out of treatment for adults and children highlights the need to address disclosure [7]. A review showed that the minority of HIV-infected children in resource-limited settings know their HIV status, and identified child-, caregiver-, clinical- and socio-economic factors associated with disclosure [10]. These predictors are not all studied within the same population. Delaying the initiation of the disclosure process will make it an increasingly difficult process [9]. Research is needed on effective strategies for disclosure in resource-limited settings [10]. Reported full disclosure to the child in South Africa ranges between 7.9% to 9% [12-14].

The South African National Department of health has committed to prioritise support and guide primary caregivers and healthcare providers for disclosure. This approach intends to ensure the physical, emotional, cognitive and social well-being of the child [8]. Mean age for disclosure in low-middle income country studies was 9.6 years (8.1-15.0), and 20.4% (3.2-69.2%) knew their status [15]. National guidelines however, recommend all children from age of three years to be prepared for disclosure. Disclosure is the first step for children transitioning into adolescents and young adults who successfully manage their own HIV care [16].

In order to support the implementation of disclosure guidelines, we assessed the prevalence of disclosure of the child's HIV status to the child. In addition, to better understand disclosure, we explored the association with disclosure and factors related to child-, caregiver-, clinical-, and socio-economic characteristics.

## METHODS

For this cross-sectional study, children aged 3-14 years who were on treatment at TC Newman clinic - a semi-urban ART clinic in the Western Cape, South Africa - and their caregivers were considered for participation between September 2012 and September 2013. The age group was based on national disclosure guidelines [9]. Comprehensive analyses of factors associated with adherence in the same population is a forthcoming publication [4]. For this study, we assessed disclosure and explored all associations between possible indicators of disclosure. Structured questionnaires were administered in interviews while patients were waiting to see the doctor and supplemented with medical record data.

### Ethical considerations

Stellenbosch University's human research ethics committee approved this study (N11/11/329) and hospital management in accordance with Provincial Research Policy (40/2009). Written consent was obtained from all caregivers and assent from children older than 7 with normal cognitive functioning.

### Disclosure

Paediatric disclosure can refer to disclosure of caregivers' HIV status to children or a child's disclosure of their own HIV status to others. However, this study focussed on disclosure of the child's HIV status to the child. Based on caregiver interview, healthcare provider report and medical files, we categorised disclosure status as non-disclosure (the child is unaware of their condition and its effect on the body), partial disclosure (the child is aware of their condition without actually naming HIV) and full disclosure (the child is made aware of their condition which is named as HIV) [9].

### Measures

To provide a comprehensive analyses of disclosure indicators, we included general demographic information, supplemented with questionnaires. The validated PedsQL™ questionnaires measured health-related quality of life (HRQoL) and the impact of paediatric chronic health conditions on family and caregivers (family impact) [17-19]. Socio-Economic Status (SES) was calculated using 21 questions from the Census 2011 [20]. A higher score (%) indicated better HRQoL, overall family functioning and SES. A combination of adherence monitoring measures was included. Pill count was calculated using the number off pills taken or volume for liquid formulations (dispensed minus returned) as a percentage of medication prescribed. Adherence was defined as 95-105% (a score >100% could be explained by ingestion of more pills than prescribed and lost pills). Self-reported adherence

for the last three days was recorded with the validated Paediatric AIDS clinical trials group (PACTG) adherence modules [21]. Adherence was defined as no missed dosages in the last three days for self-report. Treatment success was defined by a suppressed viral load (<50 copies/ml), and immune response defined by CD4 count (>500 cells/mm$^3$). This information was retrieved from medical records (six months before or three months after inclusion).



### Statistical analyses

All analyses were done using IBM SPSS statistics version 25. To describe the association between on possible predictor and disclosure, univariate logistic regression analyses were conducted presenting odds ratio (OR) and 95% confidence interval (CI) unless otherwise specified. Multivariate analyses are presented when confounding or effect modification was identified for child's age or caregiver education. Fisher's exact p-value was presented for cell size below 5. Significance was measured at p=0.05.

To describe the relation between multiple possible predictor variables and disclosure, we present a prediction model which was constructed using the forward selection procedure. This method considered all predictors of disclosure by adding the predictor with the lowest p-value under 0.05 to the crude model, which was repeated until no additional predictor had a p-value <0.05. The overall percentage correct classified cases and Hosmer and Lemeshow chi-square test with p-value for goodness of fit are presented for each model (good fit is indicated by p-value >0.05).

## RESULTS

During the study, 238 active paediatric patients on ART aged 2-14 attended the clinic. One child whose caregiver refused participation was excluded. This child was 13 years of age and not yet disclosed to. A detailed description of the population (n=195), comprehensive analyses of adherence and its determinants is a forthcoming publication [4]. This sub-analysis included 190 children from age 3 years. For five households with two children in the study, only the child enrolled first was considered for SES analyses (n=185).

### Disclosure of HIV status to the child

Most children were not disclosed to (145 of 190, 76.3%), 28 children (14.7%) had received partial disclosure and 17 children (8.9%) had full disclosure. None in early childhood (3-5 years) were disclosed to (n=49), 11 of 89 children (12.8%) aged 6-9 were disclosed to and 34 of 52 (65.4%) young adolescents (10-14 years) were disclosed to. The youngest child disclosed to was 6.6 years and the eldest child who was not disclosed to was 12.2 years.

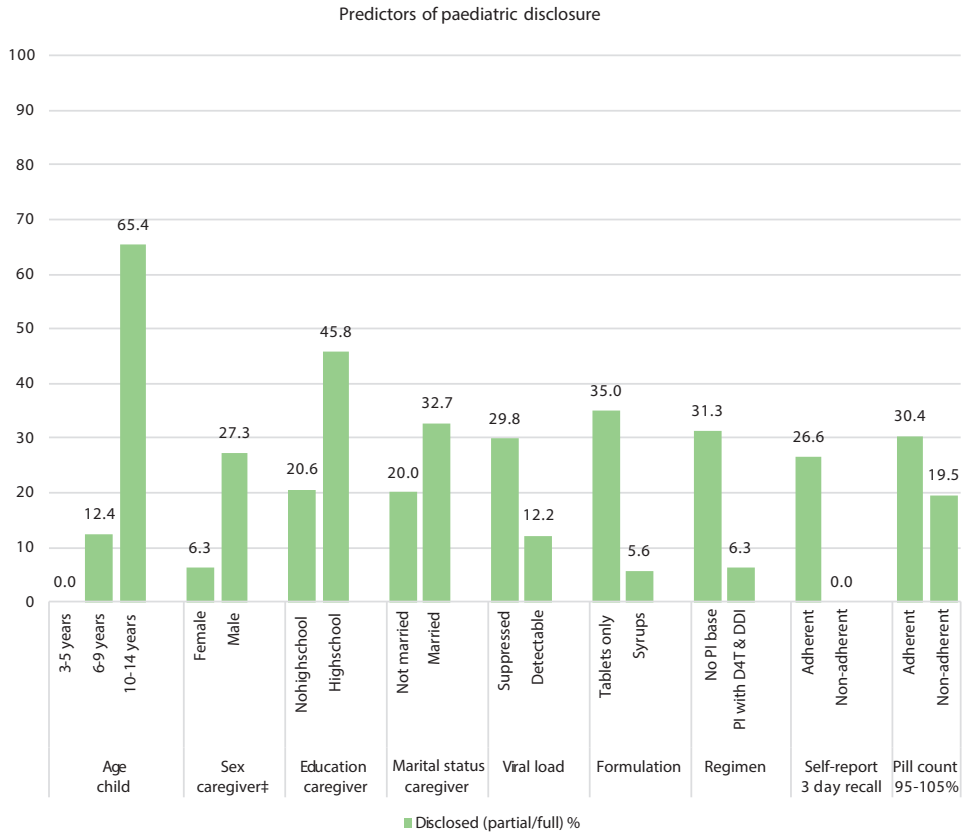


**Figure 1.** Predictors of paediatric disclosure

‡ presented for children under 10 years
PI=protease inhibitor, D4T=stavudine, DD1=didanosine

## Child characteristics

Child characteristics associated with disclosure were age and health-related quality of life. The children were aged 3.2-12.9 years and the majority (74.2%) were of school-going age (six years and older) and 27.4% were young adolescents (10-14 years). Older children were significantly more likely to be disclosed to compared to younger children (OR 21.81; 9.41-50.52). Self-reported health-related quality of life index was 91.5%. Children who rated their HRQoL highly were less likely disclosed to compared to low HRQoL (OR 0.29; 0.09-0.91). This association attenuated in multivariate analyses (OR 0.58; 0.15-2.30). We did not find significant associations between disclosure and sex of the child, overall HRQoL or school functioning (caregiver proxy-report or self-report) (Table 1).

**Table 1.** Child characteristics associations with disclosure - univariate analyses

| **Child characteristics – Univariate** | | | | | | |
|---|---|---|---|---|---|---|
| | | **Total** | **Disclosure** | | | |
| | | **%** | **Non-disclosed** | **Full/partial** | **OR (95%CI)** | **p-value** |
| Age (N=190) | Mean (sd) | 8.1 (2.6) | 7.3 (2.3) | 10.7 (1.4) | - | - |
| Age child (N=190) | 3-5 years | 25.8 | 33.8 | 0 | - | - |
| | 6-9 years | 46.8 | 53.8 | 24.4 | - | 0.008*† |
| | 10-14 years | 27.4 | 12.4 | 75.6 | - | 0.000*† |
| Age child | Young child (<10 yrs) | 72.6 | 87.6 | 24.4 | - | |
| (N=190) | Early adolescence (>= 10 yrs) | 27.4 | 12.4 | 75.6 | 21.81 (9.41-50.52)* | 0.000* |
| Sex child | Female | 57.4 | 57.9 | 55.6 | - | - |
| (N=190) | Male | 42.6 | 42.1 | 44.4 | 1.10 (0.56-2.16) | 0.778 |
| HRQoL child | Overall mean (sd) | 90.5 (10.4) | 90.1 (11.3) | 92.0 (6.4) | - | - |
| | 12.8-88.0 | 25.1 | 24.6 | 26.7 | - | - |
| | 88.1-93.0 | 24.6 | 27.5 | 15.6 | 0.52 (0.19-1.48) | 0.222 |
| | 93.1-96.6 | 24.1 | 21.1 | 33.3 | 1.46 (0.59-3.60) | 0.412 |
| | 96.7-100 | 26.2 | 26.8 | 24.4 | 0.84 (0.33-2.16) | 0.724 |
| HRQoL child | Self-report mean (sd) | 91.5 (11.4) | 90.0 (9.1) | 91.9 (12.0) | - | - |
| (N=155) | 6.5-88.0 | 23.2 | 19.5 | 35.1 | - | - |
| | 88.1-94.5 | 27.1 | 28.0 | 24.3 | 0.48 (0.18-1.32) | 0.154 |
| | 94.6-99.9 | 26.5 | 26.3 | 27.0 | 0.57 (0.21-1.53) | 0.265 |
| | 100 | 23.2 | 26.3 | 13.5 | 0.29 (0.09-0.91)* | 0.035* |
| HRQoL school | Self-report mean (sd) | 82.8 (18.2) | 83.6 (18.1) | 80.5 (18.4) | - | - |
| (N=147) | 5.0-74.9 | 23.1 | 22.7 | 24.3 | - | - |
| | 75.0-89.9 | 27.9 | 26.4 | 32.4 | 1.15 (0.42-3.18) | 0.778 |
| | 90.0-99.9 | 21.1 | 20.9 | 21.6 | 0.97 (0.32-2.93) | 0.951 |
| | 100 | 27.9 | 30.0 | 21.6 | 0.67 (0.23-1.99) | 0.475 |
| HRQoL school | Proxy-report mean (sd) | 81.6 (19.3) | 82.3 (18.9) | 79.3 (20.5) | - | - |
| (N=172) | 5.0-74.9 | 20.9 | 20.9 | 21.1 | - | - |
| | 75.0-89.9 | 32.6 | 29.1 | 44.7 | 1.53 (0.58-4.03) | 0.394 |
| | 90.0-99.9 | 23.3 | 26.1 | 13.2 | 0.50 (0.15-1.70) | 0.267 |
| | 100 | 23.3 | 23.9 | 21.1 | 0.88 (0.29-2.64) | 0.813 |

*significant (p<0.05), † p-value Fisher's Exact test (cell size below 5)
OR=odds ratio, CI=confidence interval, sd=standard deviation, HRQoL=health-related quality of life

## Caregiver characteristics

Caregiver characteristics associated with disclosure were sex, education and health related quality of life. The minority of caregivers were male (7.9%). Young children (under 10 years) of male caregivers were more likely disclosed to than young children of female caregivers (OR 5.58; 1.24-25.19). Most caregivers had not completed high-school education (87.3%). Caregivers who completed their high-school education were more likely to disclose the child's HIV status to the child (multivariate OR 4.04; 1.26-12.91) than those not completing high-school. Caregivers rated their own quality of life index at 90.5%. Caregivers who rated their quality of life higher were less likely to disclose the child's HIV status to the child (OR 0.31; 0.10-0.95). This association attenuated in multivariate analyses (OR 0.64; 0.16-2.54). We did not find significant associations between disclosure and caregiver age, relation to the child, cultural background, caregiver marital status or worry as indicator for caregiver functioning (extent of concern about child's treatment, side effects, others' reactions, child's condition, effects of illness on family and future) (Table 2).

## Clinical characteristics

Clinical characteristics associated with disclosure were detectable viral load, formulation (tablet/syrup), NNRTI in regimen, PI in regimen with stavudine and didanosine, regimens with efavirenz, duration on treatment, start of treatment in the first year of life, experiencing difficulties administering treatment and adherence to treatment. Two thirds (67.2%) of children had a suppressed viral load and were less likely disclosed to compared to those with a detectable viral load (multivariate OR 0.21; 0.05-0.84). Most children were on a regimen with a combination of three medicines (86.3%), consisting of tablets only (62.2%). Children whose regimen included syrups (syrups only or combined with tablets) were less likely disclosed to compared to children on tablets only (multivariate OR 0.28; 0.08-0.92).

Children on a regimen including an NNRTI (35.3%) were more likely disclosed to compared to children on a regimen with no NNRTI's (OR 2.71; 1.37-5.38). This association attenuated in multivariate analyses (OR 1.84; 0.78-4.31). Children on a protease inhibitor (PI)-based regimen with stavudine and didanosine (16.8%) were less likely disclosed to compared to children on a non-PI-based regimen (multivariate OR 0.19; 0.03-1.00). Children on a regimen including efavirenz were more likely disclosed to than those with no efavirenz (OR 2.90; 1.46-5.77). This association attenuated in multivariate analyses (OR 1.91; 0.81-4.48). Children on a regimen of lopinavir/ritonavir syrup (79.5%), were less likely disclosed to (OR 0.14; 0.03-0.59). This association attenuated in multivariate analyses (OR 0.54; 0.11-2.62). Children were on treatment for one month to 9.8 years (mean 5.2 years). Children with a longer treatment duration were more likely disclosed to than those more recently initiating treatment (OR3.02; 1.19-7.63). This association attenuated in multivariate analyses (OR 1.21;

**Table 2.** Caregiver characteristics associations with disclosure - univariate analyses

| **Caregiver characteristics - Univariate** | | | | | | |
|---|---|---|---|---|---|---|
| | | **Total** | | **Disclosure** | | |
| | | **%** | **Non-disclosed** | **Full/partial** | **OR (95%CI)** | **p-value** |
| Age | Mean (sd) | 39.2 (11.2) | 38.6 (11.2) | 40.8 (11.0) | - | - |
| (N=190) | 16.0-31.6 | 24.7 | 26.9 | 17.8 | - | - |
| | 31.7-37.2 | 24.7 | 26.9 | 17.8 | 1.00 (0.34-2.93) | 1.000 |
| | 37.3-44.5 | 25.8 | 22.1 | 37.8 | 2.59 (0.99-6.78) | 0.052 |
| | 44.6-74.5 | 25.8 | 24.1 | 26.7 | 1.67 (0.61-4.56) | 0.316 |
| Sex | Female | 92.1 | 93.7‡ | 72.7‡ | - | - |
| (N=190) | Male | 7.9 | 6.3‡ | 27.3‡ | 5.58 (1.24-25.19)*‡ | 0.025*‡ |
| Relation to child | Parent | 69.5 | 71.0 | 64.4 | - | - |
| (N=190) | Other | 30.5 | 29.0 | 35.6 | 1.35 (0.67-2.75) | 0.403 |
| Language | Afrikaans | 29.5 | 29.7 | 28.0 | - | - |
| (N=190) | Xhosa | 66.8 | 67.6 | 64.4 | 0.98 (0.46-2.06) | 0.955 |
| | Other | 3.7 | 2.8 | 6.7 | 2.48 (0.49-12.54) | 0.272 |
| Marital status | Not Married | 71.1 | 74.5 | 60.0 | - | - |
| (N=190) | Married | 28.9 | 25.5 | 40.0 | 1.95 (0.96-3.93) | 0.064 |
| Education | Primary school | 87.3 | 91.0 | 75.6 | - | - |
| (N=189) | High school | 12.7 | 9.0 | 24.4 | 3.26 (1.34-7.92)* | 0.009* |
| HRQoL | Mean (sd) | 90.5 (12.2) | 90.5 (12.3) | 90.6 (12.3) | - | |
| (N=181) | 36.3-84.3 | 26.0 | 23.9 | 32.6 | - | |
| | 87.4-94.6 | 23.8 | 27.5 | 11.6 | 0.31 (0.10-0.95)* | 0.041* |
| | 94.7-99.9 | 26.0 | 25.4 | 27.9 | 0.81 (0.33-2.00) | 0.645 |
| | 100 | 24.3 | 23.2 | 27.9 | 0.88 (0.36-2.12) | 0.791 |
| FI Worry | Mean (sd) | 89.2 (11.4) | 89.6 (10.9) | 88.0 (13.0) | - | - |
| (N=188) | 50.0-84.9 | 23.9 | 22.9 | 27.3 | - | - |
| | 85.0-94.9 | 30.9 | 32.6 | 25.0 | 0.64 (0.25-1.63) | 0.354 |
| | 95.0-99.9 | 12.2 | 11.8 | 13.6 | 0.98 (0.31-3.04) | 0.959 |
| | 100 | 33.0 | 32.6 | 34.1 | 0.88 (0.36-2.12) | 0.771 |

*significant ($p<0.05$), ‡ presented for children under 10 years
OR=odds ratio, CI=confidence interval, sd=standard deviation, HRQoL=health-related quality of life, FI=family impact

0.38-3.91). Children who started their treatment in the first year of their life (30.5%) were less likely disclosed to than those commencing later in life (OR 0.12; 0.04-0.40). This association attenuated in multivariate analyses (OR 0.49; 0.12-1.94). Caregivers who experienced difficulties administering medication (30.5%) had less likely disclosed compared to caregivers not experiencing difficulties administering medication (OR 0.41; 0.18-0.95). This association

attenuated in multivariate analyses (OR 0.63; 0.23-1.73). Non-adherence was 10.1% for self-report (3-day recall) and 63.1% for pill count (95-105%). Children who were non-adherent to their treatment were less likely disclosed than those who were adherent (self-report Fisher's exact p-value 0.008). We did not find significant associations between disclosure and WHO clinical staging, CD4 count, complications reported (running out of medication, flavour, forgetting, side effects, multiple caregivers, illness, depression and being away from home), side effects (ever, rash, sleep disturbance and pain), default on treatment in the past and subsequently restarted, number of medicines in regimen or adherence defined by pill count (95-105%) (Table 3).

## Socio-economic characteristics

Socio-economic characteristics associated with disclosure were family functioning, affected daily activities and water-born sanitation. Overall family impact index was 90.4%. Children with a high overall family impact scale (good family functioning) were more likely disclosed to than those from a household with low family impact index (OR 4.18; 1.54-11.32). This association attenuated in multivariate analyses (OR 0.80; 0.22-3.00). The mean score for daily activity index (component of family functioning) was 91.5% and included extent of activities taking more time and effort, difficulty finding time and energy to finish household tasks or daily activities were affected. Children from families with a higher family activity index were less likely disclosed to compared to children from families with a low family activity (activities affected) (OR 0.21; 0.04-1.000). This association attenuated in multivariate analyses (OR 0.81; 0.30-2.17). The overall SES index was 52.0%. The study population had significant more often water-born sanitation (73.7%), owned a TV (89.4%), fridge (79.9%) or cell phone (95.2%) than the general South African population. However, the study population lived with significantly more people in one household (mean 5.2), more people lived in informal dwellings (39.5%) and were less likely to own a computer (11.5%), landline (7.1%) or car (15.3%) compared to the general South African population (Table 4).

Children from households with water-born sanitation were more likely disclosed to than those from households with no toilet facilities connected to sewage (OR 2.87; 1.13-7.29). This association attenuated in multivariate analyses (OR 1.76; 0.58-5.35). We did not find significant associations between disclosure and overall SES-index (Table 5).

**Table 3.** Clinical characteristics associations with disclosure - univariate analyses

| **Clinical characteristics** | | | | | | |
|---|---|---|---|---|---|---|
| | | **Total** | **Disclosure** | | | |
| | | **%** | **Non-disclosed** | **Full/partial** | **OR (95%CI)** | **p-value** |
| WHO clinical | Stage 1 | 10.3 | 10.1 | 11.1 | - | |
| (N=184) | Stage 2 | 26.1 | 24.5 | 31.1 | 1.15 (0.353.81) | 0.816 |
| | Stage 3 | 45.1 | 46.0 | 42.2 | 0.83 (0.27-2.61) | 0.751 |
| | Stage 4 | 18.5 | 19.4 | 15.6 | 0.73 (0.20-2.71) | 0.634 |
| Health outcome | Viral load | 67.2 | 62.1 | 83.3 | - | - |
| (N=125) | | 32.8 | 37.9 | 16.7 | 0.33 (0.12-0.93)* | 0.037* |
| Health outcome | CD4 count | 92.4 | 93.5 | 88.5 | - | - |
| (N=118) | | 7.6 | 6.5 | 11.5 | 1.87 (0.43-8.05) | 0.401 |
| Complications | No | 83.0 | 82.7 | 83.7 | - | - |
| (N=182) | Yes | 17.0 | 17.3 | 16.3 | 0.93 (0.37-2.34) | 0.880 |
| Difficulties | No | 69.5 | 65.5 | 82.2 | - | - |
| (N=187) | Yes | 30.5 | 34.5 | 17.8 | 0.41 (0.18-0.95)* | 0.037* |
| Side effects | No | 88.4 | 88.4 | 88.4 | - | - |
| (N=181) | Yes | 11.6 | 11.6 | 11.6 | 1.00 (0.35-2.92) | 0.995 |
| Treatment duration | Mean (sd) | 5.2 (2.4) | 4.9 (2.3) | 6.1 (2.5) | - | - |
| (N=190) | 0.0-3.4 | 24.3 | 25.8 | 20.0 | - | - |
| | 3.5-5.5 | 22.6 | 25.8 | 13.3 | 0.67 (0.22-2.05) | 0.479 |
| | 5.6-6.6 | 27.1 | 28.0 | 24.4 | 1.32 (0.49-3.55) | 0.580 |
| | 6.7-9.9 | 26.0 | 20.5 | 42.2 | 3.02 (1.19-7.63)* | 0.020* |
| Treatment 1st life year | No | 69.5 | 62.1 | 93.3 | - | - |
| (N=190) | Yes | 30.5 | 37.9 | 6.7 | 0.12 (0.04-0.40)* | 0.001* |
| Treatment interrupted | No | 92.0 | 90.9 | 95.6 | - | - |
| (N=188) | Yes | 8.0 | 9.1 | 4.4 | 0.47 (0.10-2.14) | 0.326 |
| Regimen | Standard 3 meds | 86.3 | 85.5 | 88.9 | - | - |
| (N=190) | Less (1 or 2) | 12.6 | 13.1 | 11.1 | - | 0.803† |
| | More (4 meds) | 1.1 | 1.4 | 0 | - | 1.000† |
| Regimen formulation | Tablets only | 62.2 | 53.1 | 91.1 | - | - |
| (N=188) | Syrups | 37.8 | 46.9 | 8.9 | 0.11 (0.04-0.33)* | 0.000* |
| Regimen | no NNRTI | 64.7 | 70.3 | 46.7 | - | - |
| (N=190) | NNRTI | 35.3 | 29.7 | 53.3 | 2.71 (1.37-5.38)* | 0.004* |
| Regimen | No PI base | 42.1 | 37.9 | 55.6 | - | - |
| (N=190) | PI + D4T/DDI | 16.8 | 20.7 | 4.4 | 0.15 (0.03-0.66)* | 0.013* |
| | PI + ABC/AZT | 33.2 | 35.2 | 26.7 | 0.52 (0.24-1.14) | 0.101 |
| | PI + other | 7.9 | 6.2 | 13.3 | 1.47 (0.47-4.57) | 0.509 |
| Regimen | no EFV | 65.8 | 71.7 | 46.7 | - | - |
| (N=190) | EFV | 34.2 | 28.3 | 53.3 | 2.90 (1.46-5.77)* | 0.002* |

**Table 3.** Clinical characteristics associations with disclosure - univariate analyses *(Continued)*

| **Clinical characteristics** | | | | | | |
|---|---|---|---|---|---|---|
| | | **Total** | **Disclosure** | | | |
| | | **%** | **Non-disclosed** | **Full/partial** | **OR (95%CI)** | **p-value** |
| Regimen | no lop/rit syrup | 79.5 | 74.5 | 95.6 | - | - |
| (N=190) | lop/rit syrup | 20.5 | 25.5 | 4.4 | 0.14 (0.03-0.59)* | 0.008* |
| Adherence 3-day self-report | Adherent | 89.7 | 86.7 | 100 | - | - |
| (N=188) | Non-adherent | 10.1 | 13.3 | 0 | - | 0.008*† |
| Adherence pill count 95-105% | Adherent | 36.9 | 33.6 | 47.7 | - | - |
| (N=187) | Non-adherent | 63.1 | 66.4 | 52.3 | 0.55 (0.28-1.10) | 0.091 |

*significant (p<0.05), † p-value Fisher's Exact test (cell size below 5)
OR=odds ratio, CI=confidence interval, sd=standard deviation, NRTI=nucleoside reverse transcriptase inhibitors, NNRTI=non-nucleoside reverse transcriptase inhibitors, PI=protease inhibitor, D4T=stavudine, DDI=didanosine, ABC=abacavir, AZT=zidovudine, EFV=efavirenz, lop/rit= lopinavir/ritonavir

**Table 4.** Socio-economic characteristics associations with disclosure - univariate analyses

| **Socio-economic characteristics - univariate** | | | | | | |
|---|---|---|---|---|---|---|
| | | **Total** | **Disclosure** | | | |
| | | **%** | **Non-disclosed** | **Full/partial** | **OR (95%CI)** | **p-value** |
| FI overall | Mean (sd) | 90.4 (11.5) | 89.7 (10.8) | 92.4 (13.2) | - | - |
| (N=189) | 41.9-87.4 | 24.9 | 27.8 | 15.6 | - | - |
| | 97.5-93.3 | 24.9 | 26.4 | 20.0 | 1.35 (0.46-4.00) | 0.584 |
| | 93.4-99.1 | 26.5 | 27.8 | 22.2 | 1.43 (0.50-4.13) | 0.510 |
| | 99.2-100 | 23.8 | 18.1 | 42.2 | 4.18 (1.54-11.32)* | 0.005* |
| FI Activities | Mean (sd) | 91.4 (15.2) | 91.3 (15.2) | 91.5 (15.4) | - | |
| (N=189) | 25.0-91.6 | 23.3 | 22.2 | 26.7 | - | |
| | 91.7 | 14.8 | 18.1 | 4.4 | 0.21 (0.04-1.000)* | 0.050* |
| | 100 | 61.9 | 59.7 | 68.9 | 0.96 (0.44-2.10) | 0.921 |
| SES-index | Mean (sd) | 52.0 (17.0) | 50.7 (17.2) | 56.4 (15.8) | - | - |
| (N=183) | 9.5-42.7 | 21.9 | 24.3 | 14.0 | - | - |
| | 42.8-57.0 | 25.7 | 25.7 | 25.6 | 1.73 (0.58-5.20) | 0.328 |
| | 57.1-66.6 | 24.0 | 24.3 | 23.3 | 1.67 (0.55-5.10) | 0.371 |
| | 66.7-100 | 28.4 | 25.7 | 37.2 | 2.52 (0.88-7.19) | 0.084 |
| SES Toilet facility | No sewage | 27.0 | 31.2 | 13.6 | - | - |
| (N=185) | Water-born | 73.0 | 68.8 | 86.4 | 2.87 (1.13-7.29)* | 0.026* |

*significant (p<0.05)
OR=odds ratio, CI=confidence interval, sd=standard deviation, FI=family impact, SES=socio-economic status

**Table 5.** Socio-economic status indicators and South African comparison

| | N | Study | South Africa§ | Chi-squared p-value |
|---|---|---|---|---|
| Number of people per household | 184 | 5.2 | 3.4 | t=11.3 (0.000)* |
| Type of dwelling (formal / informal) | 185 | 60.0 | 77.6 | 32.0 (0.000)* |
| Drinking water (piped in house or yard / other) | 185 | 77.8 | 73.4 | 1.8 (0.176) |
| Toilet facilities (water-born / no sewage) | 185 | 73.0 | 57.0 | 19.3 (0.000)* |
| Share toilet facilities (no / yes) | 183 | 52.5 | - | - |
| Fuel cooking (electricity / other) | 185 | 77.3 | 73.9 | 1.1 (0.109) |
| Fuel heating (electricity / other) | 185 | 58.9 | 58.8 | 0.0 (0.978) |
| Fuel lighting (electricity / other) | 185 | 83.2 | 84.7 | 0.3 (0.571) |
| Material floor (finished / natural or rudimentary) | 185 | 95.7 | - | - |
| Material walls (finished / unfinished) | 185 | 39.5 | - | - |
| Share rooms in house (no / yes) | 183 | 82.0 | - | - |
| Radio (no / yes) | 184 | 72.8 | 67.5 | 2.4 (0.125) |
| TV (no / yes) | 184 | 89.1 | 74.5 | 20.6 (0.000)* |
| Fridge (no / yes) | 184 | 79.9 | 68.4 | 11.3 (0.001)* |
| Computer (no / yes) | 184 | 11.4 | 21.4 | 10.9 (0.001)* |
| Landline (no / yes) | 184 | 7.1 | 14.5 | 8.1 (0.004)* |
| Cellphone (no / yes) | 184 | 95.7 | 88.9 | 8.6 (0.003)* |
| Car (no / yes) | 184 | 15.8 | 29.5 | 16.6 (0.000)* |
| Bicycle (no / yes) | 184 | 16.3 | - | - |
| Motorcycle / Scooter (no / yes) | 184 | 1.1 | - | - |
| Donkey / horse (no / yes) | 184 | 0 | - | - |
| Sheep / cattle / goat (no / yes) | 184 | 0 | - | - |

*significant (p<0.05), § StatsSA 2012 [20]

## Prediction model

The prediction model for disclosure included five variables: age of the child (OR 146.56; 20.27-1059.69, p=0.000), PI regimen with stavudine and didanosine (OR 0.01; 0.00-0.22, p=0.005), marital status (OR 7.00; 1.39-35.03, p=0.018), viral load (OR 0.05; 0.01-0.41, p=0.005) and adherence (pill count 95-105%) (OR 0.16; 0.03-0.77, p=0.023). The association with caregiver education attenuated when adding viral load to the model. The overall percentage correct classified cases was 91.1% and Hosmer and Lemeshow chi-square test for goodness of fit was 58.7 (p=0.812). Figure one provides an overview of the proportion of children disclosed to within the categories of all predictors identified in multi-variate analysis and the prediction model.

## DISCUSSION

Only 17 children (8.9%) in this cohort of 3-14 year olds received full disclosure. In multi-variate analyses we found that increased age of the child and higher education of the caregiver strongly associated with disclosure of HIV status to the child. In addition, sex of caregiver, suppressed viral load, syrup formulation, PI regimens with stavudine and didanosine, and self-reported non-adherence were strongly associated with non-disclosure. The prediction model identified age of the child, caregiver marital status, viral load, regimen, and non-adherence defined by pill count (95-105%) as predictors of disclosure.

Similar to other studies, we found older age of the child strongly associated with increased probability of disclosure of the HIV status to the child [14,22,23]. Literature does not specifically associate better HRQoL of child to non-disclosure, however, health related factors and child's family situation are reported as predictors of disclosure [10].

Caregiver sex, level of education and health-related quality of life were associated with disclosure. Where other studies describe not having a biological father as a predictor of disclosure [24,25], we found children were more likely disclosed to when their main caregiver was their father. The event of a father demising or the mother not present in the household both indicate major life events which are possibly related to HIV. Disclosure is more likely when the caregiver themselves are HIV positive or when caregivers have discussed their own HIV status [26]. Some studies confirm our finding that caregivers with higher education are more likely disclose the child's HIV status to their child [27], however, other studies do not [14]. Caregivers feeling worried and unprepared for the process of disclosure and questions prevent actual disclosure [22,28]. Better educated caregivers might feel more equipped to start this process. Caregiver better health-related quality of life is not reported by literature as a predictor of non-disclosure, although the child's family situation and caregiver disclosure-related anxiety is described to affect disclosure [28].

We found a strong association between detectable viral load and disclosure. A detectable viral load is an indicator for failure on treatment [29]. Experienced health issues due to a high detectable viral load could have contributed to the need to disclose. Conversely, addressing disclosure could positively affect adherence and viral suppression [6, 23]. Non-adherence was associated with non-disclosure. Most likely, this association was reversed where non-disclosure contributed to difficulties remaining adherent (submitted for publication). Similarly, caregivers experiencing difficulties administering medication had less likely disclosed the child's HIV status. Non-disclosure may have contributed to difficulties administering medication. We did not find an association between CD4 count and disclosure. Some literature describes an association between CD4 percentage [24], where others cannot confirm this association for CD4 percentage or CD4 count [14]. Children on regimens including syrups were less likely disclosed to. Although young children generally were on syrup formulations, the association remained when corrected for age. Possibly

an easier routine with syrups does not require the need to disclose. Children on PI-based regimens with stavudine and didanosine were less likely disclosed to. Current guidelines recommend replacing stavudine and didanosine with abacavir [29].

Multiple clinical characteristics associated with disclosure in univariate analyses attenuated in multivariate analyses, explained by the child's age (lopinavir/ritonavir syrup, NNRTI based regimens, efavirenz regimens, duration on treatment, starting treatment in first year of life). Children on lopinavir/ritonavir syrup were less likely disclosed to. This could be explained by the regimen generally being given to young children and is changed to tablet from for older children. Side effects affecting the central nervous system, unusual dreams and trouble sleeping (efavirenz) and severe rash (nevirapine) [29] likely contributed to the decision of caretakers to disclose the HIV status to children on regimens including NNRTIs. Children who were on treatment for longer were more likely disclosed to. Guidelines in South Africa regard all HIV positive children eligible to initiate ART irrespective of CD4 count [29]. Older children, who are more likely on treatment longer, are more often disclosed to [10]. Other studies confirm the association we find between longer time on ART and disclosure [25]. Children wo started treatment in the first year of life however, are less likely disclosed to. Being in the same routine from birth, when no failure on treatment occurs, the need to disclose did not seem as urgent.

Socio-economic characteristics associated with disclosure included family functioning, affected daily activities and water-born sanitation. Although some studies describe an association with disclosure and the child's family situation [10,14], no specific measure for family functioning or activities were reported in literature. Indicators of SES including financial problems [24] and the child being hungry [14] are reported in literature as a predictor of disclosure. We found children from households with access to water-born sanitation more likely disclosed to. Informal living conditions more often lack water-born sanitation, are more densely populated and lack privacy required to support the disclosure process.

A limitation to our study was relying on medical records for available viral load and CD4 count. In addition, the questionnaire did not include topics like experience or perspectives on disclosure. Literature focusses on healthcare provider perspective [30, 31, 32] or caregiver perspective [12,14,22,33]. The child's perspective on disclosure is rarely or not studied at all. A strength of our study was that our interviews included all children aged 5 years or older when addressing their health-related quality of life. Although we suggest doing similar research in other settings to ensure generalizability of data, another strength of this study was the reasonable sample size.

## CONCLUSION

This cross-sectional study shows a low proportion of children knowing their HIV status. Older age of the child was strongly associated with disclosure. We find a less stringent need for caregivers to disclose the child's HIV status to the child when ART was tolerated well and no condition-related difficulties were experienced (e.g. high HRQoL for both child and caregiver, suppressed viral load and family activities not affected by chronic disease). Well-functioning families, with caregivers who received higher level of education and children from households with better SES, provided an environment enabling and promoting disclosure of the HIV status to the child. Disclosure can only be beneficial when there is a supportive social structure.

Non-disclosure can indicate a sub-optimal social structure which could negatively affect adherence and viral suppression. In order to successfully address disclosure, the complex social context needs to be taken into account. When families are in a good space, there is no pressing need to start the disclosure process. However, these circumstances positively enable the disclosure process. Targeting these families for disclosure interventions and the support of families to reach such an enabling environment can therefore be especially successful.

### Authors contributions

SLvE, AMvF conceived this cohort study, SLvE, AMvF, MFC and RPHP contributed to the conception of design and methodology of the study and prepared the protocol. SLvE and PK contributed to acquisition of data facilitated by NG. SLvE prepared the datasets and conducted the statistical analyses which were checked by AMvF, RPHP and MOK. All authors contributed substantially to the interpretation of the data. SLvE drafted the manuscript and all authors revised the manuscript critically for important intellectual content. All authors reviewed and approved the final manuscript.

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The views expressed in the submitted article are the authors' and not an official position of the institution or funder.

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# PART II

## Home-based treatment of paediatric tuberculous meningitis