

1 **Disability, Social Functioning and School Inclusion Among Older Children**
2 **and Adolescents Living with HIV In Zimbabwe**
3

4 Ruramayi Rukuni^{1, 2}, Grace McHugh¹, Edith Majonga^{1,3}, Katharina Kranzer³, Hilda Mujuru⁴,
5 Shungu Munyati¹, Kusum Nathoo⁴, Celia L Gregson⁵, Hannah Kuper⁶, Rashida A Ferrand^{1,3}
6

- 7 1. Biomedical Research and Training Institute (BRTI), Harare, Zimbabwe.
8 2. Nuffield Department of Population Health, University of Oxford, Oxford, UK.
9 3. Clinical Research Department, Faculty of Infectious and Tropical Diseases London
10 School of Hygiene and Tropical Medicine (LSHTM), London, UK.
11 4. Department of Paediatrics, University of Zimbabwe, Harare, Zimbabwe
12 5. The Musculoskeletal Research Unit, Translational Health Sciences, Bristol Medical
13 School, University of Bristol, Bristol, UK.
14 6. International Centre for Evidence in Disability, Faculty of Infectious and Tropical
15 Diseases London School of Hygiene and Tropical Medicine (LSHTM), London, UK.

16 Corresponding Author:

17 Ruramayi Rukuni, Biomedical Research and Training Institute (BRTI), 10 Seagrave Road,
18 Harare, Zimbabwe; Email: ruramayirukuni@gmail.com

19 Tel: 00263 772 362 961
20

21 Short heading: Disability and social functioning in HIV-infected children

22 Key words: disability, adolescents, children, Africa, HIV, social functioning
23

24 **Abstract**

25 **Objective** Increasing numbers of children with HIV are surviving to adolescence and
26 encountering multiple clinical and social consequences of longstanding HIV infection. We
27 aimed to investigate the association between HIV and disability, social functioning and school
28 inclusion among 6 to 16-year olds in Zimbabwe.

29 **Methods** HIV-infected children receiving antiretroviral therapy from a public-sector HIV
30 clinic, and HIV-uninfected children attending primary care clinics in the same catchment area
31 were recruited. Standardised questionnaires were used to collect sociodemographic, social
32 functioning and disability data. Multivariable logistic regression was used to assess the
33 relationship between HIV status and disability and social functioning.

34 **Results** We recruited 202 HIV-infected and 285 HIV-uninfected children. There was no
35 difference in age and gender between the two groups, but a higher proportion of HIV-infected
36 children were orphaned. The prevalence of any disability was higher in HIV-infected than
37 uninfected children (37.6% vs. 18.5%, $p < 0.001$). HIV-infected children were more likely to
38 report anxiety (adjusted odds ratio (aOR) 4.4; 95% CI 2.4, 8.1), low mood (aOR 4.2; 2.1, 8.4)
39 and difficulty forming friendships (aOR 14.8; 1.9, 116.6) than uninfected children. Children
40 with HIV also reported more missed school days, repeating a school year and social exclusion
41 in class. These associations remained apparent when comparing children with HIV and
42 disability to those with HIV but no disabilities.

43 **Conclusions** Children with HIV commonly experience disabilities, and these are associated
44 with social and educational exclusion. Rehabilitation and support services are needed to
45 facilitate educational attainment and social participation in this population.

46 **Introduction**

47 In 2016, worldwide approximately 160,000 children were newly infected with HIV (1). Of the
48 estimated 2.1 million children aged under 15 years living with HIV, nearly 90% live in Sub-
49 Saharan Africa (SSA) (1). The global scale-up of antiretroviral therapy (ART) programmes
50 has meant that increasing numbers of children with HIV who would previously have died in
51 infancy without treatment are now surviving to older childhood and adolescence. However,
52 there is increasing evidence that childhood HIV infection is associated with chronic multi-
53 system complications, resulting in hearing, cognitive, mobility and visual impairments (2, 3).

54 HIV may lead to impairments through a variety of mechanisms. For example, HIV-mediated
55 immunosuppression may lead to opportunistic infections such as CMV that can cause visual
56 impairment (4). The risk of impairments is increased if initiation of ART is delayed, as is
57 common in many resource-limited settings (5). ART itself may also contribute to impairment;
58 for instance, nucleoside analogue reverse-transcriptase inhibitors (NRTI) commonly used at
59 the time of ART roll out for children in SSA (*e.g.* stavudine and lamuvidine) is linked to hearing
60 loss (6, 7). Zidovudine has been independently linked to myopathy (8), which may lead to
61 physical impairments. Once established, impairments may not be completely reversed by ART
62 (9) and negatively impact on social functioning and schooling (3, 10). In other words, HIV or
63 its treatment may lead to disability, which is defined as the restriction of participation in society
64 of an individual due to an underlying impairment in combination with attitudinal and
65 environmental and other barriers (11). Socio-economic deprivation, often associated with HIV
66 infection (12), potentially exacerbates disability by further restricting participation in society.
67 To optimise the quality of life and long-term care amongst those living with HIV and their
68 families, HIV programmes need to broaden their focus and address longer-term consequences
69 of HIV infection, including the impact on schooling and social inclusion. Even in the absence
70 of HIV, education and schooling are a major global concern for children and adolescents with

71 disabilities, who are substantially less likely to be enrolled in school and, even when enrolled,
72 lag behind their peers in educational attainment (13). HIV is likely to magnify these issues
73 among children due to poverty resulting from parental ill health, food insecurity and
74 unemployment (14).

75 We therefore conducted a cross-sectional study to investigate the association between HIV and
76 disability, social functioning and school inclusion among HIV-infected children compared to
77 uninfected peers in Zimbabwe.

78 **Methods**

79 *Study setting and participants*

80 HIV-infected children aged 6 to 16 years and receiving either first or second line ART for at
81 least six months were consecutively recruited from Harare Central Hospital (HCH); this is the
82 largest public-sector hospital in Harare, providing HIV care for more than 3,000 children. This
83 age range was selected because it represents children of school going age. Recruitment was
84 restricted to the first five eligible participants a day for logistical ease. Exclusion criteria were
85 being acutely ill i.e. having a respiratory tract or other acute infection or tuberculosis, not
86 residing in Harare and no guardian consent and/or participant assent.

87

88 A comparison group of HIV-uninfected children aged 6-16 years was recruited from primary
89 health care clinics (PHC) in seven high-density communities from the same catchment area
90 served by the clinic from which the HIV-infected participants were enrolled. Provider initiated
91 HIV testing and counselling was offered by the PHCs to all children attending for acute care
92 regardless of the reason for presentation, and those who tested HIV-negative were invited to
93 participate and attend pre-booked appointments for assessments. The same exclusion criteria
94 were applied to HIV-uninfected children.

95 *Data collection*

96 Socio-demographic data including age, sex and orphan status were recorded. Trained research
97 nurses administered standardised questionnaires to collect data on disability, education and
98 social functioning. The Washington Group/UNICEF Child Functioning and Disability 21
99 Question Set was administered jointly to all children and caregivers by a research nurse to
100 assess disability (15). This question set is validated for children aged 2-17 years. Self-reported
101 functional difficulties were defined as binary variables in the following domains: vision,
102 hearing, walking, speech, learning, memory, self-care, anxiety, low mood, difficulty
103 controlling behaviour, dealing with change, forming friendships and concentration. Disability
104 was defined as reported difficulties in any of the functional domains. Additional information
105 on school and social functioning was collected, including the following: school enrolment,
106 school attendance, repeated school year, problems getting help from teachers and friends,
107 interaction with other children (leadership, play, bullying) and inclusion in lessons and school
108 activities. Caregivers of HIV-infected children were asked additional questions relating to HIV
109 diagnosis, testing, ART history, and children's awareness of diagnosis. At the time of
110 enrolment, CD4 count was determined using an Alere PIMA CD4⁺ (Waltham, Massachusetts,
111 USA) and HIV viral load was measured using COBAS Ampliprep/Taqman 48 Version 2.0
112 (Roche, Rotkreuz, Switzerland).

113 *Ethics*

114 Ethical approval was obtained from the Medical Research Council of Zimbabwe
115 (MRCZ/A/1856), the Biomedical Research and Training Institute (AP125) Institutional
116 Review Board, Harare Hospital Ethics Committee and the London School of Hygiene and
117 Tropical Medicine (LSHTM) Ethics Committee (8263). All guardians gave written consent,
118 and participants gave assent to participate in the study.

119 *Data management and analysis*

120 Data were collected using paper forms and entered into a Microsoft Access database using
121 optical mark recognition software (Cardiff TELEFORM Intelligent Character, Version 10.7),
122 which has inbuilt quality control checks. Paper forms were manually checked for missing data
123 and inconsistencies before being captured. Further internal and external consistency checks
124 were carried out using database queries.

125 Data completeness was assessed by summary and descriptive statistics. There was a low
126 proportion of missing data (<6%) in HIV-infected and uninfected children for demographic,
127 clinical, disability and school functioning and social inclusion data. The prevalence of
128 functional difficulties and disability was summarised as frequencies and percentages for each
129 variable by HIV status. Continuous variables were summarised as mean and standard deviation
130 (SD) when normally distributed and median and interquartile range (IQR) when not.
131 Univariable logistic regression analysis was used to compare functional, school and social
132 outcomes between HIV-infected and uninfected children. Multivariable logistic regression was
133 used to adjust each functional outcome of interest for a priori defined variables of age and sex.
134 Orphan status and previous infection/co-morbidity did not significantly affect the fit of the
135 model ($p < 0.05$) on likelihood ratio testing and therefore were excluded. Hence, the final model
136 was adjusted for age and sex alone. All statistical analyses were carried out using Stata v13.0
137 (College Station, Texas: StataCorp LP).

138

139 **Results**

140 *Baseline characteristics of participants*

141 We recruited 202 HIV-infected children (median age 11 years [IQR 8-13]; 48.0% female) and
142 285 uninfected children (median age 10 years [IQR 8-13]; 48.8% female). There were no
143 significant differences in age or sex between the two groups, but HIV-infected children were

144 more likely to be orphaned ($p < 0.001$) (Table 1). Among HIV-infected children, the median age
145 at HIV diagnosis was 5 years [IQR 3-7] and the median CD4 count was 726 cells/ μ l [IQR 476-
146 941]. The median duration of ART was 2 years [IQR 1-5] and the median age of ART initiation
147 was 8 years [IQR 5-10].

148

149 *Functioning and disability*

150 The prevalence of any self-reported difficulties in functioning (*i.e.* disability) was higher in
151 HIV-infected children compared to uninfected children (37.6% compared to 18.8% $p < 0.001$)
152 (Table 2). Amongst those with HIV, the most common types of disability were learning
153 (reported by 23.2%) and memory difficulties (reported by 17.8%). Difficulties with seeing
154 (7.7%), hearing (4.8%) and walking (2.5%) were also reported more commonly amongst HIV
155 infected children.

156 After adjustment for age and sex, the odds of any disability were 2.8 times higher in HIV-
157 infected than HIV-uninfected children (95% CI 1.8, 4.2 $p < 0.001$). HIV-infected children were
158 significantly more likely to report visual (aOR 3.0; 1.3, 6.9), hearing (aOR 3.4; 1.0, 10.5),
159 speech (aOR 3.8; 1.1, 13.9), learning (aOR 3.9; 1.4, 3.4) and memory problems (aOR 3.5; 2.0,
160 6.6) (Table 2). In addition, HIV-infected children were more likely to report anxiety (aOR 4.4;
161 2.4, 8.1), low mood (aOR 4.2; 2.1, 8.4) and difficulty forming friendships (aOR 14.8; 1.9,
162 116.6) compared to their uninfected peers. There was no significant association between age
163 at HIV diagnosis, age of ART initiation, CD4 count, viral load, ART duration or previous
164 comorbidity and disability among HIV-infected children (Table 3).

165

166 *Schooling and social inclusion*

167 School enrolment rates were high among all children (96.0% in both HIV-infected and
168 uninfected groups). However, children living with HIV were more likely to have repeated a
169 school year (aOR 3.2; 1.6, 3.8) and on average, missed more days of school in the preceding
170 month (mean 0.9 days (range 0-15 days) vs. 0.3 days (range 0-7 days). HIV-infected children
171 more frequently reported not receiving help from teachers (aOR 2.1; 1.2, 3.8) or friends (aOR
172 3.0; 2.0, 4.5) at school. They were more likely to feel excluded in lessons and activities (aOR
173 4.7; 2.7, 8.3) and more likely to be physically and verbally bullied by other children (aOR 3.7;
174 2.2, 6.0). Among children with HIV, those with disabilities were less likely to be enrolled in
175 the same school grade as their age peers (aOR 3.3; 1.7, 6.1) and more likely to repeat a school
176 year (aOR 1.9; 1.0, 3.6) compared to HIV-infected peers without disability. They were also
177 more likely to report that their peers did not look up to them as leaders (aOR 2.1; 1.4, 3.4) and
178 that they experienced violence from their peers (aOR 2.5; 1.3, 4.8) (Table 4). Amongst children
179 with disability, those with HIV were less likely to be enrolled in school, more likely to have
180 needed to repeat a school year and much more likely to have been physically or verbally bullied
181 than disabled children without HIV (Supplementary Table 5).

182 **Discussion**

183 This study demonstrates a high prevalence of physical and cognitive functional difficulties
184 among HIV-infected children compared to their uninfected peers. Children with HIV were
185 more likely to report low mood, anxiety, difficulty forming friendships, repeating a school year
186 and to experience poor social support at school, particularly when HIV and disability co-
187 existed.

188 Other studies have reported increased physical, sensory and cognitive difficulties in HIV-
189 infected children compared to those uninfected (3,16-22). Developmental delay is strongly

190 associated with HIV in SSA (2), affecting up to 78% of children (22). Fortunately, in the post-
191 ART era, severe forms of cognitive impairment in children appear to be decreasing; however,
192 the prevalence of mild impairment remains largely unchanged and may even be increasing
193 (23). A number of studies have assessed the prevalence of cognitive (18, 22, 24, 26-29) and
194 motor (18, 19, 21, 23-29) impairments among HIV-infected and uninfected children; however,
195 to date these have largely focused on infants and younger children before school age. Our study
196 highlights both the increased prevalence of learning difficulties among HIV-infected school-
197 age children, but also shows that learning difficulties are common in uninfected children in
198 Zimbabwe.

199 This study further demonstrates the additional burden of low mood and anxiety amongst HIV-
200 infected children. There is evidence of a strong bidirectional association between mental health
201 and educational attainment with mood and anxiety disorders having a direct effect on early
202 school leaving, substance misuse and disruptive behavioural disorders (30). Mental health
203 issues impact negatively on treatment compliance and retention in social care and school
204 through the fear of disclosing HIV status and social ostracism (31). Socialising and making
205 friends at school are key protective factors for psychosocial wellbeing in children with HIV,
206 whereas negative peer interactions such as lack of friends, bullying and being beaten by friends
207 have been identified as risks (32). Therefore, school peer support interventions should be
208 adopted as they have been shown to reduce psychological distress, depression, anxiety and
209 anger in children with HIV (33, 34).

210 Similar to our findings, a recent Malawian cross-sectional study found that a high proportion
211 of HIV-infected school children had hearing impairment identified by extensive audiological
212 testing (10). These children were less likely to attend school and had poorer emotional and
213 school functioning than HIV-infected children without hearing loss. Furthermore, only 40% of

214 caregivers accurately perceived their child's hearing loss, and few had sought treatment,
215 implying that routine screening may be necessary as disability may be underreported (10).

216 Our study found no significant association between HIV disease severity or treatment factors
217 and disability. However, previous studies have shown a relationship between CD4 count, viral
218 load at enrolment, ART duration and disability (2,10). The Malawian study mentioned above
219 (10) found hearing loss to be significantly associated with HIV WHO Stage 3 or 4 disease, but
220 not duration of ART or CD4 count. A recent systematic review of disability and HIV in SSA
221 found a significant dose-response relationship between indicators of disease progression (CD4
222 or WHO stage) and disability in 48% of studies (2). The evidence suggests that earlier ART
223 initiation in children may reduce the risk of impairments and consequent disability, but once
224 established, ART alone may not be sufficient to enable children with HIV to lead healthy lives
225 (2).

226 Given the high prevalence of physical and sensory impairments amongst children living with
227 HIV, our study underlines the need for increased availability of rehabilitation services to
228 support school age children and adolescents with HIV. Currently, the few existing services are
229 mainly located in urban areas or private health facilities which limits access for many (35).
230 Greater support for children with learning difficulties is required in schools to facilitate social
231 inclusion and educational attainment (36) as learning, remembering, and concentration appear
232 to be common in HIV-infected and uninfected children.

233 Although incorporating disability inclusive approaches into HIV treatment and care is likely to
234 increase the social participation and school functioning of children with HIV (37), so far only
235 5 of 18 countries (27%) in Eastern and Southern Africa have recognised the need for specific
236 support services and interventions for people with disabilities in their national strategic
237 responses to HIV and AIDS (38). Although Zimbabwe is one of these countries, the findings

238 of this study suggest that further work is required to extend services to support school age
239 children with HIV.

240 To our knowledge, this is the first study to estimate the prevalence of disability and its
241 association with school and social functioning in HIV-infected and uninfected older children
242 in a Sub-Saharan African population. Study limitations include the potential selection bias
243 from non-probability based sampling: selecting the first five children attending the HIV clinic
244 may have led to under-reported disability if children with physical or behavioral disabilities
245 were more likely to attend at clinic later. Alternatively, children with disabilities may have
246 been less likely to go to school and thus be the first to attend. Furthermore, misclassification
247 and/or recall bias from the use of self-reported functional difficulties and disability without
248 contemporaneous clinical measures of the impairments or their cause, coupled with the fact
249 that carers may not accurately perceive their children's functional difficulties, may have also
250 led to under-reported disability.

251 Unfortunately, socioeconomic data such as household income and size, asset ownership,
252 caregiver education and food security were not available which meant that analyses could not
253 be adjusted for socio-economic status. This is important as poverty and disability are likely to
254 reinforce each other, leading to vulnerability and exclusion. Children who are poor are more
255 likely to become disabled through poor healthcare, malnutrition, or dangerous living
256 conditions. Once disabled, they are more likely to be denied basic resources that would mitigate
257 deepening poverty (39). There is evidence that poverty is a major contributor to poor treatment
258 adherence among in HIV-infected children. (40). Furthermore, evidence from a large cross-
259 sectional study of South African adolescents from deprived urban areas showed that
260 orphanhood by AIDS was significantly related to childhood depression, peer problems, post-
261 traumatic stress and behavioural problems; however, adjusting for poverty indicators in this

262 study attenuated the association between AIDS-orphanhood and these psychological problems
263 (41).

264 Although it is evident that disability is common in HIV-infected children and has a major
265 impact on their lives, further research to understand the aetiology of different impairments is
266 needed to inform the design of effective interventions and appropriate rehabilitation services.
267 Examples of the type of interventions for HIV-infected children that could be introduced
268 include: 1) routine screening for impairments 2) linking HIV care to rehabilitation and
269 additional clinical services (*e.g.* ENT in the case of hearing impairment) 3) interventions to
270 promote school inclusion and social acceptance among children with HIV (*e.g.* through training
271 of parents, teachers and peers).

272 In conclusion, this study suggests physical and cognitive functional difficulties are common
273 among children with HIV. These difficulties are associated with school exclusion, including
274 impaired educational progress, difficulty forming friendships and reduced ability to participate
275 in lessons and activities. Further work is required to develop tools to better detect and
276 understand the need for rehabilitation and support services within paediatric HIV programmes.

277 **Competing interests**

278 The authors have no competing interests to declare.

279 **Authors' contributions**

280 RAF and HK designed the study. RR performed the statistical analysis and drafted the report.

281 All authors provided feedback on the draft manuscript and approved the final manuscript.

282 **Acknowledgements**

283 CLG is funded by Arthritis Research UK (grant ref 20000). This study was funded by the

284 Wellcome Trust (grant no 095878/Z/11Z).

285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347

References

1. UNICEF 2017. UNICEF Data: Monitoring the Situation of Children and Women; Global and regional trends, July 2017 Current Status and Progress. Available online from <https://data.unicef.org/topic/hivaids/global-regional-trends/#>
2. Banks LM, Zuurmond M, Ferrand R, Kuper H. The relationship between HIV and prevalence of disabilities in sub-Saharan Africa: systematic review (FA). *Trop Med Int Health*. 2015;20(4):411-29.
3. Devendra A, Makawa A, Kazembe PN, Calles NR, Kuper H. HIV and childhood disability: a case-controlled study at a paediatric antiretroviral therapy centre in Lilongwe, Malawi. *PLoS One*. 2013;8(12):e84024.
4. Yust 2004. Retinal and extraocular cytomegalovirus end-organ disease in HIV-infected patients in Europe: a EuroSIDA study, 1994–2001
5. McHugh G, Rylance J, Mujuru H, et al. Chronic Morbidity Among Older Children and Adolescents at Diagnosis of HIV Infection. *Journal of Acquired Immune Deficiency Syndromes*. 2016;73(3):275-281.
6. McNaghten AD, Wan PC, Dworkin MS, Group AASoHDP. Prevalence of hearing loss in a cohort of HIV-infected patients. *Arch Otolaryngol Head Neck Surg*. 2001;127(12):1516-8.
7. Schouten JT, Lockhart DW, Rees TS, Collier AC, Marra CM. A prospective study of hearing changes after beginning zidovudine or didanosine in HIV-1 treatment-naïve people. *BMC Infect Dis*. 2006;6:28.
8. Pasnoor, Mamatha, Richard J. Barohn, and Mazen M. Dimachkie. Toxic Myopathies. *Neurologic clinics* 32.3 (2014): 647–viii. PMC. Web. 15 May 2017.
9. Lowenthal ED, Bakeera-Kitaka S, Marukutira T, Chapman J, Goldrath K, Ferrand RA. Perinatally acquired HIV infection in adolescents from sub-Saharan Africa: a review of emerging challenges. *Lancet Infect Dis*. 2014;14(7):627-39.
10. Hrapcak S, Kuper H, Bartlett P, Devendra A, Makawa A, Kim M, et al. Hearing Loss in HIV-Infected Children in Lilongwe, Malawi. *PLoS One*. 2016;11(8):e0161421.
11. United Nations (UN). Un United Nations Convention on the Rights of Persons with Disabilities http://www.un.org/disabilities/documents/convention/convention_accessible_pdf.pdf. 2006.
12. Wabiri N, Taffa N. Socio-economic inequality and HIV in South Africa. *BMC Public Health*. 2013;13(1):1037.
13. Kuper H, Monteath-van Dok A, Wing K, Danquah L, Evans J, Zuurmond M, et al. The impact of disability on the lives of children; cross-sectional data including 8,900 children with disabilities and 898,834 children without disabilities across 30 countries. *PLoS One*. 2014;9(9):e107300.
14. Booysen, F. 2002. Financial responses of households in the free state province to HIV/AIDS-related morbidity and mortality. *South African Journal of Economics*, 70(7): 1193–1215.
15. Washington Group on Disability Statistics, UNICEF. Module on Child Functioning and Disability Available online from http://www.washingtongroup-disability.com/wp-content/uploads/2016/02/wg_unicef_child-disability-background-documentpdf. 2014.
16. Padhani DH, Manji KP, Mtanda AT. Ocular manifestations in children with HIV infection in Dar es Salaam, Tanzania. *J Trop Pediatr*. 2000;46(3):145-8.
17. Taipale A, Pelkonen T, Taipale M, Roine I, Bernardino L, Peltola H, et al. Otorhinolaryngological findings and hearing in HIV-positive and HIV-negative children in a developing country. *Eur Arch Otorhinolaryngol*. 2011;268(10):1527-32.
18. Drotar D, Olness K, Wiznitzer M, Guay L, Marum L, Svilar G, et al. Neurodevelopmental outcomes of Ugandan infants with human immunodeficiency virus type 1 infection. *Pediatrics*. 1997;100(1):E5.
19. Ferguson G, Jelsma J. The prevalence of motor delay among HIV infected children living in Cape Town, South Africa. *Int J Rehabil Res*. 2009;32(2):108-14.

- 348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
20. Kandawasvika GQ, Ogundipe E, Gumbo FZ, Kurewa EN, Mapingure MP, Stray-Pedersen B. Neurodevelopmental impairment among infants born to mothers infected with human immunodeficiency virus and uninfected mothers from three peri-urban primary care clinics in Harare, Zimbabwe. *Dev Med Child Neurol.* 2011;53(11):1046-52.
 21. Msellati P, Lepage P, Hitimana DG, Van Goethem C, Van de Perre P, Dabis F. Neurodevelopmental testing of children born to human immunodeficiency virus type 1 seropositive and seronegative mothers: a prospective cohort study in Kigali, Rwanda. *Pediatrics.* 1993;92(6):843-8.
 22. Baillieu N, Potterton J. The extent of delay of language, motor, and cognitive development in HIV-positive infants. *J Neurol Phys Ther.* 2008;32(3):118-21.
 23. Heaton RK, Clifford Db Fau - Franklin DR, Jr., Franklin Dr Jr Fau - Woods SP, Woods Sp Fau - Ake C, Ake C Fau - Vaida F, Vaida F Fau - Ellis RJ, et al. HIV-associated neurocognitive disorders persist in the era of potent antiretroviral therapy: CHARTER Study. *Neurology.* 2010, 75(23).
 24. Abubakar A, Holding P, Newton CR, van Baar A, van de Vijver FJ. The role of weight for age and disease stage in poor psychomotor outcome of HIV-infected children in Kilifi, Kenya. *Dev Med Child Neurol.* 2009;51(12):968-73.
 25. Boivin MJ, Green SD, Davies AG, Giordani B, Mokili JK, Cutting WA. A preliminary evaluation of the cognitive and motor effects of pediatric HIV infection in Zairian children. *Health Psychol.* 1995;14(1):13-21.
 26. Jelsma J, Davids N, Ferguson G. The motor development of orphaned children with and without HIV: Pilot exploration of foster care and residential placement. *BMC Pediatr.* 2011;11:11.
 27. McDonald CM, Manji KP, Kupka R, Bellinger DC, Spiegelman D, Kisenge R, et al. Stunting and wasting are associated with poorer psychomotor and mental development in HIV-exposed Tanzanian infants. *J Nutr.* 2013;143(2):204-14.
 28. Ruel TD, Boivin MJ, Boal HE, Bangirana P, Charlebois E, Havlir DV, et al. Neurocognitive and motor deficits in HIV-infected Ugandan children with high CD4 cell counts. *Clin Infect Dis.* 2012;54(7):1001-9.
 29. Shead GM, Potterton J, Stewart A. Neurodevelopment and growth of institutionalized children with vertically transmitted human immunodeficiency virus. *Vulnerable Children and Youth Studies.* 2010;5(1):33-43.
 30. Esch P, Bocquet V, Pull C, Couffignal S, Lehnert T, Graas M, Fond-Harmant, Anseau M. The downward spiral of mental disorders and educational attainment: a systematic review on early school leaving. *BMC Psychiatry*201414:237 <https://doi.org/10.1186/s12888-014-0237-4>
 31. Rao D, Kekwaletswe TC, Hosek S, Martinez J, Rodriguez F. Stigma and social barriers to medication adherence with urban youth living with HIV. *AIDS Care.* 2007 Jan;19(1):28-33.
 32. L. Cluver & F. Gardner. Risk and protective factors for psychological well-being of children orphaned by AIDS in Cape Town: a qualitative study of children and caregivers' perspectives. *AIDS Care* Vol. 19, Iss. 3,2007a.
 33. Kumakech E, Cantor-Graae E, Maling S, Bajunirwe F. Peer-group support intervention improves the psychosocial well-being of AIDS orphans: cluster randomized trial. *Soc Sci Med.* 2009 Mar; 68(6):1038-43.
 34. Betancourt TS, Meyers-Ohki SE, Charrow A, Hansen N. Mental Health and Resilience in HIV/AIDS-Affected Children: A Review of the Literature and Recommendations for Future Research. *Journal of child psychology and psychiatry, and allied disciplines.* 2013;54(4):423-444. doi:10.1111/j.1469-7610.2012.02613.
 35. World Health Organization (2010a) Community Based Rehabilitation (CBR) Guidelines. Geneva: WHO. <http://www.who.int/disabilities/cbr/guidelines/en/index.html> Werner D. (2009) Disabled Village Children. Berkeley, CA.: The Hesperian Foundation. <http://hesperian.org/books-and-resources/>
 36. UNESCO, 'Inclusive education: the way of the future', paper prepared for the International Conference on Education, Geneva, 2008.

- 411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
37. Nixon SA, Hanass-Hancock J, Whiteside A, Barnett T. The increasing chronicity of HIV in sub-Saharan Africa: Re-thinking "HIV as a long-wave event" in the era of widespread access to ART. *Globalization and Health*. 2011;7:41. doi:10.1186/1744-8603-7-41.
 38. Hanass-Hancock J, Strode A, Grant C. Inclusion of disability within national strategic responses to HIV and AIDS in Eastern and Southern Africa. *Disability and Rehabilitation*. 2011;33(22-23):2389-96.
 39. UNICEF Children and Young People with Disabilities Fact Sheet May 2013
 40. Bermudez LG, Jennings L, Ssewamala FM, Nabunya P, Mellins C, McKay M. Equity in adherence to antiretroviral therapy among economically vulnerable adolescents living with HIV in Uganda. *AIDS Care*. 2016;28(sup2):83-91. doi:10.1080/09540121.2016.1176681.
 41. Lucie Cluver, Frances Gardner & Don Operario. Poverty and psychological health among AIDS-orphaned children in Cape Town, South Africa. *AIDS Care* Vol. 21, Iss. 6,2009.

427

Table 1. Baseline Characteristics of HIV-infected and HIV-uninfected Children in Zimbabwe

Characteristic	HIV+ n=202 n (%)^a	HIV- n=285 n (%)	p value
Age			
6 -11 years	132 (65.4)	165 (57.9)	0.06 ^b
12 -16 years	70 (34.6)	32 (42.1)	
<i>Median (IQR) years</i>	<i>11 (8, 13)</i>	<i>10 (8, 13)</i>	0.61 ^c
Sex			
Female	97 (48.0)	139 (48.8)	0.11 ^b
Orphan status			
Single orphan	69 (34.2)	25 (8.8)	<0.001 ^b
Double orphan	28 (13.9)	7 (2.5)	
Not orphaned	98 (48.5)	245 (85.9)	
Age at HIV diagnosis			
<i>Median (IQR) years</i>	<i>5 (3, 7)</i>		
Age at ART initiation			
<i>Median (IQR) years</i>	<i>8 (5, 10)</i>		
ART duration			
<1 years	75 (37.1)		
1-5 years	97 (48.0)		
>5 years	30 (14.9)		
CD4			
<200 cells/ μ l	9 (4.5)		
200-500 cells/ μ l	47 (23.2)		
>500 cells/ μ l	144 (71.3)		
<i>Median (IQR) cells/μl</i>	<i>726 (476, 941)</i>		
Viral load			
<400 copies/ml	152 (75.2)		
400-5000 copies/ml	14 (7.0)		
>5000 copies/ml	32 (15.8)		
<i>Median (IQR) copies/ml</i>	<i>19 (19, 250)</i>		

Abbreviations: HIV+ HIV-infected, HIV- HIV-uninfected, SD standard deviation, IQR inter quartile range

a) n (%) shown, except for median and IQR shown in italics

b) p value from χ^2 test

c) p value from Mann-Whitney U test

431 **Table 2. Domains of Disability and Functioning in HIV-infected and HIV-uninfected Children**
 432 **in Zimbabwe**
 433

Outcome	HIV+ n=202 n (%)	HIV- n=285 n (%)	Crude OR (95% CI)	p value^a	aOR (95% CI)	p value^a
Any disability	76 (37.6)	53 (18.8)	2.3 (1.6, 5.3)	<0.001	2.8 (1.8, 4.2)	<0.001
Seeing	16 (7.7)	9 (3.1)	2.7 (1.2, 6.0)	0.009	3.0 (1.3, 6.9)	0.009
Hearing	10 (4.8)	4 (1.4)	3.4 (1.1, 10.6)	0.031	3.4 (1.0, 10.5)	0.036
Walking	5 (2.5)	1 (0.4)	7.4 (0.9, 63.5)	0.065	7.4 (0.9, 63.5)	0.055
Speaking	9 (4.3)	3 (1.1)	4.0 (1.1, 14.5)	0.042	3.8 (1.1, 13.9)	0.042
Learning	48 (23.2)	33 (11.6)	2.1 (1.3, 3.2)	0.002	3.9 (1.4, 3.4)	0.001
Memory	37 (17.8)	16 (5.6)	3.6 (2.0, 6.6)	<0.001	3.5 (2.0, 6.6)	<0.001
Self-caring	3 (1.5)	1 (0.4)	1.7 (0.4, 8.0)	0.072	1.6 (0.4, 7.8)	0.524
Anxiety	42 (20.3)	14 (5.6)	4.6 (2.4, 8.2)	0.000	4.4 (2.4, 8.1)	<0.001
Depression	32 (15.5)	12 (4.2)	4.2 (2.1, 8.5)	0.010	4.2 (2.1, 8.4)	0.010
Controlling behaviour	3 (1.5)	1 (0.4)	4.0 (0.4, 39.4)	<0.001	4.0 (0.4, 39.3)	0.003
Concentration	2 (1.0)	6 (2.1)	0.4 (0.1, 2.2)	0.478	0.4 (0.1, 2.2)	0.311
Accepting change	39 (10.9)	36 (12.6)	1.6 (0.9, 2.6)	0.085	1.5 (1.0, 2.5)	0.075
Making friends	10 (4.8)	1 (0.4)	14.6 (1.9, 115.2)	0.001	14.8 (1.9, 116.6)	0.011

Abbreviations: **HIV+** HIV-infected, **HIV-** HIV-uninfected, **OR** odds ratio, **aOR** age, sex adjusted odds ratio.
 a) p value from χ^2 test

435 **Table 3. Difference in HIV Characteristics Amongst HIV-infected Children With and Without**
 436 **Disability in Zimbabwe**
 437

Characteristic	HIV+ with disability: n ^a =76	HIV+ without disability: n=126	p value	
Age <i>Median (IQR) years</i>	<i>10.9 (2.6)</i>	<i>10.3 (2.6)</i>		
6-9 years	24 (31.6)	48 (38.1)	0.77	-
10-12 years	31 (40.8)	50 (39.7)		
13-14 years	15 (19.7)	20 (15.9)		
15-16 years	6 (7.9)	8 (6.4)		
Age at diagnosis <i>Median (IQR) years</i>	<i>5.0 (3.0)</i>	<i>5.1 (2.9)</i>		-
Age of ART initiation <i>Median (IQR) years</i>	<i>8 (6, 11)</i>	<i>7 (5, 10)</i>	0.78	
Sex Female	35 (46.0)	62 (49.2)	0.66	
				aOR (95% CI)
CD4 count <i>Median (IQR) cells/uL</i>	<i>736 (513, 914)</i>	<i>720 (459, 910)</i>		
<200 cells/uL	3 (4.0)	6 (4.7)	0.78	1.0
200-500 cells/uL	15 (19.7)	32 (25.4)		1.4 (0.8, 2.5)
>500 cells/uL	57 (75.0)	87 (69.1)		
Viral load <i>Median (IQR) copies/ml</i>	<i>19 (19, 190)</i>	<i>19 (19, 343)</i>		
<400 copies/ml	57 (75.0)	95 (75.4)	0.16	1.0
400-5000 copies/ml	2 (2.6)	12 (9.5)		1.1 (0.7, 1.6)
>5000 copies/ml	14 (18.4)	18 (14.3)		
ART duration <i>Median (IQR) years</i>	<i>2 (1, 5)</i>	<i>1 (0, 4)</i>		
<1 years	24 (31.6)	51 (40.5)	0.21	1.0
1-5 years	39 (51.3)	58 (46.0)		1.2 (0.8, 1.9)
>5 years	13 (17.1)	17 (13.5)		
No of hospital admissions in 12 months >1	5 (6.6)	5 (4.0)		1.9 (0.6, 6.1)
Past history of TB	29 (38.2)	50 (39.7)	0.94	0.9 (0.5, 1.6)

Abbreviations HIV+ HIV-infected, HIV- HIV Uninfected, **aOR** odds ratio adjusted for age and sex, **ART** antiretroviral therapy, **TB** tuberculosis, **IQR** inter quartile range.

a) n shown, except for median and IQR shown in italics

Table 4. School and Social Inclusion at School in HIV-infected and HIV-uninfected Children and in HIV-infected Children with and Without Disability

Characteristic	HIV+ n=202 n (%)	HIV- n=285 n (%)	aOR (95% CI)	HIV+ with disability n=76 n (%)	HIV+ without disability n=126 n (%)	aOR (95% CI)
School inclusion as reported by children and their carers						
Currently enrolled in school	194 (96.0)	273 (96.0)	0.98 (0.4, 2.5)	71 (93.4)	123 (97.6)	0.3 (0.1, 1.5)
Enrolled in the same grade as peers	102 (50.5)	197 (69.1)	2.4 (1.6, 3.6)	24 (31.6)	78 (61.9)	3.3 (1.7, 6.1)
Ever repeated a year at school	68 (33.7)	53 (18.6)	2.5 (1.6, 3.8)	32 (42.1)	36 (28.6)	1.9 (1.0, 3.6)
Social inclusion at school as reported by children and their carers						
No help from teachers, if problem at school	4 (2.0)	2 (0.7)	2.1 (1.2, 3.8)	2 (2.6)	2 (1.6)	1.7 (0.9, 3.2)
No help from friends, if problem at school	15 (7.4)	3 (1.1)	3.0 (2.0, 4.5)	11(14.5)	4 (3.2)	1.5 (0.9, 2.4)
Child has no friends to play with	2 (1.0)	1 (0.4)	1.8 (0.7, 5.0)	2 (2.6)	1 (0.8)	1.7 (0.8, 5.7)
Friends look up to child as a leader	108 (53.5)	147 (51.6)	1.1 (0.8, 1.6)	44 (57.9)	41 (32.5)	2.1 (1.4, 3.4)
Other children hit, hurt /say nasty things to child	58 (28.7)	28 (9.8)	3.7 (2.2, 6.0)	30 (39.5)	28 (22.2)	2.5 (1.3, 4.8)
Child does not feel included in lessons and activities	6 (3.0)	2 (0.7)	4.7 (2.7, 8.3)	3 (4.0)	3 (2.4)	0.6 (0.1, 3.0)

Abbreviations HIV+ HIV-infected, HIV- HIV Uninfected, aOR odds ratio adjusted for age and sex.

Supplementary Table 5. School and Social Inclusion at School in Disabled Children With and Without HIV-infection

Characteristic	HIV+ with disability n=76 n (%)	HIV- with disability n=53 n (%)	aOR (95% CI)
School inclusion as reported by children and their carers			
Currently enrolled in school	71 (93.4)	52 (98.1)	1.1 (0.3, 4.5)
Enrolled in the same grade as peers	24 (31.6)	32 (57.1)	0.3 (0.1, 0.6)
Ever repeated a year at school	32 (42.1)	12 (21.4)	3.3 (1.4, 8.0)
Social inclusion as reported by children and their carers			
No help from teachers, if problem at school	2 (2.6)	1 (1.8)	0.1 (0.1, 8.1)
No help from friends, if problem at school	11 (14.5)	1 (1.8)	0.5 (0.0, 0.9)
Child has no friends to play with	2 (2.6)	0 (0.0)	-
Friends look up to child as a leader	26 (34.2)	27 (48.2)	0.5 (0.3, 1.1)
Other children physically or verbally bully	30 (39.5)	3 (5.4)	11.3 (3.9, 39.8)
Child excluded in lessons and activities	3 (4.0)	1 (1.8)	0.4 (0.0, 4.4)
Abbreviations HIV+ HIV-infected, HIV- HIV Uninfected, aOR odds ratio adjusted for age and sex.			