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Decreased vigorous physical activity in school-aged children with HIV in Johannesburg, South Africa

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Abstract

Objective—To describe physical activity in South African children with and without HIV.

Study design—Study measurements were obtained in 218 children with perinatal HIV and 180 children without HIV aged 5–10 years in a study conducted in Johannesburg, South Africa. Weight-for-age (WAZ) and height-for-age (HAZ) Z-scores, and frequency and duration of moderate and vigorous physical activity, and sedentary behavior, were obtained. Measures were compared between children with and without HIV.

Results—WAZ and HAZ were significantly lower for children with HIV compared with those without HIV. Among children who attended school, less children with HIV participated in physical education (41 vs. 64%, $p=0.0003$) and organized after-school sports (38 vs. 64%, $p<0.001$) than children without HIV. The proportion of children in both groups meeting World Health Organization recommendations for physical activity was similar (84% overall). However, girls with HIV spent less time in vigorous physical activity than girls without HIV (420 vs. 780 minutes/week, $p=0.001$). This difference remained significant even when girls with medical conditions with potential to limit physical activity were excluded, and after adjusting for age. Time spent in sedentary behaviors did not differ significantly between the groups.

Conclusion—Although children with HIV with well-controlled disease after initiating antiretroviral therapy early in life achieve high levels of physical activity, vigorous physical

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activity is lower in girls with HIV than in healthy controls. This may reflect lower participation in school-based physical education and organized after-school physical activity.

Access to antiretroviral therapy (ART) for children with HIV has increased survival through adolescence and adulthood, making the optimization of long-term health outcomes an important goal. There is evidence of increased endothelial dysfunction, carotid artery intima-media thickening, inflammatory biomarkers, and re-distribution of body fat in adults, adolescents, and children with HIV.^{1–6} In addition, time spent in sedentary behaviors is independently associated with cardiovascular mortality and diabetes incidence in adults.⁷ Screen time (eg, television) is associated with cardiovascular risk factors in adolescents.⁸ In South Africa, a country with a high burden of HIV and a growing epidemic of cardiovascular disease, 1 in 3 adolescents watch more than three hours of television daily, and inactivity and obesity are increasing.^{9–13}

Physical activity provides long-term benefit for a number of outcomes, including blood pressure, bone density, and anthropometric markers such as waist circumference, in children and adolescents.^{14–20} In South Africa, school-aged children spend 20 minutes per day in moderate or vigorous physical activity.^{9–13} However, no studies describe physical activity or sedentary behaviors among children with HIV who may have greater lifetime risk for cardiovascular disease due to cumulative lifetime exposure to HIV and ART.

Given the increasing prevalence of non-communicable disease in South Africa, and the growing body of literature about adverse metabolic, bone, and cardiovascular outcomes in those living with HIV on lifelong ART, it is important to understand patterns of physical activity in this population. This study describes patterns of physical activity in a cohort of school-aged South African children with HIV who have been well controlled with ART since early in life, compared with children without HIV of similar age.

Methods

Data were obtained during the baseline visit of CHANGES (Childhood HAART Alterations in Normal Growth, Genes, and aGing Evaluation Study) Bone Study, a longitudinal observational cohort study of children with perinatal HIV and controls conducted at the Empilweni Service and Research Unit at Rahima Moosa Mother and Child Hospital in Johannesburg, South Africa, and approved by the Institutional Review Boards of Columbia University and the University of Witwatersrand. Prepubertal children with HIV aged 5–9 years old who were initiated early in life and maintained on ART were included in this study. These children were recruited after completion of prior clinical trials at the study site.^{21–23} Uninfected prepubertal controls aged 5–9 years old were recruited without matching to children with HIV, from household members of children with HIV or healthy children attending preventative health services at the study site. Children with chronic medical conditions or lack of documented HIV negative test results were excluded. The mother or legal guardian provided written informed consent and assent was obtained from children 7 years and older.

Caregiver demographic and household characteristics were obtained by questionnaire. Weight, to the nearest 0.1 kg, was measured by a digital scale, and height, to the nearest

0.1cm, by a stadiometer. Weight- (WAZ), height- (HAZ), and BMI-for-age (BAZ) z-scores were calculated using World Health Organization (WHO) standards.²⁴ Overweight and obesity were defined as having a BAZ greater than one and two standard deviations respectively, above the WHO growth standard median.²⁴ Fat free mass percentage of total body mass (FFM) was estimated by single-frequency bioimpedance analysis (Quantum II, RJL Systems, Clinton Township, Michigan, USA) using an equation derived and validated by Horlick et al based on dual x-ray absorptiometry in children and adolescents that included children with IV as follows:

$$\text{FFM} = [3.474 + 0.459 \text{ height}^2 / \text{resistance} + 0.064 * \text{weight}] / [0.769 - 0.009 * \text{age} - 0.01 * \text{sex}],$$

where male=1, and female=0.²⁵

A questionnaire quantifying total physical activity, sedentary behaviors, and time spent sleeping during the previous week was administered by a trained interviewer in the presence of both the child and caregiver. The questionnaire has been used previously and validated by accelerometry in an urban South African cohort at 9 years of age.^{18,26} Additional activities were included in the questionnaire to reflect the most common activities in our sample from a younger, Johannesburg-based, urban population, e.g. playground activities such as playing tag, skipping rope, and active household chores. Activities were evaluated using five domains: physical education at school, informal activities at school (e.g. during recess), organized after-school activities (eg, extramural or club sports), informal after-school activities, and activities of daily living (walking for transportation and chores). The frequency and duration of all physical activities, sedentary behaviors, and time spent sleeping in the previous week were recorded. The metabolic equivalent (MET, defined as the energy expenditure for sitting quietly, or approximately 3.5 ml of oxygen/kg body weight/minute in an average adult) of each physical activity reported by the participants was determined according to the Compendium of Energy Expenditures for Youth.²⁷ Vigorous physical activities were defined as ≥ 7 METs, consistent with other South African literature, and included running, soccer, netball, skipping rope, tennis, and rugby. Moderate physical activities (3–6.9 METs) included playground activities, bicycling, walking, active chores, dancing, swimming, volleyball, cricket, and high jump. Moderate-vigorous physical activity included both moderate and vigorous physical activities. The WHO recommends 60 minutes of moderate or vigorous physical activity daily, and vigorous activities at least three times weekly for children aged 5–17 years old.²⁸ Screen time was defined as time spent on activities that involved viewing a screen and included time spent watching television, or playing games on a computer or cellular phone. Medical diagnoses were assessed based on caregiver report and physical exam performed by a physician. CD4 percentage and HIV-1 RNA concentration (Roche COBAS TaqMan HIV-1) were measured in all subjects with HIV.

Statistical Analyses

Only children attending school (n=258) were included in the analysis for physical education, informal activity at school, and organized after-school activities. Time spent in all physical activity domains was calculated in minutes/week, and in order to provide a context for each

activity domain, also as a proportion of total times spent in all reported physical activities. All time reported in moderate physical activity, vigorous physical activity, sedentary behavior, and time spent sleeping was calculated in minutes/week. The proportion of children meeting WHO recommendations for physical activity was determined. Any significant findings were reanalyzed excluding children who had a medical diagnosis that had potential to limit physical activity, to assess for confounding. The data did not have a normal distribution, and therefore is presented as median (IQR) for continuous data, and frequency for categorical data. Outcomes were compared between groups using Wilcoxon tests for continuous variables and Chi-squared or Fisher exact tests for categorical variables. Linear regression was used to evaluate the relationships between FFM, BAZ, and WAZ; and physical activity and sedentary behavior. Logistic regression was used to evaluate the relationships between overweight and obesity, and physical activity and sedentary behavior. All analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC).

Results

Four hundred children enrolled from March 2013 to November 2014; 398 with complete physical activity questionnaires were included in this analysis, 218 children with HIV and 180 without HIV. Study subject characteristics are in Table I. Children with HIV were younger and fewer were attending school (70% vs 78%, $p<0.001$) compared with children without HIV. Children with HIV had lower WAZ, HAZ, but similar BAZ scores. Children with HIV were initiated on ART at a median age of 6.2 months (IQR: 3.4, 12.3), and at enrollment 94% were virologically suppressed (HIV-RNA <400 copies/mL) and had a median CD4 percentage of 38 (IQR: 33, 41). Fifty percent were taking an efavirenz-based regimen, and fifty percent were taking a lopinavir/ritonavir-based regimen. Caregivers among children with HIV were older, and more likely to be employed. Children with HIV were more likely to live in a shack rather than a house, and other socioeconomic factors were similar.

Physical Activities

Children with HIV versus children without HIV—Physical activity domains and sedentary behaviors are presented in Table II. Among children attending school, fewer children with HIV participated in physical education (41 vs. 64%, $p=0.003$) and organized after-school activities (38 vs 64%, $p<0.001$) than children without HIV. Children with HIV spent less proportion of their time in physical education (4.6 vs 8.4%, $p=0.003$) and organized after-school activities compared with children without HIV (2.9 vs 6.7%, $p<0.0001$). Almost all children participated in moderate and vigorous physical activity, with 577 minutes/week and 600 minutes/week, respectively. There were no differences in time spent in moderate physical activity between the two groups, however children with HIV spent less time in vigorous physical activity than children without HIV (470 vs. 738 minutes/week, $p=0.003$). Overall, 84% of children met WHO recommendations, and no differences were observed between the two groups (83 vs. 87%). Fifteen children (5 boys and 10 girls), all in the group with HIV, had a medical diagnosis that may have affected participation in some physical activities. These included spastic diplegia (12), cerebellar abnormalities (1) blindness (1), and residual disability from acute demyelinating

encephalomyelitis (1). After excluding those with medical diagnoses that had potential to limit physical activity, all these findings remained the same.

HIV vs those without HIV, stratified by sex—Among the children attending school (74%), 27% of girls vs. 40% of boys participated in physical education ($p=0.005$); participation was similar in other activity domains. Boys with HIV were less likely to participate in physical education (49 vs. 70%, $p=0.001$) and organized after-school activity (40 vs. 66%, $p=0.003$) compared with boys without HIV; girls with HIV were less likely to participate in physical education (34 vs. 55%, $p=0.02$) and organized after-school activity (37 vs. 61%, $p=0.008$) than girls without HIV. When determining the proportion of overall time spent in each activity domain among participants (Figure 1), boys with HIV spent a significantly less proportion of time in organized after-school activities compared with boys without HIV; girls with HIV spent a significantly less proportion of time in organized after-school activities and physical education compared with girls without HIV.

There was no difference in vigorous physical activity between boys with and without HIV (600 vs. 615 minutes/week, $p=0.34$); however, girls with HIV spent less time in vigorous physical activity than girls without HIV (420 vs. 780 minutes/week, $p=0.001$; Figure 2). These differences were similar after excluding those with medical diagnoses possibly limiting physical activity. While adjusting for age decreased the difference in vigorous physical activity between the girls with and without HIV, it remained significantly different, with girls with HIV spending 90 minutes/week less in vigorous physical activity than girls without HIV ($p=0.02$).

Sedentary behaviors and sleep—All except one child reported participating in sedentary behaviors, and total time spent in sedentary behaviors was similar among children with and without HIV (median of 960 minutes/week). Girls with HIV spent less time in sedentary behaviors than girls without HIV (Figure 2). Overall screen time was significantly lower in children with HIV, but time spent sleeping was similar between the groups.

Association between physical activity and body composition—There were no significant associations between time spent in moderate-vigorous, moderate or vigorous physical activity, sedentary behaviors, or screen time and BAZ, WAZ, being overweight or obese. However, among boys with HIV, moderate-vigorous physical activity (combined) was positively associated with FFM. Among children with HIV, for every 0.2 hours per day (SE: 0.08) spent in moderate-vigorous physical activity, there was a one percent increase in FFM ($p=0.019$). Among boys with HIV, for every 0.25 hours per day (SE: 0.13) spent in moderate-vigorous physical activity, there was a one percent increase in FFM ($p=0.048$). There were no significant associations between FFM and time spent in sedentary behaviors.

Discussion

Overall there were high levels of physical activity in this sample of urban dwelling South African children with and without HIV, with 84% meeting WHO physical activity recommendations, similar to a previous study from South Africa.¹¹ The reported levels of moderate physical activity of these children with HIV who initiated ART early in life and

have well controlled disease compare favorably with children without HIV. However, girls with HIV spent less time in vigorous physical activity, even when excluding those with medical diagnoses that potentially impede physical activity. Additionally, the children with HIV and controls without HIV in our cohort were recruited from the same community and had similar opportunities for and access to physical activities. Although there are no studies describing physical activity in children with HIV, less overall and vigorous physical activity in healthy girls compared with boys is reported in prior studies.^{11, 18, 29} Lower participation in physical education and organized after-school physical activity may account for the difference in vigorous physical activity in girls with HIV. Research is needed to understand why girls overall and girls with HIV in particular are not participating in physical education and organized after-school activities, which are important opportunities for participation in vigorous physical activity in school-aged children.

Our cohort spent a median of 2.3 hours daily in sedentary behaviors, consisting largely of watching television. This was consistent with other South African studies.¹⁹ Fifty-four percent of our cohort exceeded the American Academy of Pediatrics recommendation of less than two hours of screen time daily.^{11, 30} In our cohort, 96% of children have a television and 23% have a computer in the home. Sedentary behaviors and screen time increase with age, with girls spending the most time in sedentary behaviors.^{11, 29} School-aged girls are less physically active than boys, and those who spend more than four hours of screen time per day are twice as likely to be overweight.^{11, 29} Accessibility to television, electronic, and mobile devices facilitate sedentary behaviors at a young age, contributing to obesity in children and adolescents.

Unfavorable alterations in lipids, as well as abnormal fat distribution, risk factors for future cardiovascular disease, have been observed in young South Africans with HIV receiving ART.⁴ Cardiovascular risk may be further elevated among South African women with HIV due to increased prevalence of central adiposity compared with women without HIV, as well as elevated inflammatory biomarkers.^{1, 31} We found a positive linear relationship between FFM and physical activity among boys with HIV in our cohort, suggesting that moderate-vigorous physical activity could have a favorable impact on body composition. The absence of similar findings among the girls is unclear but may be due to less robust relationship at lower levels of exercise. This is consistent with literature reporting an exercise program with children with HIV resulting in increases in muscle strength and lean body mass.³² Although data is lacking in children, lean muscle mass is associated with decreased cardiovascular disease risk in adults.³³ In light of increased risks due to HIV, sex, and decreased physical activity, school-based interventions targeting girls with HIV, and girls in general, to increase physical education and organized after-school physical activity participation may have an impact on increasing vigorous physical activity and reducing cardiovascular risk in this population.

Our questionnaire was adapted from an established instrument which has been validated using accelerometry.²⁶ When compared with accelerometry, the questionnaires overestimate vigorous physical activity with a moderate correlation; had a good correlation with sedentary behaviors; and no correlation with moderate physical activity.²⁶ Accelerometry may provide length of time and intensity of physical activity, and be less subject to recall and reporting

bias. However, the strength of using a questionnaire is its ability to provide context, and allows for categorization of physical activities into various domains, providing direction for focused interventions. We adapted the questionnaire to include physical activities common to our sample such as playground activities, playing tag, skipping rope, and active chores. We also divided activities at school into physical education and informal in-school activities, as opposed to combining these two activity domains into one overall “school activities” category. The physical activity questionnaire we used was quite extensive, and its use in a large sample size should be acceptable for surveillance purposes. Our questionnaire was limited to physical activities over the last week in an effort to decrease recall bias, but this also may limit the ability to capture seasonal variation that may take place with certain activities. Other strengths of this study include a relatively large sample size, and the availability of uninfected controls of a similar age. Limitations of this study include its cross-sectional design, and those inherent to questionnaire based studies, including recall bias.

In conclusion, there are high levels of physical activity among school-aged children with HIV who were initiated early and are well controlled on ART. However, time spent in vigorous physical activity was lower among girls with HIV, and may reflect lower participation in school-based physical education and organized after-school physical activity. Additional research to determine if school or after-school based interventions increase physical activity participation and impact on cardiovascular risk profile in children with HIV is warranted.

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List of Abbreviations

ART	antiretroviral therapy
WAZ	weight-for-age z-score
HAZ	height-for-age z-score
BAZ	BMI-for-age z-score
WHO	World Health Organization
FFM	fat free mass percentage of total body mass
MET	metabolic equivalent

References

1. Goedecke JH, Micklesfield LK, Levitt NS, Lambert EV, West S, Maartens G, et al. Effect of different antiretroviral drug regimens on body fat distribution of HIV-infected South African women. *AIDS Res Hum Retrov*. 2013; 29:557–63.
2. Hanna DB, Post WS, Deal JA, Hodis HN, Jacobson LP, Mack WJ, et al. HIV Infection Is Associated With Progression of Subclinical Carotid Atherosclerosis. *Clin Infect Dis*. 2015; 61:640–50. [PubMed: 25904369]
3. Kuller LH, Tracy R, Belloso W, De Wit S, Drummond F, Lane HC, et al. Inflammatory and coagulation biomarkers and mortality in patients with HIV infection. *PLoS Med*. 2008; 5:e203. [PubMed: 18942885]
4. Arpad S, Shiao S, Strehlau R, Martens L, Patel F, Coovadia A, et al. Metabolic abnormalities and body composition of HIV-infected children on Lopinavir or Nevirapine-based antiretroviral therapy. *Arch Dis Child*. 2013; 98:258–64. [PubMed: 23220209]
5. Miller TI, Borkowsky W, DiMeglio LA, Dooley L, Geffner ME, Hazra R, et al. Metabolic abnormalities and viral replication are associated with biomarkers of vascular dysfunction in HIV-infected children. *HIV Med*. 2012; 13:264–75. [PubMed: 22136114]
6. Ross AC, Storer N, O'Riordan MA, Dogra V, McComsey GA. Longitudinal changes in carotid intima-media thickness and cardiovascular risk factors in human immunodeficiency virus-infected children and young adults compared with healthy controls. *Pediatr Infect Dis J*. 2010; 29:634–8. [PubMed: 20589981]
7. Biswas A, Oh PI, Faulkner GE, Bajaj RR, Silver MA, Mitchell MS, et al. Sedentary time and its association with risk for disease incidence, mortality, and hospitalization in adults: a systematic review and meta-analysis. *Ann Intern Med*. 2015; 162:123–32. [PubMed: 25599350]
8. Mark AE, Janssen I. Relationship between screen time and metabolic syndrome in adolescents. *J Public Health*. 2008; 30:153–60.
9. Reddy, SPJS.; Sewpaul, R.; Koopman, F.; Funani, NI.; Sifunda, S.; Josie, J.; Masuka, P.; Kambaran, NS.; Omdien, RG. Umthenthe Uhlaba Usamila—The South African Youth Risk Behaviour Survey 2002. Cape Town: South African Medical Research Council; 2008.
10. Reddy SP, Resnicow K, James S, Funani IN, Kambaran NS, Omdien RG, et al. Rapid increases in overweight and obesity among South African adolescents: comparison of data from the South African National Youth Risk Behaviour Survey in 2002 and 2008. *Am J Public Health*. 2012; 102:262–8. [PubMed: 21940919]
11. McVeigh J, Meiring R. Physical activity and sedentary behavior in an ethnically diverse group of South african school children. *J Sports Sci Med*. 2014; 13:371–8. [PubMed: 24790492]
12. Healthy Active Kids South Africa. 2014. Available from: https://www.discovery.co.za/microsites_za/vitality_schools/web/linked_content/pdfs/general/healthy_active_kids_report_book_web_optimized.pdf
13. Mayosi BM, Flisher AJ, Lalloo UG, Sitas F, Tollman SM, Bradshaw D. The burden of non-communicable diseases in South Africa. *Lancet*. 2009; 374:934–47. [PubMed: 19709736]
14. Haskell WL, Blair SN, Hill JO. Physical activity: health outcomes and importance for public health policy. *Prev Med*. 2009; 49:280–2. [PubMed: 19463850]
15. Ekelund U, Luan J, Sherar LB, Esliger DW, Griew P, Cooper A, et al. Moderate to vigorous physical activity and sedentary time and cardiometabolic risk factors in children and adolescents. *JAMA*. 2012; 307:704–12. [PubMed: 22337681]
16. Fedewa MV, Gist NH, Evans EM, Dishman RK. Exercise and insulin resistance in youth: a meta-analysis. *Pediatrics*. 2014; 133:e163–74. [PubMed: 24298011]
17. Vaitkeviciute D, Latt E, Maestu J, Jurimae T, Saar M, Purge P, et al. Physical activity and bone mineral accrual in boys with different body mass parameters during puberty: a longitudinal study. *PLoS One*. 2014; 9:e107759. [PubMed: 25279833]
18. McVeigh JA, Norris SA, Cameron N, Pettifor JM. Associations between physical activity and bone mass in black and white South African children at age 9 yr. *J Appl Physiol*. 2004; 97:1006–12. [PubMed: 15132999]

19. McVeigh JA, Norris SA, Pettifor JM. Bone mass accretion rates in pre- and early-pubertal South African black and white children in relation to habitual physical activity and dietary calcium intakes. *Acta Paediatr.* 2007; 96:874–80. [PubMed: 17537016]
20. Lima LR, Silva RC, de Giuliano IC, Sakuno T, Brincas SM, Carvalho AP. Bone mass in children and adolescents infected with human immunodeficiency virus. *J Pediatr (Rio J).* 2013; 89:91–9. [PubMed: 23544816]
21. Coovadia A, Abrams EJ, Stehlau R, Meyers T, Martens L, Sherman G, et al. Reuse of nevirapine in exposed HIV-infected children after protease inhibitor-based viral suppression: a randomized controlled trial. *JAMA.* 2010; 304:1082–90. [PubMed: 20823434]
22. Kuhn L, Coovadia A, Stehlau R, Martens L, Hu CC, Meyers T, et al. Switching children previously exposed to nevirapine to nevirapine-based treatment after initial suppression with a protease-inhibitor-based regimen: long-term follow-up of a randomised, open-label trial. *Lancet Infect Dis.* 2012; 12:521–30. [PubMed: 22424722]
23. Coovadia A, Abrams EJ, Stehlau R, Shiao S, Pinillos F, Martens L, et al. Efavirenz-Based Antiretroviral Therapy Among Nevirapine-Exposed HIV-Infected Children in South Africa: A Randomized Clinical Trial. *JAMA.* 2015; 314:1808–17. [PubMed: 26529159]
24. WHO. child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development. Geneva: World Health Organization; 2006.
25. Horlick M, Arpadi SM, Bethel J, Wang J, Moye J Jr, Cuff P, et al. Bioelectrical impedance analysis models for prediction of total body water and fat-free mass in healthy and HIV-infected children and adolescents. *Am J Clin Nutr.* 2002; 76:991–9. [PubMed: 12399270]
26. McVeigh JA, Norris SA. Criterion validity and test-retest reliability of a physical activity questionnaire in South African primary school-aged children. *J Sports Med.* 2012; 24:43–48.
27. Ainsworth BE, Haskell WL, Herrmann SD, Meckes N, Bassett DR Jr, Tudor-Locke C, et al. 2011 Compendium of Physical Activities: a second update of codes and MET values. *Med Sci Sports Exerc.* 2011; 43:1575–81. [PubMed: 21681120]
28. Global recommendations on physical activity for health. Geneva: World Health Organization; 2010.
29. Micklesfield LK, Pedro TM, Kahn K, Kinsman J, Pettifor JM, Tollman S, et al. Physical activity and sedentary behavior among adolescents in rural South Africa: levels, patterns and correlates. *BMC Public Health.* 2014; 14:40. [PubMed: 24433276]
30. American Academy of Pediatrics, Committee on Public Education. American Academy of Pediatrics: Children, adolescents, and television. *Pediatrics.* 2001; 107:423–6. [PubMed: 11158483]
31. Dolan SE, Hadigan C, Killilea KM, Sullivan MP, Hemphill L, Lees RS, et al. Increased cardiovascular disease risk indices in HIV-infected women. *J Acquir Immune Defic Syndr.* 2005; 39:44–54. [PubMed: 15851913]
32. Miller TL, Somarriba G, Kinnamon DD, Weinberg GA, Friedman LB, Scott GB. The effect of a structured exercise program on nutrition and fitness outcomes in human immunodeficiency virus-infected children. *AIDS Res Hum Retroviruses.* 2010; 26:313–9. [PubMed: 20218880]
33. Lang PO, Trivalle C, Vogel T, Proust J, Papazian JP. Markers of metabolic and cardiovascular health in adults: Comparative analysis of DEXA-based body composition components and BMI categories. *J Cardiol.* 2015; 65:42–9. [PubMed: 24794756]

Figure 1. Distribution of physical activities among HIV-infected and uninfected school-aged children in South Africa by physical activity domain[§]

Distribution of physical activities among school-aged children with and without HIV in South Africa by physical activity domain. [§]Analysis based on subjects who attended school in the past week * $p=0.02$ and 0.003 (comparing boys with and without HIV and girls with and without HIV, respectively) [‡] $p=0.006$ (comparing girls with and without HIV)

Figure 2. Median time spent in physical activity intensity and sedentary behavior among HIV-infected and uninfected school-aged children in South Africa*

Median time spent in physical activity intensity and sedentary behavior among school-aged children with and without HIV in South Africa. *Girls with HIV spent less time in vigorous physical activity (420, IQR:170-720 vs. 780, IQR:360-1020 minutes/week, $p=0.001$) and sedentary behaviors (935, IQR:555-1320 vs. 1080, IQR:780-1530 minutes/week, $p=0.03$) than girls without HIV.

Table 1

Characteristics of a cohort of school-aged children with and without HIV treated with ART in Johannesburg, South Africa

Characteristic	All (n=398)	HIV (n=218)	No HIV (n= 180)	P-Value (HIV vs. no HIV)
Sex, N (%)				
Male	207 (52)	108 (50)	99 (55)	0.28
Female	191 (48)	110 (50)	81 (45)	
Age (years), Median (IQR)	6.2 (5.5,7.8)	6.0(5.4,7.0)	7.1 (5.7,8.6)	<0.0001
WAZ, Median (IQR) [‡]	-0.8 (-1.5,0.0)	-0.8 (-1.5,0.2)	-0.7 (-1.4,0.1)	0.03
HAZ, Median (IQR) [‡]	-1.4 (-2.0, -0.7)	-1.4(-2.0, -0.8)	-1.2(-1.8, -0.4)	0.02
BAZ, Median (IQR) [‡]	0.05 (-0.6-0.8)	0.05 (-0.6-0.7)	0.09 (-0.5-1.0)	0.22
Medical Diagnosis, N (%) [*]	15 (3.8)	15 (6.9)	0 (0)	0.0001
FFM (% total body mass), Median (IQR)	18 (16,21)	17 (16,19)	19 (17,23)	<0.0001
Mid-upper arm circumference (cm) Median (IQR)	16 (15,18)	16 (15,17)	17 (16,18)	<0.0001
Attends school, N (%)				
Yes	294 (74)	153 (70)	141 (78)	<0.0001
No	82 (21)	43 (20)	39 (22)	
Too young to attend	22 (5)	22 (10)	0	
Caregiver characteristics				
Mother, N(%)	366 (92)	198 (91)	168 (93)	0.36
Age (years), Median (IQR)	34 (30,39)	35 (31,39)	34 (29,39)	0.03
Employment (yes) N(%)	184 (46)	113 (52)	71 (39)	0.01
Highest grade caregiver completed at school, N (%)				
0-7	28 (7)	20 (9)	8 (4)	0.2
8-11	169 (42)	92 (42)	77 (43)	
12	201 (51)	106 (49)	95 (53)	
Household Characteristics				
Housing, N(%)				
House	223 (56)	111 (51)	112 (62)	0.04
Shack	79 (20)	52 (24)	27 (15)	
Other	96 (24)	55 (25)	41 (23)	
Piped water, N(%)	229 (58)	123 (56)	106 (59)	0.62

Characteristic	All (n=398)	HIV (n=218)	No HIV (n= 180)	P-Value (HIV vs. no HIV)
Toilet, N(%)	199 (50)	103 (47)	96 (53)	0.23
Electricity, N (%)	380 (95)	204 (94)	176 (98)	0.05
TV in household, N (%)	384 (96)	210 (96)	174 (97)	0.86
Computer in household, N (%)	93 (23)	49 (22)	44(24)	0.64
Internet access, N (%)	181 (45)	89 (41)	92 (51)	0.09
Access on cellular phone	127 (70)	58 (64)	69 (75)	0.5
Other access	55 (30)	32 (36)	23 (25)	0.12

* Includes any medical diagnosis with potential to limit normal physical activity.

[‡]WHO child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development. Geneva: World Health Organization;2006.

Table 2

Physical activities and sedentary behaviors in a cohort of school-aged children with and without HIV in Johannesburg, South Africa

Activity (minutes/week)	All (n=398)	HIV (n=218)	No HIV (n= 180)	P-Value (HIV vs no HIV)
In-school Physical Education *				
N (%)	134 (52)	56 (41)	78 (64)	0.0003
Median (IQR)	150 (60,300)	135 (60,253)	180 (75,300)	0.23
Informal in-school activity *				
N (%)	228 (88)	119 (88)	109 (89)	0.64
Median (IQR)	225 (120,340)	225 (150,315)	220 (75,395)	0.32
Organized after-school activity *				
N (%)	130 (50)	52 (38)	78 (64)	<0.0001
Median (IQR)	90 (60,180)	90 (50,180)	105 (60,180)	0.67
Informal after-school activity				
N (%)	387 (97)	211 (97)	176 (98)	0.76
Median (IQR)	930 (390,1530)	885 (390,1492)	1010 (390,1665)	0.36
Activities of daily living				
N (%)	385 (97)	211 (97)	174 (97)	0.95
Median (IQR)	130 (70,195)	130 (70,223)	130 (10,180)	0.37
Moderate Physical Activity[‡]				
N (%)	397 (99.8)	217 (99.5)	178 (100)	1
Median (IQR)	577 (310,1140)	590 (325,1105)	575 (285,1195)	0.94
Vigorous Physical Activity[‡]				
N (%)	380 (95)	207 (95)	173 (96)	0.58
Median (IQR)	600 (255,990)	470 (225,870)	738 (300,1125)	0.003
Moderate-vigorous Physical Activity[‡]				
N (%)	398 (100)	218 (100)	180 (100)	1
Median (IQR)	1290 (670,2141)	1243 (645,1999)	1337 (780,2268)	0.07
Meets WHO guidelines, N (%)[‡]	336 (84)	180 (83)	156 (87)	0.26
Sedentary behaviors				
N (%)	396 (99)	216 (99)	180 (100)	0.5
Median (IQR)	960 (590,1375)	940 (553,1320)	980 (700,1455)	0.06
Reading				
N (%)	286 (72)	156(71)	130(72)	0.88
Median (IQR)	100 (60,150)	110 (60,150)	100 (60,150)	0.52
Electronic				
N (%)	319 (80)	167 (77)	152 (84)	0.051
Median (IQR)	90 (45,180)	90 (45,180)	90 (45,180)	0.37

Activity (minutes/week)	All (n=398)	HIV (n=218)	No HIV (n= 180)	P-Value (HIV vs no HIV)
Television				
N (%)	390 (98)	214 (98)	176 (98)	0.78
Median (IQR)	840 (420,1050)	630 (420,945)	840 (420,1260)	0.06
>2 hours/daily N (%) [*]	199 (50)	100 (46)	99 (55)	0.07
Screen time				
N (%)	391 (98)	214 (98)	177 (98)	1
Median (IQR)	840 (470,1260)	780 (440,1110)	885 (600,1290)	0.03
>2 hours/daily, N (%) [§]	215 (54)	107 (49)	108 (60)	0.03
Sleep, Median (IQR)	4200 (3900,4500)	4200 (3900,4530)	4200 (3990,4500)	0.38

^{*} Analysis limited to subjects who attended school in the past week.

[‡] Moderate physical activities is 3–6.9 metabolic equivalents. Vigorous physical activities is 7 metabolic equivalents. Moderate-vigorous physical activity includes both moderate and vigorous physical activity. Ainsworth BE, Haskell WL, Whitt MC, et al. Compendium of physical activities: an update of activity codes and MET intensities. *Med Sci Sports Exerc* 2000;32:S498–504

[§] American Academy of Pediatrics. Committee on Public E. American Academy of Pediatrics: Children, adolescents, and television. *Pediatrics* 2001;107:423–6

[†] Global recommendations on physical activity for health. Geneva: World Health Organization; 2010.