Influence of body composition on the respiratory muscle strength of children exposed to antiretroviral therapy for human immunodeficiency virus

Leonardo Augusto Alves de Souza*
Mayara Mendes Nogueira**
Tamara de Souza Viana***
Saul Rassy Carneiro**
Paulo Eduardo Santos Ávila****
Valéria Marques Ferreira Normando*****

Abstract

Highly active antiretroviral therapy (HAART) for Human Immunodeficiency Virus (HIV) is important for suppressing HIV replication; however, adverse effects from prolonged use cause concern. With an increasing incidence of infection in children, the analysis of the maximum respiratory pressures of children exposed to HAART aims to observe possible changes related to continued use, such as: metabolic disorders, cardiovascular disorders, fat redistribution abnormalities and respiratory musculature. Thus, the aim of this study was to evaluate the influence of body composition on the respiratory muscle strength of Amazonian children exposed to HIV therapy. It is believed that these children may have some degree of malnutrition and difficulties in accessing health services. The sample was composed of 60 volunteers, both genders, mean age of 7.85 years, in two groups: experimental (EG) (n=29) - exposed to HIV and therapy, and control (CG) (n=31) - not exposed to HIV or to therapy. The subjects were submitted to respiratory muscle strength (RMS) measurement by manovacuometry and body composition: Body Mass Index (BMI) calculation; measurement of tricipital skinfolds (TS), subscapular skinfolds (SS) and waist circumference (WC), to subsequently calculate the WC to height ratio. Data were analyzed by Fisher's exact test which identified a statistical significance between genders on maximum inspiratory ($p = 0.01$) and expiratory ($p = 0.0008$) pressures, and SS ($p=0.04$), TS ($p=0.05$) and WC ($p=0.05$) on Maximum Inspiratory Pressure. There was an influence of body fat distribution on respiratory muscle strength of female Amazonian children exposed to antiretroviral therapy of human immunodeficiency virus.

Keywords: HAART (Highly Active Antiretroviral Therapy); AIDS (Acquired Immunodeficiency Syndrome); Sex; Muscle weakness; BMI (Body Mass Index).

INTRODUCTION

Human Immunodeficiency Virus (HIV) is the cause of Acquired Immunodeficiency Syndrome (AIDS), which affects the immune system, whose function is to defend the body against opportunistic diseases. The discovery of AIDS was a major scientific advance and with that discovery an increase in the number of women, children and adolescents infected with

DOI: 10.15343/0104-7809.20194304955975

*Fundação Hospital de Clínicas Gaspar Viana (FHCGV), Belém - PA, Brasil.
**Hospital Universitário João de Barros Barreto / Universidade Federal do Pará (UFPA), Belém - PA, Brasil.
***Hospital São Paulo / Universidade Federal de São Paulo (UNIFESP), São Paulo - SP, Brasil.
****Universidade Federal do Pará (UFPA), Belém - PA, Brasil.
*****Universidade do Estado do Pará (UEPA), Belém - PA, Brasil.
E-mail: paulo.avila@aol.com

the virus was observed[1].

In Brazil, between 2007 and 2018, 247,795 cases of HIV infection were reported, and 1,559 of which were aged up to 14 years old. In the northern region of the country, a total of 19,781 cases, of which 384 were pregnant women. In the ranking of detection rate (x1,000 live births) of pregnant women with HIV from 2005 to 2017, among 27 state capitals, 04 in the Northern region are in the top 10 (Belém, Manaus, Boa Vista and Porto Velho)[2].

The transmission of HIV can be through sexual intercourse (sperm and vaginal discharge), blood (parenteral and vertical) and breast milk[3]. Vertical transmission of the immunodeficiency virus is given when the pregnant woman transmits the virus to the fetus, which can occur in several ways: during pregnancy (intrauterine), during delivery and during breastfeeding[4]; such transmission has demonstrated a rate of 25.5%[5].

According to data from the Brazilian Ministry of Health, from 2007 to 2018, 116,292 cases of pregnant women infected with HIV were registered. The notification rate in pregnant women with the virus in Brazil has significantly increased in recent years[2].

In Brazil, the prevalence of infection in parturients is approximately 12,000 cases per year. The Northern region was third (59.6%) with the highest percentage of reported cases compared to the expected number[2].

However, with the advent of antiretroviral therapy, patients' life expectancy and quality of life increased significantly, especially in young people and children, leading to a decline in mortality from opportunistic diseases (infections and neoplasms)[6]. This therapy aims to curb the reproduction of the virus in the body, where there is no elimination of HIV, but helps to contain the weakening of the immune system[7].

As the therapy spread and its duration increased, toxicities became more evident. In the long term, the most common side effects are metabolic disorders such as dyslipidemia, insulin resistance and cardiovascular risk. Abnormalities in fat redistribution may also occur, characterized as lipodystrophic syndrome[8].

Individuals exposed to HIV also have muscle alterations, especially respiratory muscles, which leads to loss of functional capacity and dysfunction[9].

Infected children have progressive skeletal muscle dysfunction, as well as mitochondrial dysfunction, both caused by biochemical changes due to infection and the use of HAART (High Activity Antiretroviral Therapy). This may be one of the factors that may clarify the origin of inspiratory muscle weakness in immunodeficient patients[10].

Children exposed to HIV tend to start antiretroviral therapy very early, when possible, even during pregnancy. This prolongs the duration of antiretroviral use and, consequently, its adverse effects, as well as influences the changes caused by a vulnerable immune system which is susceptible to opportunistic diseases[11].

With the increasing incidence of HIV infection in children, the analysis of the maximum respiratory pressures of children exposed to HAART aims to evaluate possible respiratory changes due to depletion caused by respiratory system disorders; which becomes vulnerable due to low immunity[12]. It is hypothesized that opportunistic infections and prolonged exposure to antiretroviral treatments cause changes in body composition and therefore respiratory muscle strength.

Thus, this study aimed to analyze the distribution of body fat against the respiratory muscle strength of Amazonian children exposed to antiretroviral therapy of the human immunodeficiency virus. It is hypothesized that children exposed to HIV and antiretroviral therapy from birth and living in areas with less access to health services may present changes in body composition and, consequently, in RMS (Respiratory Muscle Strength).

METHODOLOGY

Type of study and ethical aspects

The study was designed as a cross-sectional, quantitative, prospective and nonrandomized study. It was approved by the Research Ethics Committee (CEP) of the University of Amazonia (UNAMA) under the registration number 364.864 and developed at the Maternal and Child Reference Center (UREMIA). Those responsible for the study participants signed an informed consent form.

Sampling

To be included in the study, participants must not have pulmonary or cardiovascular disease, disabling physical limitations, visual or hearing impairment, decompensated diabetes mellitus, recent upper or thoracoabdominal airway surgery or trauma, and obesity.

Initially, 78 volunteers of both sexes, aged 6 to 11 years were interviewed. Of the total individuals, 18 did not fit the inclusion criteria of the research; of these, 06 had asthma, 11 were in the viral process and 01 was obese.

Sixty individuals were selected, aged 7.85 ± 2.36 years, height 129.85 ± 13.22 cm and weight 28.52 ± 8.79 kg. They were divided into two groups: the experimental group (EG, n=29; 13 boys and 16 girls), those who were HIV-infected and exposed to antiretroviral therapy, enrolled at the State Coordination of Sexually Transmitted Diseases of the State of Pará and treated at UREMIA in the city of Belém-PA; and the control group (CG, n=31; 17 boys and 14 girls), those individuals not exposed to therapy.

Procedures

In the evaluation, participants were first screened, parents and/or guardians were interviewed to fill out identification forms. Then, an assessment protocol was applied and respiratory muscle strength was measured using a Digital Manovacuometer ± 300mm/H_2O (GLOBALMED) and body composition was identified by calculating BMI (Filizola Stadiometer Scale), tricipital (TS), subscapular (SS) cutaneous skinfold and waist circumference (WC) measurements were taken, the ratio between WC and height was calculated. This ratio is considered a risk factor for the development of metabolic and cardiovascular diseases values when ≥0.5cm (according to Ashwell; Hsieh guidelines[13]).

The sitting patient used the nasal clip and disposable mouthpiece. To measure Maximum Inspiratory Pressure (MIP), the subject performs a maximum exhalation, followed by a forced inspiration. For maximum expiratory pressure (MEP) measurement, a maximum inhalation is required, followed by a forced expiration. The patient was instructed to close their lips against the mouth to avoid air leakage[14].

To obtain satisfactory results, the technique was performed in three repetitions with rest interval of 30 seconds between maneuvers. According to the results obtained, the highest value among the three measurements was considered, provided that the difference between them was not greater than 10%; otherwise, the test would be performed again.

Skinfold measurements were performed using a Lange® adipometer. All measurements were performed according to the criteria and techniques standardized by Benedetti et al.15. Participants were asked to stand and relax. The folds were always made in the non-dominant hemibody. In all measurements, the evaluator followed the following technique: separate the adipose tissue from the muscle tissue with the thumb and index finger; adjust the ends of the adipometer over the anatomical point; place the skinfold forceps 1 cm above the anatomical point; wait 02 seconds for reading; perform 03 non-

consecutive measurements and, if there were differences in the results from 5% to 10%, make a fourth measurement, with the device perpendicular to the anatomical point.

Measurements of triceps brachii and subscapularis muscle folds were taken. For the triceps brachii flexion, tweezers were placed on the back of the arm at the midpoint between the scapula acromion and the ulna olecranon. For the subscapularis, tweezers were placed 2 cm below the inferior angle of the scapula with the adipometer at 45° in relation to the longitudinal axis of the body.

Statistical analysis

The reference values for respiratory pressures were obtained through the BioEstat 5.3 program, with parameter estimation by the mean values of the control group, to then analyze the experimental group in comparison with the estimated normal values.

Data were tabulated in Excel database and analyzed in EpiInfo program. Statistical analysis was performed for categorical data (P-value ≤ 0.05), considering normal values equal to or better than those estimated in the control group and abnormal values below those estimated in the control group. The control group mean was taken as the reference.

The reference values for respiratory pressures were obtained through the program BioEstat 5.3, with an estimation of parameters from the mean values of the control group.

Fisher's exact test, considering significant variables with p-value ≤ 0.05, evaluated the differences between the two independent groups, differing the proportions in which each group is included in each of the evaluated parameters (normal or altered respiratory forces, normal or altered body composition).

Therefore, it was possible to cross-check the data of each of the evaluated parameters (skinfold measurements, circumferences, height and maximum inspiratory or expiratory pressures) with the sample characteristics (age, sex, exposure to therapy). Crossing these data allows the statistical significance of each variable to be evaluated within the sample characteristics.

RESULTS

The results described below show the most significant data from the study, highlighted in their respective tables.

Inspiratory muscle weakness was present in 55% of participants, and expiratory weakness in 45% (Table 1). In the analysis performed using Fisher's Exact test, correlating the analyzed body composition and RMS variables with the characteristics of the sample, there was significance concerning the MEP (Table 2) between genders (0.0008), and concerning MIP (Table 3) with 04 variables: gender (0.01), SS (0.04), TS (0.05) and WC (0.05).

Among the characteristics for body composition (SS, TS and WC) related to inspiratory muscle weakness, data show that body composition measurements remained within the normal range but were predictive of a lower MIP (table 4).

Table 1 – Characterization of the sample regarding maximum respiratory pressures, anthropometric measurements and gender. Feb. to Dec. 2014. UREMIA, Belém (PA).

Variables	No.	%	C.I. %
MIP			
Normal	27	45	32.1 to 58.4
Altered	33	55	41.6 to 67.9
MEP			
Normal	33	55	41.6 to 67.9
Altered	27	45	32.1 to 58.4
Sex			
Female	30	50	36.8 to 63.2
Male	30	50	36.8 to 63.2
Weight			
≤ 25 kg	31	51.7	38.4 to 64.8
> 25 kg	29	48.3	35.2 to 61.6
Height			
≤ 130 cm	44	73.3	60.3 to 83.9
> 130 cm	16	26.7	16.1 to 39.7

Quantitative and percentage values. MIP: Maximum inspiratory pressure; MEP: Maximum expiratory pressure. CI: Confidence Index. Sample distribution according to the studied characteristics.

Table 2 – Influence of variables on expiratory muscle weakness. Feb. to Dec. 2014. UREMIA, Belém (PA).

Variables	Nº	%	C.I. %	P-value
HAART				0.22
Not Exposed (CG)	12	44.4	25.5 to 64.7	
Exposed (EG)	15	55.6	35.3 to 74.5	
Sex				0.0008*
Female	20	74.1	53.7 to 88.9	
Male	7	25.9	11.1 to 46.3	
Weight				0.59
≤ 25 kg	14	51.9	31.9 to 71.3	
> 25 kg	13	48.1	28.7 to 68.1	
Height				0.08
≤ 130 cm	17	63	42.4 to 80.6	
> 130 cm	10	37	19.4 to 57.6	
Weight for age				0.24
Normal	5	18.5	6.3 to 38.1	
Below	15	55.6	35.3 to 74.5	
Above	7	25.9	11.1 to 46.3	
Height to age				0.49
Normal	22	81.5	61.9 to 93.7	
Below	5	18.5	6.3 to 38.1	
BMI				0.07
Normal	18	66.7	46.0 to 83.5	
Below	6	22.2	8.6 to 42.3	
Above	3	11.1	2.4 to 29.2	
Subscapular Bending				**0.18**
Normal	20	74.1	53.7 to 88.9	
Below	7	25.9	11.1 to 46.3	
Triceps Bending				**0.06**
Normal	23	85.2	66.3 to 95.8	
Below	3	11.1	2.4 to 29.2	
Above	1	3.7	0.1 to 19.0	
Circ. Waist				**0.43**
Normal	25	92.6	75.7 to 99.1	
Altered	2	7.4	0.9 to 24.3	

Quantitative and percentage values. HAART: Highly active antiretroviral therapy; BMI: Body mass index. C.I.: Confidence Index. P-value ≤ 0.05 (*). Distribution of participants with altered maximal expiratory pressure.

Table 3 – Influence of variables on inspiratory muscle weakness. Feb. to Dec. 2014. UREMIA, Belém (PA).

Variables	Nº	%	I.C. %	P-valor
HAART				**0.09**
Not exposed (CG)	14	42.4	25.5 to 60.8	
Exposed (EG)	19	47.6	39.2 to 74.5	
Sex				**0.01***
Female	21	63.6	45.1 to 79.6	
Male	12	36.4	20.4 to 54.9	
Weight				**0.40**
≤ 25 kg	18	54.5	36.4 to 71.9	
> 25 kg	15	45.5	28.1 to 63.6	
Height				**0.15**
≤ 130cm	22	66.7	48.2 to 82.0	
>130 cm	11	33.3	18.0 to 51.8	
Weight for age				**0.17**
Normal	6	18.2	7.0 to 35.5	
Below	18	54.5	36.4 to 71.9	
Above	9	27.3	13.3 to 45.5	
Height to age				**0.49**
Normal	5	15.2	5.1 to 31.9	
Below	28	84.8	68.1 to 94.9	
BMI				**0.12**
Normal	21	63.6	45.1 to 79.6	
Below	7	21.2	9.0 to 38.9	
Above	5	15.2	5.1 to 31.9	
Subscapular Bending				**0.04***
Normal	25	75.8	57.7 to 88.9	
Below	8	24.2	11.1 to 42.3	
Triceps Bending				**0.05***
Normal	26	78.8	61.1 to 91.0	
Below	7	21.2	9.0 to 38.9	
Circ. Waist				**0.05***
Normal	32	97	84.2 to 99.9	
Altered	1	3	0.1 to 15.8	

Quantitative and percentage values. HAART: Highly active antiretroviral therapy; BMI: Body mass index. C.I.: Confidence Index. P-value ≤ 0.05 (*). Distribution of participants with altered maximal inspiratory pressure.

Table 4 – Altered sample distribution in statistically significant variables. Feb. to Dec. 2014. UREMIA, Belém (PA).

Altered MIP (33)	SS Normal	SS Below	Female	Male
CG	13 (39.4%)	1 (3.01%)	9 (27.2%)	5 (15.1%)
EG	12 (36.3%)	7 (21.2%)	12 (36.3%)	7 (21.2%)
P-value	0.04*		0.01*	
Altered MEP (27)				
CG			10 (37%)	2 (7.4%)
EG			10 (37%)	5 (18.5%)
P-value			0.0008*	

Quantitative and percentage values. MIP: Maximum inspiratory pressure; MEP Maximum expiratory pressure; CG: Control Group; EG: Experimental Group. P-value ≤ 0.05 (*). Distribution of participants with altered maximal inspiratory and/or expiratory pressure in their respective groups and variables with statistical significance.

DISCUSSION

The present study aimed to evaluate RMS and body composition in children exposed to antiretroviral therapy for HIV. The results indicate that there is an influence of SS on inspiratory muscle strength, as well as gender on inspiratory and expiratory muscle strength.

Antiretroviral therapy has revolutionized the treatment of HIV-infected individuals because it is highly effective in suppressing viral replication and restoring immune function in these individuals[16]. However, its consumption correlates with mitochondrial dysfunction, resulting in decreased RMS[17].

In this study, inspiratory muscle weakness was observed in 55% of participants and expiratory muscle weakness in 45%. In the study by Oliveira et al.,18 it was pointed out that 61% and 40% of AIDS patients were deficient in their maximum expiratory and inspiratory pressures, respectively, for their age group. Similar result found in the study by Jerônimo[19], where inspiratory muscle strength was altered in 58% of patients infected with HIV.

In the current study, data on body composition and respiratory muscle strength were cross-linked, making it possible to attribute the respiratory muscle weakness of children exposed to the therapy to the appearance of lipodystrophic characteristics. However, only one of the body composition measurements was correlated with a statistically significant reduction in respiratory muscle strength. Body composition had an influence on inspiratory muscle weakness when the variables SS (P-value 0.04), TS (P-value 0.05) and WC (P-value 0.05) were analyzed.

In the study by Raso *et al.*[20] it was concluded that HIV induces muscle mass reduction, which causes loss of muscle strength and affects anaerobic exertion and oxygen fraction. The cause of reduced RMS may also be involved with the class of drugs called Nucleoside Analog Reverse Transcriptase Inhibitors (NRTIs). Its prolonged use may result in mitochondrial toxicity, affecting highly oxygen-dependent tissues, such as cardiac, skeletal and smooth muscles, the central and peripheral nervous system, among others[21].

As in Ramalho *et al.*[22], it was observed that children and adolescents infected with HIV showed greater impairment in body composition, nutritional status, low levels of physical activity and physical fitness. This finding raises the need for cardiorespiratory training for this group of children and adolescents affected by HIV; given that just as in the present study, other authors corroborate the reduced strength in this population.

As for the comparison between the sexes, the females (75.1% MEP; 63.6% MIP) presented lower values in the maximal respiratory pressures, when compared to the males (24.9% MEP; 36.4% MIP). In females, these pressures may have been influenced by the shape of the rib cage and respiratory muscles, and in males by the cross-sectional muscle area[23].

Morphological changes such as the decreased cross section of the diaphragm muscle and rib cage are some of the mechanisms that contribute to this respiratory weakness. There is also the duration of HIV infection, frequent associated respiratory infections and the duration of HAART use[19]. In turn, anthropometric indicators are strongly associated with body fat and may assist health professionals in monitoring the health of children and adolescents with HIV[24].

With prolonged use of antiretroviral therapy, HIV-infected children tend to develop chronic problems in linear growth and weight gain due to the direct influence of viral load on growth and nutritional status. The high viral load of HIV influences the reduction of fat mass and disease progression[22]. Even with its adverse effects, HAART is crucial for improving the quality of life of infected people, significantly reducing viral load and the incidence of opportunistic infections[25,26,27].

The study by Miller *et al.*[26] suggested that the combination of antiretroviral therapy has a positive and significant effect on weight, height, growth rate, appetite and well-being, i.e. reduced viral load improved nutritional status. These results agree with the present study, in which children exposed to therapy did not present statistically significant changes in weight for age, height for age, BMI and waist-to-height ratio.

In the study by Werner *et al.*[28], which analyzed the body composition profile in HIV-infected children and adolescents treated with antiretroviral therapy, it was found that nutritional status was adequate (81.3%), both in BMI and body composition by TS. These results are similar to the findings in the present study, where the group that used HAART did not exhibit significant statistical variation in BMI as well as in TS.

However, in the study by Remteke *et al.*[29], a cohort of HIV-infected and uninfected South African children was conducted. Unfavorable changes in lipid profile were detected in HIV-infected children, regardless of treatment regimen compared to uninfected ones.

In contrast, in the present study, there was an influence of SS, TS and CC on inspiratory muscle weakness. Of 33 children who had a deficit in inspiratory muscle strength, 25 had an SS within normal limits, 39.4% from CG and 36.3% from EG.

This result may be related to the benefits of HAART on body composition and the cellular alterations of individuals with immunodeficiency, such as mitochondrial excitotoxicity, which would lead to the maintenance of body composition, but with a reduction in RMS[19]. This finding shows that measurements of SS, TS and CC may be related to lower inspiratory muscle strength in both healthy children and those exposed to antiretroviral therapy.

Considering that most of the participants who presented a decrease in MIP with a normal SS belonged to the CG (39.4%) with an isolated average age of 6.8 years and the EG with an average of 8.9 years, it is noteworthy that children under 8 years of age may express a low level of understanding and cooperation, which may cause changes in the reproduction of measurements[30].

It is necessary to consider that the changes associated with antiretroviral therapy result from a set of interactions between HIV infection, specific antiretroviral agents, age, gender and, mainly, factors such as lifestyle and genetics[29].

CONCLUSION

According to the results presented, the evaluation of the influence of body composition on the RMS indicated an interference of SS and gender variables on the maximal respiratory pressures.

The data found are relevant for understanding and acting on the reduced respiratory muscle strength in patients exposed to HAARTS and, above all, for the establishment of treatment protocols, in order to reduce the deleterious effects of antiretroviral therapy and provide a better quality of life.

Given that children would be mostly affected by the long-term effects of antiretroviral therapy due to the exposure time, this population needs more targeted care, not just for the immune system, but for holistic care considering functionality and quality of task execution.

Further studies should be conducted to ratify the results found and increase credibility and knowledge about the researched subject.

REFERENCES

1. CARDOSO, C.A.A Aparecida Araújo. Impacto da terapia antirretroviral combinada na história natural da infecção pelo vírus da imunodeficiência humana em população pediátrica. [Tese de Doutorado]. Departamento de Pós-Graduação em Ciências da Saúde. Universidade Federal de Minas Gerais. Belo Horizonte, 2006. 129 p.
2. BRASIL, Ministério da Saúde. Secretaria de Vigilância em Saúde. Departamento de DST, AIDS e Hepatites Virais. Ministério da Saúde. Boletim Epidemiológico - Aids e DST. jun 2018; 49 (53). 63p.
3. BRASIL. Ministério da Saúde, Secretaria de Vigilância em Saúde, Coordenação-Geral de Desenvolvimento da Epidemiologia em Serviços. – 3ª. ed. – Brasília: Ministério da Saúde, 2019. 740 p.
4. BAZIN, G.R. et al. Antiretroviral therapy in HIV-infected children and adolescents: lessons learned in 30 years of the epidemic. Cad. Saúde Pública, Rio de Janeiro Apr. 2014; 30 (4). Disponível em <http://dx.doi.org/10.1590/0102-311X00075413>. Acesso em 21 de Outubro de 2019.
5. BRASIL, Ministério da Saúde. Secretaria de Vigilância em Saúde. Departamento de Vigilância, Prevenção e Controle das Infecções Sexualmente Transmissíveis, do HIV/AIDS e das Hepatites Virais. Protocolo Clínico e Diretrizes Terapêuticas para Manejo da Infecção pelo HIV em Crianças e Adolescentes – Brasília: Ministério da Saúde, 2018. 218 p.
6. PILOYA T. et al. Lipodystrophy among HIV-infected children and adolescents on highly active antiretroviral therapy in Uganda: a cross sectional study. Journal of the International AIDS Society, 2012 Jul; 15 (2): 1-7.
7. BRASIL, Ministério da Saúde. Secretaria de Vigilância em Saúde. Boletim Epidemiológico Aids & DST. 2018.
8. MUSIIME, V. et al. Anthropometric measurements and lipid profiles to detect early lipodystrophy in antiretroviral therapy experienced HIV-infected children in the CHAPAS-3 trial. Antivir Ther. 2014; 19 (3): 269-76.
9. ARRIVE, E. et al. Metabolic risk factors in young adults infected with HIV since childhood compared with the general population. PLoS One. 2018 Nov 8;13(11):e0206745. Disponível em: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6226109/>. Acesso em 22 de Outubro de 2019.
10. OURSLER K.K. et al. Prediction of cardiorespiratory fitness in older men infected with the human immune deficiency virus: clinical factors and value of the six-minute walk distance. J. Am. Geriatr. Soc. 2009 Nov; 57: 2055-61.
11. GOLUCCI, A.P.B.S. et al. Influência da terapia antirretroviral da Aids no padrão de crescimento J. Pediatr. (Rio J.) vol.95 no.1 Porto Alegre jan./fev. 2019. Disponível em: em: <http://dx.doi.org/10.1016/j.jped.2018.02.006>. Acesso em 21 de outubro de 2019.
12. HOFFMANN, I.C. et al. A five-year review of vertical HIV transmission in a specialized service: cross-sectional study. Sao Paulo Med. J. São Paulo Nov./Dec. 2016; 134 (6). 508-12.
13. ASHWELL, M.; HSIEH, S.D. Six reasons why the waist-to-height ratio is a rapid and effective global indicator for health risks of obesity and how its use could simplify the international public health message on obesity. International Journal of Food Sciences and Nutrition. 2005 Ago; 56(5): 303-307.
14. PETROSKI, E.L. Antropometria: técnicas e padronizações. São Paulo: Fontoura. 2011. 88 p.
15. BENEDETTI, T.B. et al. Dobras Cutâneas. In: Antropometria: técnicas e padronizações. 5ª ed. São Paulo: Fontoura, 2011. p. 49-60.
16. PAYNE, B. et al. In Vivo Mitochondrial Function in HIV-Infected Persons Treated with Contemporary Anti-Retroviral Therapy: A Magnetic Resonance Spectroscopy Study. Plos One. 2014 Jan; 9 (1): 1-9.
17. LIMA, L.R.A. et al. Aerobic fitness and physical activity are inversely associated with body fat, dyslipidemia and inflammatory mediators in children and adolescents living with HIV. J Sports Sci. 2019 Jan;37(1):50-58.
18. OLIVEIRA, D.Z.; DAMIN, S.; SKROCH, E.O.K. Medida das Pressões Respiratórias Máximas em Indivíduos Portadores de HIV. RUBS, Curitiba. 2008 Set/Dez; 1 (3): 91-6.
19. JERÔNIMO, F.S. Determinantes da fraqueza muscular inspiratória em pessoas vivendo com HIV/AIDS. Criciúma. Dissertação (Mestrado) - Curso de Ciências da Saúde, Universidade do Extremo Sul Catarinense; 2012.
20. RASO, V. et al. Association between muscle strength and the cardiopulmonary status of individuals living with HIV/AIDS. Clinics. 2013 Mar; 68 (3): 359-64.
21. ZHANG, Y, et al. Long-Term Exposure of Mice to Nucleoside Analogues Disrupts Mitochondrial DNA Maintenance in Cortical

Neurons. PLoS One. 2014 Jan; 9 (1): 1-7.
22. RAMALHO, L.C.B. Composição corporal, aptidão física e fatores de risco cardiometabólicos de crianças e adolescentes infectados pelo HIV em terapia antirretroviral combinada. [Tese de Doutorado]. Universidade estadual de campinas - Faculdade de ciências médicas. Campinas, 2016. 194 p.
23. HEIZMANN-FILHO, J.P.; DONADIO, M.V.F. Teste de forca muscular ventilatória: é viável em crianças jovens?. Rev Paul Pediatr. 2015; 33(3):274-279.
24. LIMA, L.R.A. et al. Anthropometric measures associated with fat mass estimation in children and adolescents with HIV. Appl Physiol Nutr Metab. 2019 May;44(5):493-498.
25. SWETHA, G.K. et al. Health & nutritional status of HIV infected children in Hyderabad, India. Indian J Med Res. 2015 Jan; 141 (1): 46–54.
26. MILLER, T.L. et al. The effect of protease inhibitor therapy on growth and body compositions in immunodeficiency virus type-1 infected children. Pediatrics. 2001 Mai; 107 (5): 1-6.
27. LUZURIAGA, K. et al. HIV Type 1 (HIV-1) Proviral Reservoirs Decay Continuously Under Sustained Virologic Control in HIV-1-Infected Children Who Received Early Treatment. Journal Of Infectious Diseases, California. 2014 Nov; 210 (10): 1529-1538.
28. WERNER, M.L.F. et al. Síndrome da lipodistrofia e fatores de risco cardiovasculares em crianças e adolescentes infectados pelo HIV/AIDS em uso de terapia antirretroviral de alta potência. Jornal de Pediatria. Porto Alegre, 2010 Jan/Fev; 86 (1): 27-32.
29. RAMTEKE, S.M. et al. Patterns of Growth, Body Composition, and Lipid Profiles in a South African Cohort of Human Immunodeficiency Virus-Infected and Uninfected Children: A Cross-Sectional Study. J Pediatric Infect Dis Soc. 2018; 7(2): 143–150.
30. REIS, L.C. et al. Anthropometry and body composition of vertically HIV-infected children and adolescents under therapy with and without protease inhibitors. Public Health Nutr. 2015 Mai; 18 (7): 1255-61.

Received in january 2019.
Accepted in november2019.