A relationship between Single Nucleotide Polymorphism (SNP) in *HSD11β1* and *ADIPOQ* genes and obesity related features in children and adolescents submitted on physical exercises

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ORIGINAL ARTICLE

ABSTRACT

Obesity have overloaded the public health system and it is considered a multifactorial trait. This study aimed to verify if Single Nucleotide Polymorphisms (SNP) in *ADIPOQ* (rs1501299) and *HSD11β1* (rs12086634) genes influence the anthropometric and biochemical outcomes (Body Mass Index (BMI), Abdominal Circumference (AC), Low Density Lipoprotein (LDL-C), High Density Lipoprotein (HDL-C), Triglycerides (TG), Total Cholesterol (TC) and Glucose (Glu)) before and after practicing physical exercises training modalities, in a sample of 126 Southern Brazilian children and adolescents. Genotyping were performed by Taqman allelic discrimination. T carriers of rs1501299 had a higher BMI reduction (b*=0.28±0.12; p=$1.70.10^{-2}$) and TT genotype of rs12086634 influence on AC reduction (b*=-0.33±0.13; p=$1.24.10^{-2}$), independent of sex, age and modality of physical exercise. Ultimately, we observed an association of SNP of *ADIPOQ* and *HSD11β1* gene with anthropometric variables early in life and the importance of physical exercise on biochemical and obesity related features.

Keywords: rs1501299, rs12086634, physical exercise, childhood, obesity.

Relação entre Polimosfismos de Nucleotídeo Único (SNP) dos genes HSD11β1 e ADIPOQ e características relacionadas à obesidade em crianças e adolescentes submetidos a exercícios físicos

RESUMO

A obesidade tem sobrecarregado o sistema de saúde pública e é considerada um traço multifatorial. Esse estudo teve por objetivo verificar se Polimorfismos de Nucleotídeo Único (SNP) nos genes *ADIPOQ* (rs1501299) e *HSD11β1* (rs12086634) influenciam resultados antropométricos e bioquímicos (Índice de Massa Corporal (IMC), Circunferência Abdominal (CA), Lipoproteína de Baixa Densidade (LDL-C), Lipoproteína de Alta Densidade (HDL-C), Triglicerídeos (TG), Colesterol Total (TC) e Glicose (Glu)) antes e após a prática de exercícios físicos em uma amostra de 126 crianças e adolescentes brasileiros. A genotipagem foi realizada através de discriminação alélica utilizando sondas Taqman. Observou-se que portadores do alelo T do polimorfismo rs1501299 do gene *ADIPOQ* tiveram uma maior redução de IMC ($b^*=0{,}28\pm0{,}12$; $p=1{,}70.10^{-2}$) e que o genótipo TT do polimorfismo rs12086634 do gene *HSD11β1* influencia na redução da CA ($b^*=-0{,}33\pm0{,}13$; $p=1{,}24.10^{-2}$), independente de sexo, idade e modalidade de exercício físico. Em última análise, observamos uma associação entre os SNPs dos genes *ADIPOQ* e *HSD11β1* e variáveis antropométricas no início da vida, bem como a importância da prática de exercícios físicos sobre variáveis bioquímicas e relacionadas à obesidade.

Palavras-chave: rs1501299, rs12086634, exercício físico, infância, obesidade.

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INTRODUCTION

Obesity and dyslipidemias have impacts on psychosocial comorbidities and have been related to cerebrovascular and cardiovascular diseases, overloading the public health system (PULGARÓN, 2013; ANVISA, 2011; MARIA et al., 2011; SAHOO et al., 2015). In a systematic literature revision, Pulgarón (2013) highlighted that the rates of overweight and obesity increase each year and observed that the main comorbidities associated with childhood obesity include asthma, metabolic risk factors and dental health (PULGARÓN, 2013). The worldwide prevalence of overweight and obesity in childhood have grown dramatically since 1990, increasing from 4.2% in 1990 to 6.7% in 2010, being expected to reach 9.1%, or about 60 million in 2020 (DE ONIS; BLÖSSNER; BORGHI, 2010). In a Brazilian sample of children a rate of dyslipidemia of 25.5% and a relationship between dyslipidemia and overweight were observed (ALCÂNTARA NETO et al., 2012).

It is possible to verify that lipid profile and obesity are influenced by many factors as nutritional behavior, practice of physical exercise and genetics (QI et al., 2005; GOMES FRAGA; BRAGA GOMES, 2014; OGUNDELE et al., 2017; LUIS et al., 2016; TUREK et al., 2014; DEVANG et al., 2017; GAMBINERI et al., 2011; FICHNA et al., 2017; LOPES et al., 2015).

Regarding genetic factors that can influence these features, it is possible to highlight the polymorphisms in *ADIPOQ* and *HSD11β1* genes as important examples. The *ADIPOQ* gene (3q27) encodes adiponectin and is the most expressed gene in adipose tissue (MAEDA et al., 1996). Features as obesity, type 2 diabetes mellitus, coronary disease and arterial hypertension are accompanied by a reduction of serum adiponectin (ARITA et al. 1999; LARA-CASTRO et al. 2007). The SNP rs1501299: NM_001177800.1:c.214+62G>T of *ADIPOQ* gene, wich is analyzed in the present study, was already associated to higher adiponectin levels (QI et al., 2005).

The hydroxysteroid dehydrogenase type 1 (11β-HSD1) is encoded by *HDS11β1* gene (1q32.2) and it is capable to reduce cortisone to active hormone cortisol, besides regulating the interaction between cortisol and glucocorticoid receptors (BUJALSKA; KUMAR; M STEWART, 1997). Masuzaki et al. (2001), highlighted that transgenic mice overexpressing this enzyme in adipose tissue develop visceral obesity, insulin

resistance, hyperglycemia and hyperlipidemia (MASUZAKI et al., 2001). The SNP rs12086634 of this gene (NM_001206741.1:c.332-29T>G) occurs in an enhancer region in the intron 3 (GAMBINERI et al., 2011). Thus, the purpose of this longitudinal study was to verify if genetic factors (rs1501299 of *ADIPOQ* and rs12086634 of *HDS11β1* gene) could influence on lipid profile and anthropometric outcomes before and after practicing physical exercises, in a sample of children and adolescents from Southern Brazilian population.

METODOLOGY

Subjects and physical exercises

A total of 126 young students (12.76 years old ± 1.92) from public schools located in Curitiba - Brazil were enrolled in this study, being all overweight or obese individuals according to World Health Organization (WHO) 2014 ("WHO | Obesity", 2014). The sample is composed by 55 girls and 71 boys. The individuals able to perform physical exercises, according to a medical report, and those who did not use medications that could interfere with the lipid profile or weight loss were included in this research.

All the participants and their parents or legal guardians signed a Consent Form and this study was approved by the Institutional Ethics Committee of University Federal of Parana.

These same individuals were previously analyzed for Leite et al., (2010), Leite et al., (2013), Milano et al., (2013), Lopes et al., (2015), Lopes et al., (2016) and Pizzi et al., (2017), but in distinct context and distinct period of time (LEITE et al., 2010; LEITE et al., 2013; MILANO et al., 2013; LOPES et al., 2015; LOPES et al., 2016; PIZZI et al., 2017). Originally, the children and adolescents were grouped in four different training modalities: Aerobic Training, Water Walking, Combined Training Programme and High-Intensity Interval Training (HIIT). However, due the small sample in each modality we chose to join of all them in only one group and the modality of physical exercise was used as correction factor in Logistic Regression Analysis. The physical exercises were

conducted by a certified fitness instructor, lasting twelve weeks, with a frequency of three times per week. The features of each training are detailed in Table 1.

Body Mass Index (BMI) was calculated through division between weight (Kilograms) by the square of height (meters). BMI z-score specified by sex and age and percentiles were calculated (KUCZMARSKI et al., 2002; "WHO | Obesity," 2014). Individuals were classified as overweight (BMI Z-score was between +1 and +2 or 85≤percentile<95) and obese (BMI Z-score more than +3 or percentile ≥95) according to parameters adopted by World Health Organization (WHO), 2014 ("WHO | Obesity", 2014). The measurement of Abdominal Circumference (AC) was done at the level of the iliac crest in centimeters (cm).

Biochemical variables and genetic analyzes

The measurements of glucose (Glu), triglycerides (TG), total cholesterol (TC) and high density lipoprotein cholesterol (HDL-C) were performed from blood samples after 12 hours of fasting and standard automated methods were used. The serum concentrations of Low density lipoprotein cholesterol (LDL-C) were calculated according to Friedewald equation (FRIEDEWALD; LEVY; FREDRICKSON, 1972), when TG levels were below 200 mg/dL.

A salting-out method was used to extract DNA from peripheral blood (LAHIRI; NUMBERGER, 1991). After DNA extraction, it was diluted to 20ng/μL and genotyping assays were performed by TaqMan allelic discrimination in a Mastercycler realplex 2 real time PCR system. For each sample the following reaction conditions were used: 3.0μL of Master Mix (2X); 1.7 μL of ultrapure water; 0.3 of μL of primer (diluted for 20X) and 3.0 μL of DNA. Temperature and time cycle used for genotyping assay were the following: (1) 50°C / 2 min, (2) 95°C / 10 min, (3) repeated 50 times 95°C / 15 sec interspersed with 62ºC / min.

Table 1 - Features of each training modality.

Training Modalities	N	Features of each training
Aerobic Training	45	This modality involved: 45 minutes **indoor cycling**, 45 minutes **outdoor walking/running** and 20 minutes **stretching**. 1º - 4º week: 45 minutes **indoor cycling** and 45 minutes **outdoor walking/running** were performed in intensity between 35 and 55% of the **Heart Rate Reserve** (HRR); 5º - 8º weeks: intensity increased to 45 to 65%; 9º - 12º weeks: intensity was increased between 55 and 75% of the HRR.
Water Walking	31	Sessions consisted of 5 minutes of **Warm-up**, 45 minutes of **Water Walking** and 10 minutes of **Recovery**. The individuals performed the **Water Walking** in a vertical position with the body submerged to their shoulders and movements similar to Land Walking were performed (LEITE et al., 2010).
Combined Training Programme	27	This modality consisted of **six resistance exercises** (leg press, leg extension, leg curl, bench press, lateral pulldown and arm curl), three series of 6-10 repetitions at **60-70% 1 MR** (1 maximal repetition) followed by 30 min of **aerobic exercise** (walking/running) on an **athletic track**. The load of the resistance training was adjusted weekly and the intensity reached in the aerobic training was 50-80% of the VO_2 peak;
High-Intensity Interval Training	24	Sessions were constituted of **warm-up exercises**, **running/walking** at different intensities totaling 45 min with **cooling**. Two high-intensity series repeated for 30 seconds were did, in which the individuals run as fast as possible, with a recovery time of 60 seconds walk and 4 minutes of rest between series.

References: Leite et al., 2013; Milano et al., 2013; Lopes et al., 2015; Lopes et al., 2016; Pizzi et al., 2017

Statistical analysis

Hardy-Weinberg equilibrium was tested by χ2 test using Clump (JAKOBSSON; ROSENBERG, 2007). All genetic models were analyzed for each polymorphism, being the recessive model adopted for rs12086634 (*HSD11β1* gene) SNP (TT *versus* GT+GG) and the dominant model adopted for rs1501299 (*ADIPOQ* gene) (TT+GT *versus* GG, respectively).

Kolmogorov-Smirnov test with Lillefors correction was used to test for normal distribution of the variables. Wilcoxon test was performed to verify the difference between initial and final medians. Differences between medians (median before – median after physical exercise) were calculated for each variable. Mann Whitney test were used to compare the differences of medians between genotypes according to Dominant or Recessive Models. The differences between means are shown in Table 2.

The difference between medians was calculated for all variables (variable before physical exercise – variable after physical exercise) and this difference was used as dependent variable in logistic regression analyses. The dependent variable was grouped in two strata according to their median, in which participants with values below the median were classified in one stratum (0), while the individuals with values above the median were grouped in other stratum (1). This manner, these tests used as dependent variables differences between medians of BMI, AC, TC, LDL-C, TG, HDL-C and Glu, all classified in this binary manner. Sex, age, SNP and modality of physical exercise were used as independent variables. The probability value for the comparative tests were considered significant at $p < 5.10^{-2}$ (5%)

Table 2 – Differences between means (before and after the physical exercise practice) according to genetic model adopted for polymorphisms sites.

Variables (Mean before – Mean after)	ADIPOQ gene (rs1501299) TT+GT X GG	p-value	HSD11β1 gene (rs12086634) TT X GT+GG	p-value
BMI_{before} - BMI_{after} (Kg/m²)	0.39±0.89 (43) X −0.13±0.79 (28)	$1.89.10^{-2}$	0.20±0.82 (54) X 0.33±1.11 (22)	$9.86.10^{-1}$
AC_{before} - AC_{after} (cm)	0.39±0.89 (43) X -0.13±0.79 (28)	$9.74.10^{-1}$	1.62±3.29 (41) X -1.12±3.59 (13)	$3.28.10^{-2}$
$HDL\text{-}C_{before}$ – $HDL\text{-}C_{after}$ (mg/dL)	1.61±13.12 (38) X 2.72±12.63 (25)	$6.23.10^{-1}$	3.55±11.02 (48) X 1.52±15.18 (20)	$6.04.10^{-1}$
$LDL\text{-}C_{before}$ – $LDL\text{-}C_{after}$ (mg/dL)	1.42±20.77 (30) X 2.91±25.99 (15)	$9.90.10^{-1}$	3.04±19.54 (33) X 3.53±30.08 (14)	$8.98.10^{-1}$
TG_{before} - TG_{after} (mg/dL)	-2.83±46.65 (38) X 6.79±3.39 (25)	$5.27.10^{-1}$	3.06±40.54 (48) X 2.33±43.22 (19)	$8.46.10^{-1}$
TC_{before} – TC_{after} (mg/dL)	6.85±20.13 (38) X 11.49±21.14 (25)	$3.72.10^{-1}$	12.03±15.70 (48) X 7.18±29.42 (19)	$7.27.10^{-1}$
Glu_{before} - Glu_{after} (mg/dL)	2.93±8.56 (39) X -1.68±10.84 (39)	$5.36.10^{-2}$	1.14±9.63 (49) X 2.38±10.45 (21)	$5.64.10^{-1}$

* Below each genetic model is demonstrated the median± standard deviation and **n** between parenthesis. N=number the individuals.

* Body Mass Index (BMI) is in Kilogram/meters², Abdominal Circumference (AC) is in centimeters, High Density Lipoprotein Cholesterol (HDL-C), Low Density Lipoprotein Cholesterol (LDL-C), Triglycerides (TG), Total Cholesterol (TC) and Glucose (Glu) are in mg/Dl. * p-value from Mann-Whitney Test through the comparisons of the difference of medians by genotype.

RESULTS

The differences between means before and after the physical exercise stratified by sex are shown in **Table 3**. It is possible to verify that through physical exercise practice many features are improved in both sexes, being BMI ($1.11.10^{-3}$), AC (p=$1.58.10^{-2}$), LDL-C (p=$2.00.10^{-2}$) and TC (p=$1.98.10^{-3}$) for girls and BMI ($2.76.10^{-3}$), TC (p=$6.3.10^{-5}$) and Glu (p=$4.42.10^{-2}$) for boys as already demonstrated in a previous study of our research group (GASPARIN, et al, 2018). Furthermore, logistic regression analyses without including genotypes as independent variables, demonstrated that the modality of physical exercise influences BMI measures, HDL-C and TG levels (b*= -0.29±0.09; p=$1.38.10^{-3}$; b*= 0.31±0.09; p=$8.20.10^{-4}$; b*= -0.32±0.09; p=$6.32.10^{-4}$; respectively), being the aerobic training the best modality to improve these features. Besides, older individuals reduced more AC measures and LDL-C levels than did the younger (b*= 0.25±0.10; p=$1.59.10^{-2}$; b*= 0.24±0.11; p=$3.89.10^{-2}$; respectively).

According to Logistic Regression analysis, including genotypes as independent variables, carriers of T allele of rs1501299 have a higher BMI reduction, independent of sex, physical exercise and age (b*=0.284±0.12; p=$1.70.10^{-2}$). Mann-Whitney Test also demonstrated that T carriers had a higher BMI reduction when compared to non carriers, through the practice of physical exercise (p=$1.82.10^{-2}$).

Individuals bearing TT genotype of rs12086634 have a higher AC reduction independent of gender, age and modality of physical exercise (b*=-0.33±0.13; p=$1.24.10^{-2}$). According to Mann-Whitney Test, carriers of this genotype also have a better reduction of this variable (p=$3.28.10^{-2}$).

The genotype distributions are in Hardy-Weinberg equilibrium.

Table 3 – Comparison between medians of anthropometric and biochemical variables before and after the physical exercise by Wilcoxon Test.

	Girls			Boys		
	Before Mean± standard deviation (n)	After Mean± standard deviation (n)	p-value	Before Mean± standard deviation (n)	After Mean± standard deviation (n)	p-value
BMI (Kg/m²)	29.23±4.91 (55)	28.87±5.02 (52)		30.34±6.04 (71)	29.72±5.94 (70)	
Average difference	0.36		$1.11.10^{-3}$	0.62		$2.76.10^{-3}$
AC (cm)	95.98±13.51 (42)	94.65±13.26 (41)		98.80±13.73 (56)	97.51±14.41 (55)	
Average difference	1.33		$1.58.10^{-2}$	1.29		$1.21.10^{-1}$
HDL-c (mg/dL)	50.64±11.25 (55)	49.08±13.28 (51)		45.64±9.31 (71)	43.15±8.90 (62)	
Average difference	1.56		$3.51.10^{-1}$	2.49		$5.74.10^{-2}$
LDL-c (mg/dL)	98.84±30.56 (55)	91.15± 27.09 (42)		93.62±29.43(71)	89.00±26.14 (50)	
Average difference	7.69		$2.00.10^{-2}$	4.62		$7.60.10^{-2}$
TG (mg/dL)	90.26±36.42 (55)	86.62±44.47 (50)		99.33±58.32 (71)	90.61±45.06 (62)	
Average difference	3.64		$2.39.10^{-1}$	8.72		$3.37.10^{-1}$
TC (mg/dL)	167.52±33.98 (55)	156.35±29.29 (50)		169.64± 35.75(71)	153.20±29.25 (62)	
Average difference	11.17		$1.98.10^{-3}$	16.44		$6.3.10^{-5}$
Glu (mg/dL)	87.05±9.88 (55)	88.09±6.50 (51)		86.84±10.72 (71)	84.68±10.73 (64)	
Average difference	-1.04		$9.42.10^{-1}$	2.16		$4.42.10^{-2}$

Body Mass Index (BMI) is in Kilogram/meters², Abdominal Circumference is in centimeters, High Density Lipoprotein Cholesterol (HDL-C), Low Density Lipoprotein Cholesterol (LDL-C), Triglycerides (TG), Total Cholesterol (TC) and Glucose (Glu) are in mg/dL. Wilcoxon test was used to compare differences between medians (before and after the physical exercises) for Girls and for Boys, but it is demonstrated the mean before and after the physical exercise to easy the understanding.

DISCUSSION

Considering the health complications of altered lipid profile and obesity-related anthropometric features, our purpose in the present research was to evaluate the changes of lipid profile and anthropometric features related to obesity, considering the practice of physical exercise, sex, age and the polymorphisms rs1501299 of *ADIPOQ* gene and rs12086634 of *HSD11β1* gene.

This is the first longitudinal study with young individuals including these polymorphisms, obesity-related anthropometric features and biochemical parameters, and our findings highlight the importance of physical exercises early in life, besides the influence of these SNP on anthropometric variables. It is known that the reduction of physical activity and weight gain are related to many deteriorating health predictors, as hypertension, hypercholesterolemia and insulin resistance (BRANDES, 2012; ZAER GHODSI et al., 2016). Kelley *et al.* (2015) emphasize the importance of the regular practice of an exercise program, indicating an estimative in which through this practice, approximately 2.5 million overweight and obese children in the USA and 22.0 million overweight and obese children worldwide could reduce their BMI (KELLEY; KELLEY; PATE, 2015).

Besides, genetic factors also influence this feature. In our study T carriers of rs1501299 of *ADIPOQ* gene presented higher reduction of BMI, independent of sex, physical exercise and age. Similar to us, Qi *et al*. (2005) observed in their prospective study of diabetic men that TT genotype was related to lower risk of Cardiovascular Disease and with higher adiponectin levels (QI et al., 2005). It is known that these higher concentrations are related to features opposed to the Metabolic Syndrome (MetS) (ARITA et al., 1999; LARA-CASTRO et al., 2007; QI et al., 2005; GOMES FRAGA; BRAGA GOMES, 2014). Thus, the T allele of rs1501299 could be related to higher levels of adiponectin and consequently contribute to the highest reduction of BMI observed in our sample. Gomes Fraga *et al.* (2014) highlighted this question in their literature revision, demonstrating the relationship between adiponectin levels and features related to Metabolic Syndrome in adults, children and adolescents (GOMES FRAGA; BRAGA GOMES, 2014). Many studies have shown that hypoadiponectinemia could be

related to overweight, obesity, type 2 diabetes mellitus, cardiovascular risk factors, hypertension and insulin resistance and some polymorphisms in *ADIPOQ* gene could influence its expression (ARITA et al., 1999; LARA-CASTRO et al., 2007; GOMES FRAGA; BRAGA GOMES, 2014). However, the findings associating this polymorphism with features related to obesity are controversial (QI et al., 2005; GOMES FRAGA; BRAGA GOMES, 2014; OGUNDELE et al., 2017; LUIS et al., 2016). Ogundele *et al*. (2017), who analyzed young Nigerian adults, did not find any association between rs1501299 of *ADIPOQ* gene and BMI, waist circumference (WC) or hip circumference (HC) (OGUNDELE et al., 2017). Controversially to us, Luis *et al.* (2016) observed that T allele carriers have an increased risk for Metabolic Syndrome (LUIS et al., 2016).

There are many modalities of physical exercise which improve features related to obesity and the aerobic training have been demonstrated as a contributing factor for health improvement (KLIJN; VAN DER BAAN-SLOOTWEG; VAN STEL, 2007; LEITE et al., 2013). Klijn *et al.* (2007) demonstrated the beneficial effects on aerobic fitness in a obese childhood sample (KLIJN; VAN DER BAAN-SLOOTWEG; VAN STEL, 2007). Some studies reinforce that after an aerobic exercise intervention, many improvements have been observed in children and adolescents, as a significant reduction in body weight and BMI (KLIJN; VAN DER BAAN-SLOOTWEG; VAN STEL, 2007), and associated with nutritional intervention results in substantial benefits on metabolic health indicators (LEITE et al., 2013), reduction in triceps skinfold thickness, percent body fat and fat mass and an increase in fat-free mass and in HDL-c levels (SILVA et al., 2014). Thus, besides improving anthropometric features, the practice of aerobic training also contributing for a healthy lipid profile (KLIJN; VAN DER BAAN-SLOOTWEG; VAN STEL, 2007; LEITE et al., 2013; SILVA et al., 2014), being this modality the most effective to reduce BMI and LDL-C and to increase HDL-C levels in our sample.

We also observed a relationship between rs12086634 of *HSD11β1* gene and abdominal circumference, in a way that TT genotype individuals had a higher reduction of this variable after participating of the physical exercise training. Devang *et al.* (2017) also found benefic effects on carriers of TT genotype, in which homozygote for T allele had lower BMI, lower waist circumference, lower TG and higher HDL levels than heterozygote TG (DEVANG et al., 2017). Besides, Tureck et al (2014) observed that

carriers of the G allele of SNP rs12086634 had higher glucose levels when compared to non-carriers (TUREK et al., 2014). Controversially to us, Gambineri *et al.* (2011) verified that heterozygous GA for rs846910 and homozygous TT for allele of rs12086634 had a higher risk of metabolic syndrome, regardless of the diagnosis of PCOS (Polycystic Ovary Syndrome) (GAMBINERI et al., 2011). According to the authors, carriers of the two SNPs rs846910 A and rs12086634 T had an increased HSD11β1 expression and activity (GAMBINERI et al., 2011). Furthermore, Fichna *et al.* (2017) did not verify an association between polymorphisms in this gene and features related to MetS (FICHNA et al., 2017). Since distinct results are observed in many studies (TUREK et al., 2014; DEVANG et al., 2017; GAMBINERI et al., 2011; FICHNA et al., 2017) and considering that T allele already was associated to higher expression of HSD11β1 it is possible to consider a possible linkage disequilibrium with another polymorphism in this gene could cause the benefic effect of this allele (MALAVASI et al., 2010). Lastly and according to our results, the TT genotype appears to contribute for better anthropometric measures.   The practice of physical exercise also influence many biochemical variables, and independent by genetic factors it was possible to observe the benefic effect of the practice of physical exercise and nutritional treatment in both, anthropometric variables and lipid profile, in oldest and youngest individuals (ROSSI et al., 2015; LOPES et al., 2016; ELMAHGOUB et al., 2011). Besides there are many modalities of physical exercises, some of them can be highlighted as: aerobic training (on land or in water), combined training and High-Intensity Interval Training. According to Rossi *et al.* (2015) in an obese female postmenopausal sample, the practice of a combined training was very relevant to improve their fat-free mass and to decrease whole and abdominal adiposity (ROSSI et al., 2015). Some studies reinforced the importance of physical exercises, discussing its contributions for reducing inflammatory markers associated with obesity, besides improving the physical fitness and lipid profile (LOPES et al., 2016; ELMAHGOUB et al., 2011).

Other important modality is the "Aerobic Water Walking Training" and it has been recommended for obese individuals due to reduced joint load, contributing to improve physical fitness and being relevant for cholesterol reduction when combined with nutritional guidance (LOPES et al., 2015). Furthermore, the improvements from aquatic exercise training on glucose and lipids serum measures are very important

(DELEVATTI; MARSON; KRUEL, 2015).

The HIIT also have been highlighted as a method capable to improve health and according to Martínez *et al.* (2016), this intervention improved motor capacity (speed/agility) in children (7-9 years) (MARTÍNEZ et al., 2016). Pizzi *et al.* (2017) demonstrated that a significant decrease in BMI z-score, Waist Circumference, TC, LDL-C, and BChE activity was observed after the practice of HIIT (PIZZI et al., 2017). Ghodsi *et al.* (2016) also verified improvement on lipid profile through this practice (ZAER GHODSI et al., 2016). Lastly, is important to emphasize that any modality of physical exercise is positive for children and adolescents' health, and this practice contributes to restore cellular and cardiovascular homeostasis and activating metabolism (PAES; MARINS; ANDREAZZI, 2015).

CONCLUSION

It was possible to verify an influence of genetic factors and the practice of physical exercise on anthropometric features even in a small sample size. In summary we highlighted that the T allele of rs1501299 appears to contribute for reducing BMI measures ($p=1.70.10^{-2}$) while the TT genotype of rs12086634 seems to influence on a reduction of AC ($p=1.24.10^{-2}$), through physical exercises and independent of other variables. Furthermore the practice of physical exercise, independent by genetic factors, improves the lipid profile and anthropometric features. This manner both genetic variants and physical exercise influence on obesity related features and could be used as a strategy to avoid complications from these characteristics early in life.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest that could be perceived as prejudicial to the impartiality of the reported research.

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