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IMPACT OF ORGANIZED SPORTS ON RISK OF BONE FRACTURE AMONG ADOLESCENTS: ABCD – GROWTH STUDY

KYLE ROBINSON LYNCH

Orientador: Prof. Dr. Rômulo Araújo Fernandes

Presidente Prudente, 2018

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Dissertação apresentada a Faculdade de Ciências e Tecnologia do Campus de Presidente Prudente, Universidade Estadual Paulista "Júlio de Mesquita Filho", como parte dos requisitos para obtenção do título de Mestre em Ciências de Motricidade.

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ERRATA

Onde se lê:

To FAPESP, for funding my masters (Process number 2016/20377-0).

Leia-se:

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CERTIFICADO DE APROVAÇÃO

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I dedicate this dissertation first to God, who has blessed me infinitely during this journey, to my father Lou (in memorial) and my mother James Ann, for giving me all the education, love and support, and my wife Bruna, the great love of my life and my biggest inspiration.

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RESUMO

Objetivo: Analisar o risco de fraturas traumáticas de acordo com o engajamento em esportes com diferentes níveis de impacto, assim como identificar o potencial impacto da participação esportiva nos gastos entre adolescentes. **Métodos:** Estudo longitudinal com 24 meses de seguimento. A amostra foi composta por 285 adolescentes de ambos os sexos (202 meninos e 83 meninas) que foram contatados pelos pesquisadores em escolas (n= 104) e clubes esportivos (n= 181) localizados na região metropolitana de Presidente Prudente, SP, Brasil. Todos os adolescentes foram convidados considerando os seguintes critérios de inclusão: a) idade entre 10-19 anos, 2) assinatura dos pais no termo de consentimento, 3) se contatados em clubes esportivos, pelo menos um ano de treino; se contatados na escola, pelo menos um ano sem prática esportiva ou exercícios. Os grupos foram classificados em: Controle (n= 104), Natação (n= 34), e Esportes de Impacto (n= 147). A ocorrência de fraturas e gastos em saúde foram avaliadas mensalmente durante 12 meses antes da linha de base e 12 meses após linha de base. Sexo, idade, composição corporal, participação esportiva, maturação biológica e proteína C-Reativa (PCR) foram avaliados durante os 12 meses após a linha de base. Análise estatística foi composta por teste Mann-Whitney, qui-quadrado, Regressão de Cox, Kruskal-Wallis, Analise de Covariância e medidas de tamanho de efeito. A significância estatística foi fixada em p<0.05 e todas as análises foram realizadas no software BioEstat (versão 5,2 [BioEstat, Teffe, Brasil]). **Resultados:** A incidência de novas fraturas foi de 2,1% (n= 6). A ocorrência de fraturas traumáticas durante o período de 24 meses (12 meses de seguimento + 12 meses prévios) foi de 6,0% ([IC95%: 3,2% a 8,7%]; n= 17). Os gastos totais acumulados durante o período de 12 meses de seguimento foram de U$ 2.991,96. Quando comparados os adolescentes de acordo com a incidência de novas fraturas, não houveram diferenças por sexo, idade, densidade óssea, gordura corporal, esportes, maturação biológica e PCR. Gastos totais também não apresentaram diferença de acordo com a ocorrência de qualquer fratura durante o período de 24 meses. Participação esportiva não mostrou qualquer associação ou risco para a ocorrência de fraturas traumáticas. Quando desmembrados os grupos por esportes, atletismo [US$ 4,13 (27,67)], ginástica [US$ 10,77 (23,90)], judô [US$ 4,24 (6,96)] e natação [US$ 24,67 (46,50)] apresentaram maiores gastos quando comparados ao grupo controle. Caratê, kung-Fu, tênis, basquete e baseball não apresentaram diferenças significativas quando comparados ao grupo controle. Nadadores apresentaram maiores gastos com medicação (p-valor= 0,001), consultas (p-valor= 0,001) e exames (p-valor= 0,005) quando comparados ao grupo controle e esportes de impacto. Mesmo após ajustes por fatores de confusão, nadadores (Média: US$ $_{log10}$ 1,172 [IC95%: 0.925 a 1.420]) tiveram maiores gastos do que o grupo controle (Média: US$ $_{log10}$ 0,280 [IC95%: 0,101 a 0,459]) e esportes de impacto (Média: US$ $_{log10}$ 0,404 [IC95%: 0,290 a 0,519]) (p-valor = 0,001). Participação esportiva explicou 13,2% de toda variância em gastos com saúde, enquanto sexo (2,6% da variância) e fraturas (3,5% da variância) também foram covariáveis relacionadas aos gastos nesse modelo. **Conclusão:** Os achados desse estudo indicaram que participação esportiva (incluindo esportes de impacto) não aumentou o risco de fraturas entre adolescentes, enquanto fraturas traumáticas foram o principal determinante de gastos com saúde entre adolescentes. Além disso, alguns esportes pareceram estar mais relacionados a maiores gastos com saúde entre adolescentes, independente do impacto econômico de fraturas e sexo.

Palavras-chave: Densidade mineral óssea; Esportes; Adolescentes; Fraturas por estresse.

ABSTRACT

Objective: To analyze the risk of traumatic fractures according to the engagement in sports with different levels of physical impact, as well as to identify the potential impact of sports participation on health care costs among adolescents. **Methods:** Longitudinal study with 24 months of follow-up. The sample was composed of 285 adolescents of both sexes (202 boys and 83 girls) who were contacted by the researchers in schools (n= 104) and sports clubs (n= 181) located in the metropolitan region of Presidente Prudente, Sao Paulo, Brazil. All adolescents were invited, considering the inclusion criteria: 1) 10-19 years-old, 2) parents' consent form signed, 3) if contacted in any sports club, at least one year of training experience; if contacted in any school unit, at least one year without regular practice of sport or exercise. The groups were classified as: Control (n= 104), Swimming (n= 34), and Impact Sports (n= 147). The occurrence of fractures and health care costs were assessed monthly during the 12 months before baseline, as well as 12 months after baseline. Sex, age, body composition, sports participation, peak height velocity (PHV) and C-reactive protein (CRP) were assessed during the 12 months of follow-up. Statistical analyses were composed of Mann-Whitney test, chi-square test, Cox Regression, Kruskal-Wallis test, Analysis of Covariance and measures of effect size. Statistical significance was set at $p<0.05$ and all analyzes were performed using BioEstat software (version 5.2 [BioEstat, Teffe, Brazil]). **Results:** The incidence of new fractures was 2.1% (n= 6). The occurrence of traumatic fractures during the 24-month period (12-month follow-up plus previous 12 months) was 6.0% ([95%CI: 3.2% to 8.7%]; n= 17). The overall costs accounted during the 12-month follow-up were U$ 2,991.96. When comparing the adolescents according to the incidence of new fractures, there were no differences regarding age, BMD, BF, sports, PHV, and CRP. Overall health care costs were also not different according to subjects with any fracture during the 24-month period. Sports participation did not show any significant association or risk with the occurrence of traumatic fractures. When breaking the groups down by sport, track and field [US$ 4.13 (27.67)], gymnastics [US$ 10.77 (23.90)], judo [US$ 4.24 (6.96)], and swimming [US$ 24.67 (46.50)] presented higher costs when compared to the control group. Karate, kung-Fu, tennis, basketball and baseball did not show significant differences when compared to the control group. Concerning health care costs, swimmers presented higher costs with medicine (p-value= 0.001), appointments (p-value= 0.001), and tests (p-value= 0.005) when compared to control and impact sports groups. Even after adjustment by confounders, swimmers (Mean: US$ $_{log10}$ 1.172 [95%CI: 0.925 to 1.420]) had higher health care costs than control (Mean: US$ $_{log10}$ 0.280 [95%CI: 0.101 to 0.459]) and impact sports (Mean: US$ $_{log10}$ 0.404 [95%CI: 0.290 to 0.519]) (p-value = 0.001). Sports participation explained 13.2% of all variance in health care costs, while sex (2.6% of the variance) and fractures (3.5% of the variance) were also covariates related to health care costs in this model. **Conclusion:** The findings from this study indicate that sports participation (including impact sports) did not increase the risk of fracture among adolescents, while traumatic fracture was the main determinant of health care costs among these adolescents. Moreover, some sports seem to be related to higher health care costs among adolescents, independently of the significant economic burden of fractures and sex.

Keywords: Bone mineral density; Sports; Adolescents; Stress fractures.

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ABREVIATIONS

ABCD – Analysis of Behaviors of Children During Growth

BMD – Bone Mineral Density

PHV – Peak Height Velocity

IGF – 1 – Insulin Growth Factor 1

FM – Fat Mass

LST – Lean Soft Tissue

FAPESP – Fundação de Amparo a Pesquisa do Estado de São Paulo

UNESP – Universidade Estadual Paulista

SUS – Sistema Único de Saúde

CRP – C Reactive Protein

HR – Hazard Ratio

CI – Confidence Interval

ANCOVA – Analysis of Covariance

OR – Odds Ratio

LIVE – Laboratory of Investigation in Exercise

R$ - Real

US$ - Dollar

Kg – Kilogram

DXA – Dual-energy x-ray absorptiometry

GE – General Electric

Mg/L – Milligrams per Liter

ES – r – Eta-squared values

BF – Body Fat

SUMMARY

INTRODUCTION

In 2016, the city of Rio de Janeiro held the Olympic Games, four years after London and eight years after Beijing. The months leading up to the Olympic Games, there is an intensive discussion in the society about the consequences of this sort of big event on Brazilian society. Regarding the consequences, the promotion of sports participation among youth groups is one of the most relevant ones, not only to inspire futures generations of athletes but also to promote benefits of health, related to sports (STRONG et al., 2005). Sports participation constitutes the most common manifestation of physical activity among adolescents (STRONG et al., 2005). In the United States, it is estimated that 30 to 45 million individuals between 6 and 18 years of age participate in sports (BRENNER & COUNCIL ON SPORTS MEDICINE AND FITNESS, 2007). In São Paulo state, the percentage of adolescents regularly engaged in sports is lower than 15% (DUNCAN et al., 2011; FERNANDES et al., 2012), while this percentage reaches almost 50% in Germany (WATTIE et al., 2014). Regarding public health, the low percentage of adolescents engaged in sports constitutes a public health concern in developing nations, such as Brazil (DUNCAN et al., 2011; FERNANDES et al., 2012).

In fact, sports participation is capable of promoting cardiovascular, metabolic and psychological benefits during pediatric ages (STRONG et al., 2005; TENFORDE & FREDERICSON, 2011). Regarding the health benefits attributed to the regular engagement in sports, the improvement of the skeleton has been widely investigated, mainly due to its potential role in the prevention of osteoporosis (BAPTISTA & JANZ, 2012). Several sports produce high physical load during participation and thus act positively on bone accrual during growth through a process known as mechanotransduction. During childhood and adolescence, the bone surface is widely covered by active osteoblasts, which are mechanically stimulated by deformations suffered by the bone matrix during sports participation. Moreover, the physical loads generated by sports participation are perceived by the bone matrix as strain, suppressing the osteocyte secretion of substances related to lower bone formation (BAPTISTA & JANZ, 2012), while through other pathways, physical exercise also stimulates the release of hormones related to higher bone formation (KOHRT et al., 2004; ELLOUMI et al., 2009).

The pathways above mentioned stimulates bone turnover (KOHRT et al., 2004). Therefore, studies have shown that young athletes involved in impact sports have a greater bone mineral density (BMD) than non-athletes (FEHLING et al., 1995; RISSER et al., 1990). For example, on lower limbs, soccer practice makes muscle-skeletal structures respond positively to weight bearing and impact loading (SEABRA et al., 2012), while basketball significantly improves upper limbs BMD when compared to controls and other sports (AGOSTINETE et al., 2016). However, the same effects are inconclusive in hypogravity sports, due to the absence of impact loading in sports like swimming (RIBEIRO-DOS-SANTOS et al., 2016).

The fact of the osteogenic effect attributed to sports participation is based on the exposition of the bone matrix to mechanical loading creates a complicated situation, mainly because excessive mechanical load can cause traumatic fractures. Moreover, BMD is improved by sports participation, but its liability on the risk of fracture is not clear yet (WREN et al., 2012) and it is not known if non-impact sports are effective in reducing the risk for stress fractures when compared to adolescents non-engaged in sports (KEMPER, 2006). Thus, despite the health benefits of sports participation, an increased prevalence of bone injuries in adolescents has raised concerns regarding the safety of intense athletic participation at a young age, since stress fractures can impair growth with potential lifelong effects (MAFFULLI & BRUNS, 2000). Vanderlei et al. (2014) estimated that the frequency of injuries related to sports among adolescents aged 12 to 18 years is about 21% in Brazil. However, the impact of sports participation on risk of fractures in children and adolescents is not clear due to the existence of conflicting data (WREN et al., 2012; LÖFGREN et al., 2012) and gaps in the scientific literature about this issue involving the role of biological maturation and inflammation on occurrence of bone fracture, as well as its economic burden.

Regarding biological maturation, although specific types of sports influence bone variables in different ways, maturation is a key component in this process. Regarding bone mass gain, the pubertal period is responsible for significant accrual in bone mass in boys and girls (KEMPER, 2006). Peak height velocity (PHV) constitutes a relevant maturational event, which occurs during adolescence, increasing significantly the skeletal size (KEMPER, 2006). PHV precedes the peak bone mass accrual, denoting a situation of potential risk to sports fractures (KEMPER, 2006; WREN et al., 2012), in which skeleton mass does not accompany the increase in skeleton size. On the other hand, the impact of that dissociation between linear growth and bone mass gain on the recognized osteogenic effect caused by physical exercise is still unclear so far.

Regarding the role of inflammation on this process, prolonged physical exercise at moderate intensity has anti-inflammatory effects, but pro-inflammatory status is stimulated following intense prolonged physical exercise (PEDERSEN, 2012; ELIAKIM & NEMET, 2012). In male wrestling adolescents, the acute effect of a high-intensity exercise session increased the concentration of inflammatory markers significantly and decreased insulin-like growth factor-1 (IGF-1) concentrations (NEMET et al., 2002), which is relevant in process related to bone formation. In pre-pubertal and early pubertal males, after five weeks of a very high amount of physical exercise, the inflammation increased, and in turn, IGF-1 and IGF-1 binding protein 3 decreased significantly (SCHEETT et al., 2002). Physical exercise, depending on combinations between its frequency, intensity, and duration, can assume either anabolic or catabolic effects (ELIAKIM & NEMET, 2012), leading to imbalances on bone formation and hence higher risk of sports fracture. Therefore, although inflammation promoted by physical exercise can be potentially harmful to the growth hormone – IGF-1 axis, its burden on the risk of traumatic fracture during sports participation constitutes an opened line of research (RIBEIRO-DOS-SANTOS et al., 2016).

Finally, in a background in which public health campaigns are developed to promote sports participation among pediatric groups targeting health promotion, the economic burden of fractures related to sports participation should be considered as well. A survey conducted in the United States of America investigating pediatric orthopedic injuries showed that the highest total hospitalization charges were among children with femur fractures and adolescents with vertebral fractures (NAKANIIDA et al., 2014). Additionally, another study with Rugby players found that 2% (n = 71) of the 3652 players sought medical care after the tournament. For these players, average treatment costs were high (US$ 731 per player [95%CI: 425 to 1096]), with fractures being the most expensive type of injury (BROWN et al., 2015). To the best of our knowledge, there is no such data in Brazil highlighting the need for a complete cost picture following pediatric fractures related to sports participation.

OBJECTIVES

Main objective

To identify the impact of participation in organized sports on the occurrence of traumatic fractures among adolescents, taking into account the role of biological maturation and inflammation on this phenomenon, as well as to estimate the direct costs related to fractures in these adolescents.

Secondary objectives

i) To characterize the occurrence of fractures in different sports (impact and non-impact) according to type and mechanism;

ii) To investigate the role that participation in different sports (impact and non-impact) play on inflammation and health care costs in adolescents;

iii) To analyze how the following variables: sex, age, biological maturation, and inflammation affect body composition (BMD, fat mass [FM] and lean soft tissue [LST]) and contribute to the occurrence of fractures in different sports;

iv) To assess how sports participation and other variables (sex, age, biological maturation, inflammation and body composition) interfere with health costs related to fractures.

METHODS

Sample Size

This research project is part of a "Projeto Regular FAPESP" that was recently approved and started activities on October 1, 2016 (Process number: 2015/19710-3). The research project has a longitudinal design (cohort study), which is based on 12 months of follow-up. The minimum sample size required for the study was based on the occurrence of fractures among adolescents (21%) (VANDERLEI et al., 2014), a statistical power of 80% and an alpha error of 5.5% (Z= 1.96). Due to this configuration, the minimal sample size was estimated at 211 adolescents. Predicting sample losses during the 12 months of follow-up (20% estimation), the final sample size (minimum) was 233 adolescents.

Regarding the ethical aspects, the research project was recently approved by the Ethics Research Committee of São Paulo State University (UNESP), Presidente Prudente Campus (CAAE: 57585416.4.0000.5402 / Process number: 1677938/2016 [**Appendix 1**]).

Sampling and Inclusion Criteria

Data collection was organized to take place over one calendar year, which involved two periods of data collection (baseline measurements [previous 12 months] and 12-month follow-up). However, contact with participants to collect information about bone fractures and health care use happened monthly. Information regarding sex, chronological age, ethnicity, socioeconomic status, alcohol consumption and smoking were reported by the participants during a face-to-face interview.

Adolescents were recruited at schools and sports clubs in the metropolitan region of Presidente Prudente, with the existing authorization of the Department of Education and Sports. Presidente Prudente has the largest population in the western region of São Paulo state (~220,600 inhabitants), and many people commute to the city for work and educational purposes. According to the Department of Education, the city of Presidente Prudente has about 37,000 students (2009 data) that are enrolled in public and private schools (elementary, middle and high school). Of this total, 27,860 students are enrolled in elementary/middle school, and 9,105 in high school and about 20% of these students are enrolled in private schools. Adolescents were chosen from both public and private schools. School units and sports clubs that meet the target age group were listed and selected randomly.

The selected schools and sports clubs were contacted and informed of the purpose, criteria for the research project. After receiving permission from each school, 30% of the classes were drawn randomly, and all the students were invited to participate. In the selected sports clubs, all adolescents were invited to participate. The inclusion criteria for both sites were, as follow: i) age between 12 and 17 years old; ii) do not present any clinical or metabolic disorder (previously diagnosed) that can hinder physical activity; iii) do not use any medication that may interfere with blood pressure control, lipid metabolism, bone or accumulation of fat in the liver (corticosteroids, estrogen, amiodarone, antiretroviral drugs, diltiazem, and Tamoxifen); iv) the legal guardian must sign the consent form.

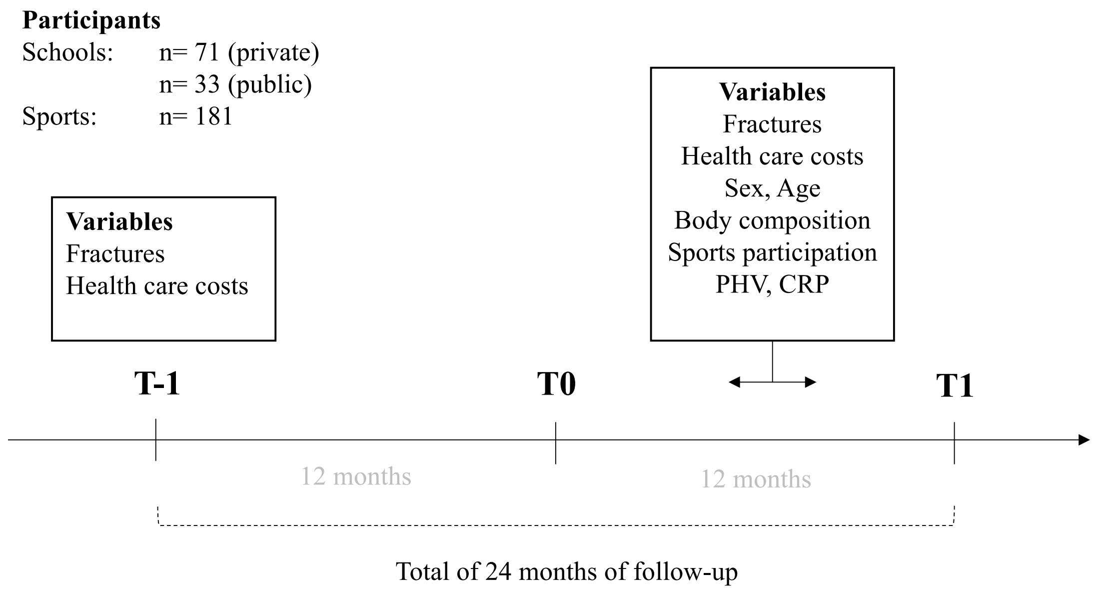

Figure 1. Sample and timeline of data collection (ABCD – Growth Study).

Notes: T-1: Previous 12 months (retrospective); T0: Baseline; T1: 12-month follow-up (prospective); PHV: Peak height velocity; CRP: C-reactive protein.

Strategies to Reduce Losses

The city of Presidente Prudente is characterized as the largest in the western region of São Paulo state. This coupled with the fact that the city has four colleges and one university, making it a great location for the study to take place because the chances that the adolescents will stay in the city are high.

Although these characteristics allow the development of the cohort study, the longitudinal design has a real possibility of dropouts during the follow-up. Thus, certain methodological steps were taken to ensure a lower rate of sample loss: (i) In addition to residential and electronic addresses, telephone numbers (home and cell) were collected; (ii) The contact phone number and home address of at least two relatives were recorded; (iii) Once the schools and sports clubs were the intermediaries between researchers and the participants, the Department of Education and Sports assisted in monitoring these adolescents, even if they moved to another school or sports club; (iv) optimization of time and logistics of data collection, so the adolescents did not have to travel to the university more than once to be analyzed.

Dependent Variables

Traumatic Fractures

The information on the occurrence of traumatic fractures was collected monthly. Once a month, the research team contacted the participants to record the incidence of fractures using a standard interview. This interview consisted of date that the fracture occurred, fracture site (feet / ankles, legs, torso, arms / forearms, wrist / fingers and other body parts) and how the fracture occurred [car accident/bike, fall on the same plane, downhill fall, fall between planes, and sport participation (HEDSTRÖM et al., 2010)]. When reporting the traumatic fracture during sports, we also asked whether the fracture occurred by physical contact or fall, as well as during training or competition.

At baseline, participants were asked about the occurrence of fractures in the 12 months before the beginning of the study because it is an important confounding factor (WREN et al., 2012).

Health Care Costs

Information on the use of health care services was reported by parents or guardians of adolescents through a questionnaire (IDLER et al. 2015). Once a month, the research team collected data using the questionnaires, which have been used to estimate health care costs among pediatric populations (IDLER et al., 2015). During the 12 months of follow-up, the health care services were computed as medical consultations (quantity and specialty [pediatrics, endocrinology, cardiology, etc.]), non-medical specialties [quantity of consultation with psychologist, physiotherapist, nutritionist, etc.]), hospitalizations (number of days), laboratory and clinical tests (quantity and type), and medication used. Additionally, we asked if the health care service used was subsidized by the Brazilian National Health System (SUS), private health insurance or own resources.

To estimate the healthcare costs covered by SUS, the methodology was the same used in previous studies (CODOGNO et al., 2011; CODOGNO et al., 2015; TURI et., 2016). To convert cost into local currency (Real [R$]), we used the price of medication, medical and laboratory procedures paid by the Department of Health. To estimate the health care cost covered by private health insurance, a specific list of prices was applied (HANSEN et al., 2013). Finally, to estimate the health care cost covered by personal resources, we used average prices from pharmacies in the city of Presidente Prudente.

Independent Variable

Sports

Participants were divided into three groups and classified by the amount of physical impact in the sport: Control (not engaged in any sport), Swimming and Impact (Track and field, Basketball, Gymnastics, Judo, Karate, Kung-Fu, Tennis, and Baseball) (AGOSTINETE et al., 2016). In the present investigation, swimmers and karatekas were involved in state and national competitions, while adolescents engaged in track and field, basketball, gymnastics, judo, kung-Fu, tennis, and baseball were involved in state-level competitions.

Covariates

Body Composition

Whole body measurements of body fatness (in percentage), lean soft tissue (LST) (in kg) and BMD (g/cm^2) were assessed using a dual-energy x-ray absorptiometry scanner (Lunar DPX-NT; General Electric Healthcare, Little Chalfont, Buckinghamshire, UK) with GE Medical System Lunar software (version 4.7). The radiation dose is not harmful to the health of the participant [less than 0.05 mrem (LASKEY et al., 1992)], and only one researcher previously trained handled the measurements. DXA measurements were performed in the morning after a light breakfast, and the scanner quality was tested by a trained researcher before each day of measurement, following the manufacturer's recommendations. The participants wore light clothing, without shoes and remained in the supine position on the machine (approximately 15 minutes).

Biological Maturation

Body weight was measured using an electronic scale (Filizola model Personal Line 200, Filizzola Ltda., Brazil), height and sitting- height using a wall-mounted stadiometer (Sanny, Professional model, Sanny®, Brazil) with accuracy of 0.1 cm, according to the procedures described in the literature (GORDON, CHUMLEA & ROCHE, 1988). Biological maturation was estimated by the PHV, from mathematical models based on anthropometric measurements, described by Mirwald et al. (2002). These equations represent time (in years) before (negative values) or after (positive values) PHV, which is characterized as an important biological event in the human aging process.

Inflammation

A qualified professional collected participants' blood samples in the morning after 12 hours of fasting. The laboratory where the samples were analyzed is certified, and the dosages followed the recommendations of the IV Brazilian Guidelines for Dyslipidemia and Atherosclerosis prevention (SPOSITO et al., 2007). The plasma concentration of C-reactive protein (CRP) was determined by the turbidimetric method using an enzymatic kit (Millipore, St. Charles, MO [inter and intra assay coefficient variation between 4.6 and 6.0%, respectively]).

Statistical Analysis

Descriptive statistics were expressed in values of percentage (%), median and interquartile range (IR) because the data showed non-normal distribution. Mann-Whitney test was used to compare the occurrence of traumatic fractures according to independent variables (age, BMD, body fatness, sports participation, maturity offset, CRP, and health care costs). Then, chi-square test (with Fisher's exact test) was applied to verify associations between traumatic fractures and independent variables (sex, age, sports participation, body fatness, maturation, BMD, and CRP). Additionally, we assessed the risk of traumatic fractures according to the same independent variables using Cox Regression (Hazard Ratio [HR] and 95% Confidence Intervals [95%CI] Next, Kruskal-Wallis test was used to compare health care costs according to different sports groups. Finally, analysis of covariance (ANCOVA) was used to verify the interaction effect between overall health care costs and sports participation adjusted by sex, age, PHV, BMD, body fatness, CRP, occurrence of fractures, previous engagement in sports and minutes of practice per week. Statistical significance was set at $p<0.05$ and all analyzes were performed using BioEstat software (version 5.2 [BioEstat, Teffe, Brazil]).

RESULTS

PAPER – 1

How sports affect the incidence of traumatic fractures and health care costs among adolescents? Findings from the ABCD – Growth Study

INTRODUCTION

Physical activity has been pointed out as an important behavior leading to better health and growth among pediatric groups (STRONG et al., 2005). In fact, sports participation is the most relevant manifestation of exercise during adolescence, being a valuable way to meet physical activity guidelines. In terms of health benefits, sports participation is capable of promoting cardiovascular, metabolic and psychological aspects during pediatric ages (STRONG et al., 2005; TENFORDE & FREDERICSON, 2011). In fact, adolescents engaged in sports have better lipid profile than their peers (AGOSTINETE et al., 2016), as well as sports participation seems to affect blood pressure more significantly than other physical activity domains, such as physical activity performed at school and during leisure-time (CHRISTOFARO et al., 2013).

Another health aspect linked to sports participation is its osteogenic effect on skeleton, which has been widely investigated in adolescence, mainly due to its potential role in the prevention of osteoporosis later in life (BAPTISTA & JANZ, 2012). Supporting the relevance of this osteogenic impact, adults who were engaged in sports during childhood and adolescence have higher bone content and density than their peers who were not engaged (MANTOVANI et al., 2018). However, even with sports participation in early life improving bone parameters during adulthood, the osteogenic effect creates a complicated situation, mainly because mechanical load generated during sports (which is essential to estimate bone formation [TENFORDE & FREDERICSON, 2011]) can lead to stress and traumatic fractures.

It is not possible to ignore the fact that physical actions embraced by different sports (e.g. running, jumping, physical contact with other players) can increase the risk of any adverse event, such as injuries and fractures. A survey conducted in the United States of America investigating pediatric orthopedic injuries showed that the highest total hospitalization charges were among children with femur fractures and adolescents with vertebral fractures (NAKANIIDA et al., 2014). Additionally, another study with Rugby players found that 2% (*n* = 71) of the 3652 players sought medical care after the tournament. For these players, average treatment costs were high (US$ 731 per player

[95%CI: 425 to 1096]), with fractures being the most expensive type of injury (BROWN et al., 2015). However, recent intervention studies also have shown that long-term exercise and physical activity programs improve bone mass and bone size among children and adolescents, without affecting the fracture risk (FRITZ et al., 2016; CÖSTER et al., 2016; DETTER et al., 2014; LÖFGREN et al., 2011). Additionally, evidence confirms that participation in ball sports promote supplementary bone health than other sports, representing key strategy to reduce risk of fractures (TENFORDE et al., 2016).

In a background in which public health campaigns are developed to promote sports participation among pediatric groups targeting health promotion, the burden of sports participation and its outcomes (e.g. injuries and fractures) on economic aspects need to be considered as well. Among adults, the economic benefits of sports participation seem to be easier to identify than in pediatric groups, mainly because chronic conditions linked to physical inactivity are usually observed in this age group. In fact, the risk of higher health care costs is increased among adults not engaged in sports than those engaged in (OR= 1.57 [95%CI: 1.12 to 2.18]) (CODOGNO et al., 2015). On the other hand, this relationship among the pediatric population is far from being clear because the dynamics of health care costs in both age groups differ (IDLER et al., 2015). For instance, in pediatric groups, the impact of sports participation on health care outcomes are more difficult to identify than in adults (IDLER et al., 2015), mainly because the main health benefits generated by sports participation are observed later in life (FERNANDES & ZANESCO, 2015; MANTOVANI et al., 2018). Therefore, potential economic benefits of sports participation might be overshadowed by the costs generated by the treatment of outcomes related to sports participation, such as fractures, injuries, and upper respiratory infections (commonly observed in water sports) (PITREZ et al., 2003; CONSTANTINI et al., 2011; MARSHALL et al., 2016).

Therefore, this longitudinal study aimed to analyze the risk of traumatic fractures according to the engagement in sports with different levels of physical impact, as well as to identify the potential impact of sports participation on health care costs among adolescents. As far as we know, this is the first study to investigate the impact of sports participation on health care costs among adolescents.

METHODS

Sampling

The longitudinal research entitled "Analysis of Behaviors of Children During Growth" (ABCD – Growth Study) is an ongoing study dedicated to identifying the impact of sports participation on different health aspects of adolescents, including health care costs. The present study is part of the ABCD – Growth Study, which is being carried out in Presidente Prudente (~200,000 inhabitants and human development index 0.806), western state of São Paulo, Brazil. Data collection and analyzes were performed by members of the Laboratory of Investigation in Exercise (LIVE) in 2017 (baseline) and 2018 (12 months follow-up). The ethics committee of UNESP approved the study (process number 1.677.938/2016). All the parents/guardians signed the consent form, and the coaches responsible for the athletes also signed an authorization form. Adolescents signed a form agreeing to participate in the longitudinal study.

The sample was composed of 285 adolescents of both sexes (202 boys and 83 girls) who were contacted by the researchers in eleven schools and sports clubs located in the metropolitan region of the city (the contact has been previously authorized by the principals [school] and coaches [sports clubs]). All adolescents in all eleven places were invited, considering the inclusion criteria 1) 10-19 years-old, 2) parents' consent form signed, 3) if contacted in any sports club, at least one year of training experience; if contacted in any school unit, at least one year without regular practice of sport or exercise.

Dependent variables

Traumatic fractures

The occurrence of traumatic fractures was assessed at baseline and during the 12-months follow-up period (**Figure 1**). At baseline, the participants were asked the following yes or no question: “During the past 12 months, have you experienced any broken bones?” (LYNCH et al., 2017). During the 12-months follow-up, once a month the researchers contacted the adolescents by phone to register any occurrence of traumatic bone fracture, as well as the bone broken and date of the event. Eleven adolescents reported traumatic fractures in the previous 12 months before the baseline measure, while there was the incidence of six new fractures during the follow-up period (n= 1 in the elbow, n= 2 in the toe, n= 1 in radio and n= 1 in right arm; n= 1 in the finger). In this manuscript, fractures were treated as two outcomes: 12 months (n= 6 [only fractures counted during follow-up periods]) and 24 months (baseline plus 12-months follow-up [n= 17]). There was no traumatic fracture caused by a car accident during the 12-month follow-up.

Health care costs

Health care costs were assessed during 12 months of follow-up by the researchers throughout monthly phone contacts with adolescents and their parents/legal guardians. Researchers asked adolescents monthly about the use of medication (name and dosage), appointments (medical specialties [e.g. pediatrician, general practitioner, ophthalmologist, orthopedist, ear, nose and throat specialist, dermatologist, pulmonologist, emergency doctor, physiotherapist, speech therapist, psychotherapist, occupational therapist, homeopath and others) and laboratory tests. The price of each of the components of health care services was collected from pharmacies (when bought by the participant), private health care plan (when paid by the participant) and National Health Service (when provided by the government) (CODOGNO et al., 2011; CODOGNO et al., 2015). In the case of pharmacies, three independent researchers contacted three different pharmacies in the metropolitan region of the city, and the average price of the medicine was considered. The prices were computed in Brazilian currency (Real [R$]), and all these values converted into American dollar (US$), using the average quotation of the 12 months of follow-up (US$ 1.00 equal to R$ 3.193).

Independent variable

In terms of sports participation, adolescents were divided into three groups according to the level of physical impact: control (n= 104), non-impact sport (swimming [n= 34]), and impact sports (n= 147 [track and field, basketball, gymnastics, judo, karate, kung Fu, tennis, and baseball]) (AGOSTINETE et al., 2016).

Covariates

In a face-to-face interview, the adolescents reported sex and birthday (chronological age). Adolescents engaged in any sport reported the number of days per week involved in practice, as well as the time (in minutes). Coaches confirmed this data.

Body weight (kg) was measured using a digital scale (Filizzola PL 150; Filizzola Ltda, São Paulo, Brazil) and height (cm) was measured using a stadiometer with a precision of 0.1 cm. Both measurements were collected using standard protocols. Analysis of the sitting height and length of the legs were performed to calculate the maturity offset, which denotes the time (years) from/to the age at the peak height velocity (PHV), an indicator of biological maturation (MIRWALD et al., 2002). PHV is an important event of the biological maturation process, which can influence body composition and bone variables.

Body fatness (in percentage [%]), and BMD (g/cm^2) of the whole body were assessed using a dual-energy x-ray absorptiometry (DXA) scanner (Lunar DPX-NT; General Electric Healthcare, Little Chalfont, Buckinghamshire, UK) with GE Medical System Lunar software (version 4.7). DXA measurements were performed in the morning after a light breakfast, and the scanner quality was tested by a trained researcher before each day of measurement, following the manufacturer's recommendations. The participants wore light clothing, without shoes and remained in the supine position on the machine (approximately 15 min). Obesity has been defined taking into account the cut points proposed by Williams et al. (1992).

Finally, the adolescents' blood was collected by a nurse in an independent laboratory (which meets all the guidelines of the Brazilian Ministry of Health), and C-reactive protein (CRP) levels (mg/L) were assessed as an inflammatory marker. In this study, high CRP has been defined as values ≥3.0 mg/L (CAO et al., 2007).

Statistical Analysis

Descriptive statistics were expressed in values of percentage (%), mean, median, 95% confidence interval (95%CI) and interquartile range (IR) because the data showed non-normal distribution. Mann-Whitney test was used to compare continuous data according to the presence of traumatic fractures (**Table 1**). Chi-square test (with Fisher's exact test when necessary) was applied to verify associations of traumatic fractures with independent variable (sports participation) and covariates (sex, age, sports participation, body fatness, maturation, BMD, and CRP) (**Table 2**). Additionally, we assessed the risk of traumatic fractures according to the sports participation and covariates using Cox Regression (Hazard Ratio [HR] and its 95%CI) (**Table 2**). Next, analysis of covariance (ANCOVA) was used to verify the interaction effect between overall health care costs and sports participation adjusted by sex, age, PHV, BMD, body fatness, CRP, occurrence of fractures, previous engagement in sports and minutes of practice per week (**Table 3**). In ANCOVA model, heath care costs were converted into a logarithm transformed variable due non-parametric distribution, Levene's test assessed how fit the ANCOVA model was (model was adequately fit) and measures of effect-size were expressed as Eta-squared values (ES-r). Finally, Kruskal-Wallis test was used to compare health care costs according to different sports groups (**Figure 2**). Statistical significance was set at $p<0.05$ and all analyzes were performed using BioEstat software (version 5.2 [BioEstat, Teffe, Brazil]).

RESULTS

The sample was composed of 285 adolescents (202 boys and 83 girls) and the incidence of new fractures was 2.1% (n= 6). The occurrence of traumatic fractures during the 24-month period (12-month follow-up plus previous 12 months) was 6.0% ([95%CI: 3.2% to 8.7%]; n= 17). The overall costs accounted during the 12-month follow-up were U$ 2,991.96 (medication: 52.9%, appointments: 28.7% and laboratory tests: 18.4%). When comparing the adolescents according to the incidence of new fractures, there were no differences regarding age, BMD, BF, sports, PHV, and CRP. However, the group with fracture presented significant higher health care costs for medicine (p-value = 0.028), appointment (p-value = 0.007), tests (p-value = 0.001), and overall (p-value = 0.005) (**Table 1**). Overall health care costs were also not different according to subjects with any fracture during the 24-month period.

Table 2 shows the risk of traumatic fractures and its correlates. Sports participation did not show any significant association or risk with the occurrence of traumatic fractures.

When breaking the groups down by sport, track and field [US$ 4.13 (27.67)], gymnastics [US$ 10.77 (23.90)], judo [US$ 4.24 (6.96)], and swimming [US$ 24.67 (46.50)] presented higher costs when compared to the control group. Karate, kung-Fu, tennis, basketball and baseball did not show significant differences when compared to the control group (**Figure 2**). Concerning health care costs, swimmers presented higher costs with medicine (p-value= 0.001), appointments (p-value= 0.001), and tests (p-value= 0.005) when compared to control and impact sports groups.

Finally, **Table 3** shows the overall health care costs according to sports participation adjusted by covariates (ANCOVA). Even after adjustment by confounders, swimmers (Mean: US$ $_{log10}$ 1.172 [95%CI: 0.925 to 1.420]) had higher health care costs than control (Mean: US$ $_{log10}$ 0.280 [95%CI: 0.101 to 0.459]) and impact sports (Mean: US$ $_{log10}$ 0.404 [95%CI: 0.290 to 0.519]) (p-value = 0.001). Sports participation explained 13.2% of all variance in health care costs, while sex (2.6% of the variance) and fractures (3.5% of the variance) were also covariates related to health care costs in this model.

Table 1. General characteristics according to the occurrence of traumatic fracture in adolescents (ABCD – Growth Study; n= 285).

	Traumatic Fracture 12 months*		
	No (n= 279)	Yes (n= 6)	
Independent variables	Median (IR)	Median (IR)	*p*-value**
Age (years)	14.88 (3.5)	16.89 (3.3)	0.055
BMD (g/cm^2)	1.122 (0.169)	1.137 (0.144)	0.783
Body fatness (%)	21.4 (16.3)	13.85 (8.8)	0.067
Sports (min/wk)	240 (720)	360 (607.5)	0.490
Maturity offset (years)	1.44 (2.14)	2.62 (2.23)	0.092
C-reactive protein (mg/L)	2.50 (2.2)	2.15 (5.2)	0.779
Health care costs (US$)			
Medicines	0.0 (5.14)	12.12 (26.40)	**0.028**
Appointments	0.0 (0.0)	10.17 (12.72)	**0.007**
Tests	0.0 (0.0)	2.81 (6.39)	**0.001**
Overall	0.0 (10.07)	23.05 (29.12)	**0.005**

*= incidence of new traumatic fractures that happened during the 12-month follow-up; **= Mann-Whitney test; IR= interquartile range; BMD= bone mineral density.

Table 2. Risk of traumatic fractures according to sports participation in adolescents (ABCD – Growth Study; n= 285).

Variables	Traumatic fracture 12-month (n= 6) §		Traumatic fracture 24-month (n= 17) §§	
	n (%)	HR (95%CI)	*n* (%)	HR (95%CI)
Independent				
Sports participation				
Control	2 (1.9)	1.00	6 (5.8)	1.00
Swimming	1 (2.9)	1.58 (0.13-19.06)	3 (8.8)	1.53 (0.27-8.73)
Impact	3 (2.0)	1.24 (0.15-10.21)	8 (5.4)	0.80 (0.22-2.85)
Covariates				
Sex				
Girls	1 (1.2)	1.00	2 (2.4)	1.00
Boys	5 (2.5)	1.27 (0.12-12.70)	15 (7.4)	2.28 (0.46-11.22)
Age				
10-12 years	1 (1.5)	1.00	2 (3.1)	1.00
13-15 years	1 (0.8)	0.26 (0.01-4.81)	8 (6.6)	1.30 (0.20-8.38)
≥16 years	4 (4.0)	1.69 (0.09-30.23)	7 (7.1)	1.05 (0.11-10.03)
Body fatness				
Non-obese	6 (3.1)	1.00	16 (8.2)	1.00
Obese	0 (0.0)	---	1 (1.1)*	0.13 (0.01-1.10)
Maturation				
Early	1 (1.3)	1.00	4 (5.0)	1.00
On time	4 (2.8)	0.77 (0.05-11.67)	8 (5.6)	0.73 (0.17-3.01)
Late	1 (1.6)	0.31 (0.01-10.66)	5 (8.2)	1.45 (0.21-9.84)
BMD				
>1SD	6 (2.5)	1.00	16 (6.7)	1.00
≤1SD	0 (0.0)	---	1 (2.2)	0.43 (0.04-4.35)
C-reactive protein				
<3.0 mg/L	4 (2.5)	1.00	7 (4.4)	1.00
≥3.0 mg/L	2 (2.0)	1.07 (0.15-7.24)	8 (7.9)	2.46 (0.75-7.99)

*= incidence of new traumatic fractures that happened during the 12-month follow-up; **= traumatic fractures reported at baseline (previous 12-months) plus those that happened during the 12-months follow-up; ***= Fisher's exact test; BMD= bone mineral density.

Table 3. Overall health care costs (US$) in adolescents according to sports participation (ABCD – Growth Study; n= 285).

	Control (n= 104) Mean (95%CI)	Swimming (n= 34) Mean (95%CI)	Impact Sports (n= 147) Mean (95%CI)	Sports participation *p*-value (ES-r [qualitative])
ANCOVA $_{\text{crude model}}$				
Overall health care costs $_{\text{log10}}$	0.272 (0.162 to 0.382)	1.178 (0.986 to 1.370) [a]	0.368 (0.273 to 0.457) [b]	0.001 (0.196 [high])
ANCOVA $_{\text{adjusted model}}$*				
Overall health care costs $_{\text{log10}}$	0.280 (0.101 to 0.459)	1.172 (0.925 to 1.420) [a]	0.404 (0.290 to 0.519) [b]	0.001 (0.132 [moderate])

95%CI= 95% confidence interval; ES-r= eta-squared; ANCOVA= analysis of covariance; log10= variable converted into logarithm base 10.

a= denotes difference (*p*-value <0.05) compared to Control; b= denotes difference (*p*-value <0.05) compared to Swimming;

*=ANCOVA adjusted by sex (ES-r= 0.026 [p-value < 0.05]), age (ES-r= 0.004), peak of height velocity (ES-r= 0.002), whole body bone mineral density (ES-r= 0.001), body fatness (ES-r= 0.001), C-reactive protein (ES-r= 0.002), fracture 12-months follow-up (ES-r= 0.035 [p-value < 0.05]), sport practice in min/week (ES-r= 0.001) and previous time of sport practice in years (ES-r= 0.002).

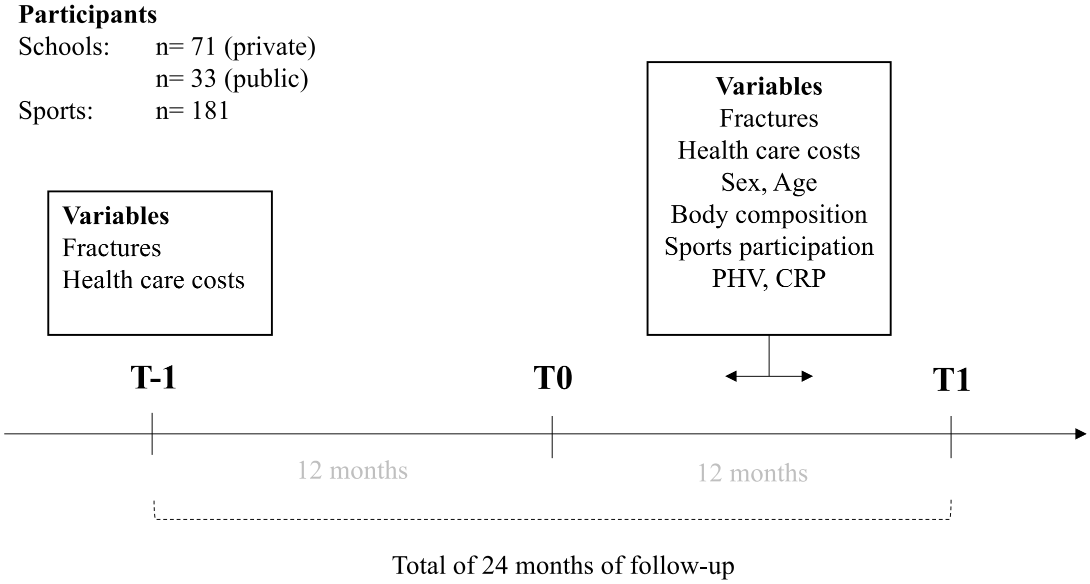

Figure 1. Sample and timeline of data collection (ABCD – Growth Study).

Notes: T-1: Previous 12 months (retrospective); T0: Baseline; T1: 12-month follow-up (prospective); PHV: Peak height velocity; CRP: C-reactive protein.

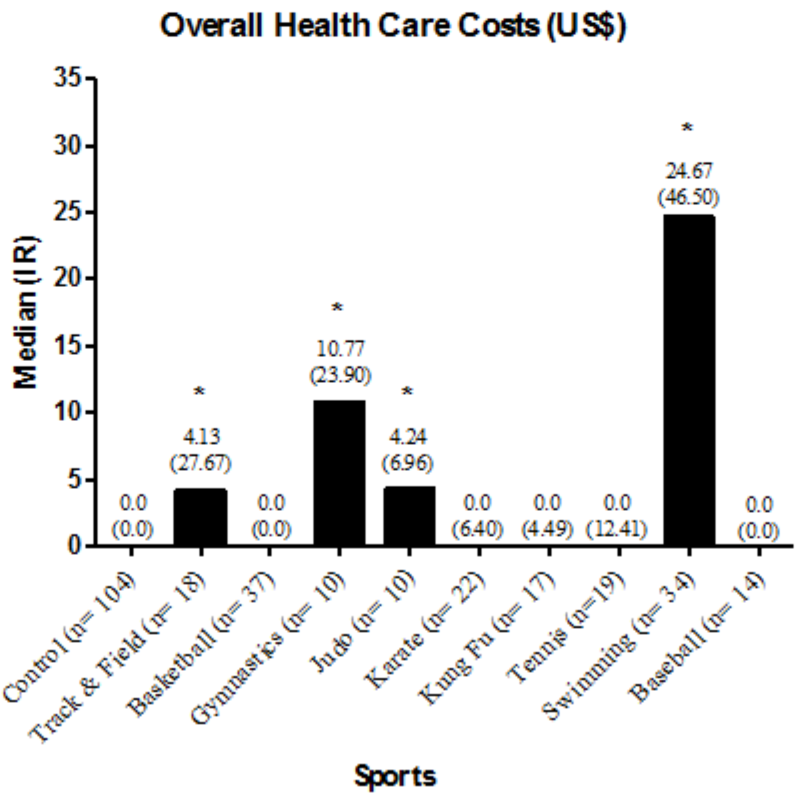

Figure 2. Health care costs in adolescents according to sports (ABCD – Growth Study; n= 285).

DISCUSSION

This study investigated the risk of traumatic fractures according to the engagement in sports with different levels of physical impact, as well as the relationship between sports participation and health care costs among adolescents. We found that engagement in impact sports did not increase the risk of fractures, while adolescents engaged in swimming, track and field, gymnastics, and judo presented higher health care costs when compared to the control group.

The incidence of new fractures during the follow-up period was 2.1% (n= 6), which is lower than 7.1% observed in previous data (LYNCH et al., 2017). The low incidence of fractures might be the reason explaining the absence of significant associations between sports participation and traumatic fracture. However, previous studies with higher incidence of fractures also found similar findings, denoting no additional risk of fractures among adolescents engaged in sports (LYNCH et al., 2017; FRITZ et al., 2016; CÖSTER et al., 2016; DETTER et al., 2014; LÖFGREN et al., 2011). Moreover, even non-significant, in our study the risk of fractures was lower in adolescents engaged in impact sports (LYNCH et al., 2017), emphasizing that participation in impact sports did not increase the risk of fractures, confirming the role of mechanical load in improving bone health with no additional risk for fractures (LYNCH et al., 2017).

Even with no association with sports participation, we found that the incidence of new fractures significantly increased health care costs, explaining 3.5% of overall health care costs among adolescents. In fact, previous data reported similar findings, in which the occurrence of fractures is the cause of high health care costs in adolescents engaged in sports like rugby (BROWN et al., 2015). It is also relevant to identify that the incidence of new fractures affected significantly all components of overall health care costs (medication, appointment, and tests [data not shown]), reflecting the steps of treatment and healing of the traumatic event. On the other hand, the absence of significant results for fractures reported at baseline might be justified by the fact that health care costs related to their treatment were not computed during the follow-up, denoting that the economic impact attributed to fractures seems not to affect health care costs of these adolescents for a long time after the fracture. Moreover, it is pertinent to recognize that small changes in training (e.g. replacing regular warm-up by neuromuscular training) are able to mitigate costs attributed to sport injuries

(MARSHALL et al., 2016), denoting the relevance of having highly qualified coaches and trainers with the athletes.

Another variable affecting costs among these adolescents (independently of sports participation and incidence of fractures) was sex, in which girls accumulated higher health care costs than boys (p-value= 0.003). Similar to our findings but among adults, women usually accumulate more annual health care costs than men (CODOGNO et al., 2015), mainly due to social and cultural aspects. Women are more prone to be regularly engaged in preventive medicine than men (e.g. birth control, gynecologist), and it is plausible to believe that this kind of health-related behavior tracks from early age, and it is mainly related to birth control (MATERNOSWSKA et al., 2014). Therefore, cost-effective interventions involving exercise targeting the mitigation of costs among adolescents should be designed focusing on sex-related particularities, because the dynamic of economic variables seems to be sex-dependent.

Regarding health care cost among different sports, we found that track and field, gymnastics, judo, and swimming presented significant higher costs when compared to the control group. In all sports above mentioned, this finding could be justified by the high amount of repetitive movements required by these sports during practice, plus the high volume of training and inflammation, which could lead to damage to the muscle and joints and weakening of the immune system (PEDERSEN et al., 2000). Moreover, each of these sports have its inherent aspects that could affect health care costs. For example, judo athletes are constantly reducing body weight using dehydration and food restriction in order to be able to compete in specific weight classes (sometimes using medicines for that), leading to harmful health implications (e.g. anxiety, eating disorders) which have worse consequences in young athletes (ESCOBAR-MOLINA et al., 2015). Eating disorders and anxiety symptoms are outcomes commonly observed in gymnasts as well (NEVES et al., 2017) due to the necessity of having less body weight for better performance. Moreover, symptoms of anxiety and depression are identified in young athletes of track and field (WEBER et al., 2018).

Swimmers accumulated the highest health care costs in this study. In fact, the consumption of medicines to treat cold symptoms was the most frequently reported by our athletes, mainly swimmers. Concerning the highest health care costs among swimmers, it could be explained by the higher training load among this particular group, as well as the humid environment where practice takes place (PITREZ et al., 2003; CONSTANTINI et al., 2011). Confirming our findings, a 4-year longitudinal study conducted in France found that the risk of upper respiratory tract and pulmonary infections and muscular affections among swimmers increased significantly with higher training loads (HELLARD et al., 2015). Additionally, it is already established that swimming does not promote osteogenic effects like other sports because of the lack of impact (LYNCH et al., 2017, AGOSTINETE et al., 2017b) and in our sample, three of the 17 fractures were reported by swimmers (17.6% of overall), also denoting the economic burden of these fractures in this group of athletes.

In this survey, sports participation increased health care cost among adolescents, but health professional should interpret these findings with caution. First, most of health care costs observed in this study came from primary care services, while more complex health procedures were not observed. Sports participation prevent the development of a large variety of diseases that significantly increase costs in a more complex level, such as childhood obesity and high blood pressure. Second, even with higher costs among adolescents engaged in some sports, the amount of money accounted over the last 12 months was low (U$ 2,991.96), while in adults, the mitigation attributed to physical activity in developing settings is accounted in US$ 26 million (TURI et al., 2016). Finally, sports participation tracks from adolescence to adulthood more than exercise (BÉLANGER et al., 2015), and affects health in adolescence and adulthood (CAYRES et al., 2018; FERNANDES & ZANESCO, 2010), representing a huge potential to mitigate health care costs throughout life.

As the main strength of the study, we emphasize the originality, being the first research investigating the relationship between sports participation and health care costs among adolescents. The assessment of health care costs among these adolescents is a challenging aspect of this survey (CODOGNO et al., 2015; CODOGNO et al., 2011), but also a strong methodology aspect. As limitations, we recognize the absence of clinical records to assess more details about the traumatic fracture reported, as well as the absence of data about stress fractures. Additionally, the use of health care services was self-reported monthly by the participants, which it is prone to bias recall, even being assessed every month. Lastly, the short period of follow-up could be considered a limitation, but this will be addressed in future studies because the ABCD – Growth Study is still ongoing.

In conclusion, the findings from this study indicate that sports participation (including impact sports) did not increase the risk of fracture among adolescents, while traumatic fracture was the main determinant of health care costs among these adolescents. Moreover, some sports seem to be related to higher health care costs among adolescents, independently of the significant economic burden of fractures and sex.

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CONCLUSIONS (RESEARCH PROJECT)

In summary, based on the data available in the ABCD – Growth Study, it was possible to conclude that:

- Sports participation did not increase the risk of fracture, even considering sports performed on land (impact) and in hypogravity (water);
- Traumatic fracture was the main determinant of health care costs among adolescents;
- Swimming, judo, track and field and gymnastics seem to be related to higher health care costs among adolescents.

What are the new findings?

- Sports participation explained 13.2% of all variance in health care costs among adolescents independently of sex (2.6% of the variance) and incidence of fractures (3.5% of the variance). Engagement in sports raised the costs, but it is necessary to consider that the amount of money attributed to sports participation was low, while its maintenance has potential to mitigate costs throughout life.

How these findings might impact clinical practice in the future?

- Besides swimming and gymnastics showed higher health care costs, it does not mean that engagement in these sports are harmful in any way. Sports participation prevent the development of a large variety of diseases that significantly increase costs in a more complex level (such as childhood obesity and high blood pressure). Therefore, engagement in these sports should be encouraged and the health of those participants closely monitored.
- Parents and pediatricians should continue to encourage sports participation since early life because it improves cardiovascular, metabolic and bone health throughout life.

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APPENDIX – 1

UNESP - FACULDADE DE CIÊNCIAS E TECNOLOGIA DO CAMPUS DE PRESIDENTE

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: ANÁLISE DE COMPORTAMENTOS DE ADOLESCENTES DURANTE O

Pesquisador: ROMULO ARAÚJO FERNANDES

Área Temática:

Versão: 2

CAAE: 57585416.4.0000.5402

Instituição Proponente: UNIVERSIDADE ESTADUAL PAULISTA JULIO DE MESQUITA FILHO

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 1.677.938

Apresentação do Projeto:

Vide 1º parecer.

Objetivo da Pesquisa:

Vide 1º parecer.

Avaliação dos Riscos e Benefícios:

Vide 1º parecer.

Comentários e Considerações sobre a Pesquisa:

Os pesquisadores esclareceram que ainda não iniciaram a pesquisa, pois estão aguardando o auxilio pesquisa da FAPESP e alteraram o cronograma para inicio da coleta de dados para 05 de setembro de 2016.

Considerações sobre os Termos de apresentação obrigatória:

O Termo de compromisso foi enviado, conforme solicitado, e está correto.

Recomendações:

Não há.

Conclusões ou Pendências e Lista de Inadequações:

O presente estudo não fere princípios éticos segundo a Resolução CNS 466/2012.

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UF: SP **Município:** PRESIDENTE PRUDENTE
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Considerações Finais a critério do CEP:

Em reunião realizada no dia 12.08.2016, o Comitê de Ética em Pesquisa da Faculdade de Ciências e Tecnologia - Unesp - Presidente Prudente, em concordância com o parecerista, considerou o projeto APROVADO.

Obs: Lembramos que ao finalizar a pesquisa, o (a) pesquisador (a) deverá apresentar o relatório final.

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação
Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_DO_PROJETO_717347.pdf	05/08/2016 10:35:59		Aceito
Cronograma	EsclarecimentoCEPc.pdf	05/08/2016 10:33:14	Alessandra Madia Mantovani	Aceito
Outros	TermoCompromisso.pdf	05/08/2016 10:15:25	Alessandra Madia Mantovani	Aceito
Outros	CEP_UNILAB.pdf	05/07/2016 08:39:32	Alessandra Madia Mantovani	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	TCLE.doc	22/06/2016 09:37:33	Alessandra Madia Mantovani	Aceito
Folha de Rosto	Termo_CEP.pdf	21/05/2016 12:55:37	Alessandra Madia Mantovani	Aceito
Cronograma	CRONOGRAMA.docx	17/05/2016 15:26:57	Alessandra Madia Mantovani	Aceito
Outros	Termos.pdf	17/05/2016 15:23:45	Alessandra Madia Mantovani	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	termo_assentimento.doc	17/05/2016 15:19:32	Alessandra Madia Mantovani	Aceito
Declaração de Instituição e Infraestrutura	Declaracao_LIVE.pdf	17/05/2016 15:18:53	Alessandra Madia Mantovani	Aceito
Projeto Detalhado / Brochura Investigador	projeto_adolescentes.doc	17/05/2016 15:17:40	Alessandra Madia Mantovani	Aceito

Situação do Parecer:

Aprovado

Necessita Apreciação da CONEP:
Não

PRESIDENTE PRUDENTE, 15 de Agosto de 2016

Assinado por:
Edna Maria do Carmo
(Coordenador)

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