Young adults motor competence after a 12 months period

Competencia motriz en jóvenes adultos después de un período de 12 meses

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Abstract

The aim of this study was to analyse the change in motor competence (*MC*), body composition, and habitual physical activity (*PA*) levels in a group of university students over 12-month. 92 participants (68 males; 21.2±5.5 years old) took part in this study. All participants were sport sciences students and had their *MC*, body composition and habitual *PA*, assessed at baseline and after 12 months. Lean mass significantly increased in females (+0.2%; Effect Size (*ES)*= 0.726) and males (+0.2%; *ES* = 0.555). In females, was also observed a significant increase in weight (+0.1%; *ES*=0.734). In terms of *MC*, significant improvements were observed in females *MC* stability (+0.3%; *ES*=0.696), *MC* manipulative (+1.1%; *ES*=0.866), standing long jump performance (+0.7%; *ES*=0.511), and total *MC* (+1.9%; *ES*=0.699). Males exhibited significant decreases in *MC* manipulative (-1.5%; *ES*=0.640), throwing velocity (-1.3%; *ES*=0.473), kicking velocity (-1.4%; *ES*=0.755), standing long jump performance (-1.1%; *ES*=0.408), and shuttle run (-1.3%; *ES*=0.502). In early adulthood, sport science undergraduate students *MC* can differ across a 12-month period, changing in accordance with habitual *PA* levels. It appears that the changes related to the growth and maintenance of *MC* continue throughout adulthood.

Key words: motor skills, weight status, physical fitness, university students.

Resumen

El objetivo de este estudio fue analizar los cambios en los niveles de competencia motriz (*CM*), composición corporal y actividad física (*AF*) en un grupo de estudiantes universitarios durante un período de 12 meses. 92 participantes (68 hombres; 21.2±5.5 años) participaron en este estudio. Todos los participantes eran estudiantes de ciencias del deporte y se les evaluó la *CM*, composición corporal y la *AF* habitual al inicio del estudio y después de 12 meses. La masa magra aumentó significativamente en las mujeres (+0.2%; tamaño del efecto (*TE*) = 0.726) y en los hombres (+0.2%; *TE*=0.555). Además, en las mujeres se observó un aumento significativo del peso (+0.1%; *TE*=0.734). Para las mujeres, se observaron mejoras significativas de la *CM* estabilidad (+0.3%; *TE*=0.696), *CM* manipulativa (+1.1%;*TE*=0.866), salto horizontal (+0.7%; *TE*=0.511) y *CM* total (+1.9%;*TE*=0.699). Los hombres mostraron una disminución significativa de la *CM* manipulativa (-1.5%;*TE*=0.640), velocidad de lanzamiento (-1.3%;*TE*=0.473), velocidad de disparo (-1.4%;*TE*=0.755), salto horizontal (-1.1%;*TE*=0.408) y velocidad de lanzamiento (-1.3%;*ES*=0.502). En el inicio de la edad adulta, la CM de los estudiantes de licenciatura en ciencias del deporte pueden diferir en un período de 12 meses, cambiando de acuerdo con los niveles habituales de AF. Parece que los cambios relacionados con el crecimiento y mantenimiento de CM continúan durante la edad adulta.

Palabras clave: habilidades motoras, composición corporal, aptitud física, estudiantes universitarios.

Introduction

Physical inactivity has become a global issue (Sallis et al., 2016), which is apparent as early as during childhood (World Health Organization, 2018). Physical inactivity leads to the reduction of physical fitness, which is related to a person's physical abilities and is influenced by the interconnections between several factors, including cardiorespiratory fitness, muscular strength, and body composition (Caspersen et al., 1985; Department of Health Physical Activity Health Improvement and Protection, 2011).The transition period from adolescence to adulthood is a crucial time that determines one's lifestyle, with physically inactive adolescents demonstrating a significantly increased risk of obesity during adulthood (Pietiläinen et al., 2008). Physical activity is the habit of healthy life (Esnaola et al., 2011) and there are several methods for measuring physical activity (*PA*) levels (Shephard & Aoyagi, 2012). Although, for practical reasons, most studies use *PA* questionnaires (Camões et al., 2010; Skender et al., 2016) for measuring PA levels. That, in general, minimize the potential for confounding effects (Ferrari et al., 2007).

Body composition and growth are also key components of health in both individuals and populations (Wells & Fewtrell, 2006),

Therefore, is growing the body of evidence supporting the importance of motor competence (*MC*) 1) as a strong predictor of PA (Lopes et al., 2011), 2) as having a positive impact in physical fitness (Barnett et al., 2008; Cattuzzo et al., 2016; Luz et al., 2017b), 3) as being associated with higher PA status and future outcomes (Barnett et al., 2009), and 4) as being crucial to the development of a healthy lifestyle (Robinson et al., 2015; Stodden et al., 2008; Tomkinson et al., 2018). *MC* involves the mastery of fundamental motor skills (Luz et al., 2016) related to the development and performance of human movement (Stodden et al., 2008) as a basis for one's ability to perform sports and recreational activities. However, *MC* is a complex concept; the research on the topic has used several different instruments and observation tools that have led researchers to consider the purpose of assessing population characteristics and the range of practical aspects that determine which instrument should be used in any given case (Bardid et al., 2018).

In 2017, a novel proposal to assess *MC* was presented. The motor competence assessment (MCA) (Luz et al., 2017b) offers solutions to the majority of potential problems associated with the most commonly used protocols. Primary related to the developmental span and the lack of objectivity or reproducibility in the assessment protocols, and second being proficient in assessing the three fundamental domains of motor skill competence (i.e., stability, locomotor, and manipulative) (Bardid et al., 2018; Luz et al., 2017a).

Because there is a limited body of knowledge specifically targeting adolescents and adults (Hands et al., 2019) and because the majority of these instruments were built primarily for the diagnosis of children at risk of motor impairment (Bardid et al., 2018; Luz et al., 2017a), not much is known about young adults' *MC* (Rodrigues et al., 2019). Therefore, this study aimed to analyse the rates of change in *MC*, body composition, and habitual PA levels (sports and leisure) in a group of young adults from a Sport Science undergraduate course before and after a 12-month period.

Methods

Participants

A total of 92 young adults, 68 of whom were male (21.8 years; 72.9kg; 175.8cm) and 24 of whom were females (19.7 years; 57.8kg; 162.6cm) participated in this study. All participants were volunteers who were students, from the first and second year, in a Faculty of Sports Sciences undergraduate course. Participants had no motor, cognitive, or health impairments that would have affected their performance and were selected according to the inclusion criteria i) be enrolled and attending the Sports Science undergraduate course; ii) belong to the 1st or 2nd year and be enrolled in 60% or more of the program; iii) not showing any injury at the time of the evaluation or in the previous week (an injury is understood as any complaint of physical or psychological parameters that result in an inability to normally practice or compete a particular sport or physical activity) (Clarsen & Bahr, 2014) and exclusion criteria i) do not have an active enrollment in the Sports Science undergraduate course; ii) be enrolled in 40% or less of the program; iii) at the end of the academic year, failing one or more practical subjects due to the absence of participation in classes.

At baseline, the majority (~85%) of the participants perform regular physical exercise. As sports sciences students, the participants had, on average, a total of 602 hours of practice sessions per academic year, related to curriculum practice (soccer, volleyball, handball, roller hockey, running, throwing, jumping, and rock climbing). The study was approved by the Scientific Council of the Polytechnic Institute of Viana do Castelo (CTC-ESDL-CE002-2017). After being briefed about the study design and potential risks and benefits of their participation, participants signed a free informed consent in accordance with the ethical standards for the study in humans as suggested by the Declaration of Helsinki.

Instruments

Physical activity

Several validated and widely used questionnaires are available; however, there is no consensus as to which questionnaire is the best. Thus, researchers need to choose the one that best fits the objectives of their research (Dowd et al., 2018; Poppel et al., 2010).

Considering the sample characteristics and the necessity to quantitative access general, sports and leisure habitual PA, the Portuguese version of the Baecke Habitual Physical Activity Questionnaire (Almeida & Ribeiro, 2014) was applied before and after 12 months. The questionnaire was fulfilled before the remains tests and includes eight items grouped into two dimensions. The Physical Activity – Sports dimension (four items) is used to evaluate the habitual *PA* performed in organized sports and physical exercise practised during leisure hours. The Physical Activity – Leisure dimension (four items) is used to evaluate habitual *PA* in activities other than sports that are practised during one's leisure time (e.g., walking, cycling). All answers were scored on a five-point scale, except for the sports question. The higher the score for each item, the higher the level of habitual *PA*. Partial index values for habitual *PA* were calculated for each of the two dimensions, and total habitual *PA* was calculated as the sum of the two partial values.

Body composition

Body composition can be assessed in accordance with field and laboratory methods (Kuriyan, 2018). Considering the different field (less accurate) and laboratory (more accurate) methods, dual-energy X-ray absorptiometry, provides rapid, non-invasive regional as well as whole-body composition measurement, on bone mineral density, relative fat and lean mass, considered to meet the highest criteria of accuracy in a single measurement (Kuriyan, 2018; Wells & Fewtrell, 2006).

Participants' height was measured using a portable stadiometer (SECA 217, Germany), and body weights were assessed using a mechanical dial scale (SECA 760, Germany). During these evaluations, all participants stood barefoot and dressed in light clothing. Height measurements were rounded to the nearest 0.1 cm, with the head oriented according to the Frankfurt plane. Body weight was rounded to the nearest 0.5 kg. Body mass index (*BMI*) was calculated for each participant and recorded in kg/m^2. Body composition was assessed according to dual-energy X-ray absorptiometry (*DXA*), General Electric Hologic Discovery scanner (Hologic Inc., Waltham, MA, USA), by a certified and experienced *DXA* operator. All evaluations were performed according to the manufacturer's specifications, and specific protocols were followed while participants were assisted (Hart et al., 2015). From the information provided, only some data pertaining to fat mass, lean mass, and bone mineral density (*BMD*) were included for further analysis.

Motor competence assessment

The *MC* assessment (*MCA*) (Luz et al., 2016; Rodrigues et al., 2019) battery were performed in accordance with the two tests for each categories: locomotor (shuttle run and standing long jump), manipulative (throwing and kicking ball velocity), and stability (lateral jumps and shifting platforms).

Shuttle run (*SHR*): Participants were required to run 4x10 meters, running at their maximal speed between the start and finish line. The test began at the starting line after an acoustic starting sound. Then, participants ran to the opposite line, picked up a block of wood, ran back and placed the block beyond the starting line. Without stopping, subjects ran back to retrieve a second block and to carry it back across the starting line to finish the test. The best time of the two trials was recorded. Standing Long Jump (*SLJ*): Participants were required to jump with both feet at the same time as far as possible. The test began with both feet placed on the starting line. After three attempts, the longest distance between the starting line and the back of the heel at landing was scored in centimeters. Throwing Velocity (*TV*): Participants were required to throw a baseball ball (diameter: 7.3 cm; weight: 142 g) against a wall at their maximum speed using an overarm action with a preparatory balance. Kicking Velocity (*KV*): Participants were required to kick a soccer ball n°5 (circumference: 68 cm; weight: 410g) against a wall at their maximum speed using a preparatory balance. For the *TV* and *KV* tests, peak velocity was measured in m/s with a Stalker ATS II Radar System (Applied Concepts, Inc., TX, USA). The radar gun was placed on a tripod and positioned behind a target marked on the wall in front of the kicking and throwing line. Each subject performed three trials, with the final score being the best result. Lateral Jumps (*LJ*): Participants were required to jump sideways as fast as possible for 15 seconds. During testing, participants jumped, with their feet together, over a small wooden beam (60cm length × 4cm high × 2cm width) located in the middle of a rectangular surface (100cm length × 60cm width). Each correct jump (i.e., a jump made without touching the outside the rectangle or the wooden beam) was awarded one point, and the best score was recorded the best score was recorded after two trials. Shifting Platforms (*SP*): Participants were required to move sideways using two wooden platforms (25cm × 25cm × 2cm, with four 3.7cm) with their feet at the corners for 20 seconds. Each successful transfer from one platform to the other was scored. One point was achieved for moving the platform, and another point was awarded for moving into the platform (i.e., each complete successful transfer resulted in two points). Participants completed two trials, and the best score was recorded. To obtain scores for each *MC* category (stability, locomotor, and manipulative), the sum of the t-scores of the two tasks was calculated. Inverse t-values were used for *SHR*, given that higher values represented lower performance, and total *MC* was calculated as the mean of the t-scores for all categories. (Luz et al., 2016; Luz et al., 2017a; Silva et al., 2019).

Procedures

All participants were assessed based on their body composition, *MC* and habitual *PA*. The data were collected in the first month of the academic year (from October to November); data were collected a second time after 12 months had elapsed.

Initially, all subjects registered their habitual *PA* profiles and gave their informed consent. The assessments were made during the morning period in an indoor facility with groups of 20 participants at an average temperature of 26°C and a relative humidity of 18%. For each test, a trained and experienced specialist conducted the assessment in the following sequence: (1) habitual *PA* questionnaire, (2) body composition (anthropometric and dual X-Ray absorptiometry), and (3) *MC*.

Statistical Analyses

Descriptive statistics (averages and 95% confidence intervals for lower and upper limits) were calculated and presented in tables. Based on the non-normal distribution, the Wilcoxon signed-rank test was applied to assess variables statically difference from base line to after 12 months. The effect size (*ES*) for non-parametric tests was obtained (Pallant, 2011):

$$r = \frac{|z|}{\sqrt{N}}$$

where N is the total sample size, and the value of z is reported after applying the Wilcoxon signed-rank test. The classification of ES magnitude was obtained by using the following thresholds (Pallant, 2011): very small effect ($r < 0.1$); small effect ($0.1 \leq r < 0.3$); medium effect ($0.3 \leq r < 0.5$); and large effect ($r \geq 0.5$). All statistical analyses were completed using SPSS version 25.0 for Windows (IBM, USA) for $p < 0.05$.

Results

There were verified a drop out of 51.5% in the body composition assessment and 41.2% in the *MCA* assessment, from the male group. For females, the drop out were lower, 16.7% in the body composition assessment and 29.2% in the *MCA* assessment.

Some statistically significant differences between baseline and second assessment values were observed in female, for body composition (Table 1). First a significant increase in weight (+1.9 kg) and total lean mass (307.0g), and second a decrease in total percentage of fat mass (-3.7%).

For males (Table 2), an increase was observed in height at 0.4cm and total lean mass at 532.4g. Decreases were indicated for leisure habitual *PA* score, 0.8 points, and total habitual *PA* score, 1.1 points.

After 12 months, in terms of MC, females (Table 3) exhibited statistically significant increases in *MC* stability in 12.3 points; *LJ* in 3.9 repetitions; *MC* manipulative in 26.3 points; *SLJ* in 19.0 cm and total *MC* in 13.2 points.

In males, after 12 months, *MC* related measures presents substantially statistic differences when compared to first assessment (Table 4). Decreases were observed for MC manipulative in 13.3 points; *TV* in 2.7m.seg^{-1}; *KV* in 5.3m.seg^{-1}; *SLJ* in 27.4 cm; and *SR* in 1.1 seconds.

Discussion

Young adults from a Sport Science undergraduate course *MC* and body composition present different trajectories in accordance with habitual *PA* practice. The measurements taken during the 12-month follow-up indicated that the habitual *PA* levels of females had not changed significantly. However, weight, total percent of fat mass, and total lean mass had different trajectories (Table 1). Weight and total lean mass

Table 1. Physical activity habits (sports and leisure) and body composition assessments before and after 12 months for female.

	1st Assessment Mean (SD) [95%CI]	2nd Assessment Mean (SD) [95%CI]	% difference	p-value	ES
Weight (kg)	57.5 (1.7) [54.2 – 61.1]	59.4 (1.7) [55.8 – 63.1]	0.1%	0.001	0.734*
Height (cm)	162.3 (1.2) [159.9 – 164.7]	162.5 (1.1) [160.2 – 164.9]	0.1%	0.251	0.245
Total fat mass (g)	4849.8 (281.1) [4261.4 – 5438.2]	4843.7 (287.9) [4241.1 – 5446.3]	- 0.2%	0.526	0.142
Total fat mass (%)	35.6 (1.2) [32.9 – 38.3]	29.8 (2.1) [25.3 – 34.3]	- 3.7%	0.039	0.461*
Total lean mass (g)	9096.1 (206.4) [8664.0 – 9528.2]	9403.1 (233.1) [8915.1 – 9891.0]	0.2%	0.001	0.726*
BMD (g/cm²)	1.218 (0.14) [1.1 – 1.2]	1.227 (0.14) [1.1 – 1.2]	0.08%	0.911	0.028
PAQ – Sport (A.U.)	4.1 (0.3) [3.5 – 4.6]	4.0 (0.2) [3.5 – 4.5]	- 2.3%	0.906	0.166
PAQ – Leisure (A.U.)	4.3 (0.1) [4.1 – 4.6]	4.1 (0.3) [3.5 – 4.7]	- 5.0%	0.493	0.189
PAQ – Total (A.U.)	8.4 (0.3) [7.8 – 9.0]	8.1 (0.4) [7.3 – 8.9]	- 1.4%	0.435	0.065

cm: centimetres; kg: kilograms; g/cm²: grams per square centimetre; g: grams; BMD: bone mineral density; PAQ: Physical Activity Questionnaire; A.U.: arbitrary units; 95%CI: confidence interval at 95%; ES: effect size; * significant differences comparing first and second assessment; $p<0.05$.

Table 2. Physical activity habits (sports and leisure) and body composition assessments before and after 12 months for male.

	1st Assessment Mean (SD) [95%CI]	2nd Assessment Mean (SD) [95%CI]	% difference	p-value	ES
Weight (kg)	73.8 (1.3) [71.1 – 76.5]	74.0 (1.4) [71.2 – 76.8]	0.1%	0.537	0.083
Height (cm)	176.3 (0.8) [174.6 – 177.9]	176.7 (0.9) [175.0 – 178.4]	0.1%	0.031	0.321*
Total fat mass (g)	4196.8 (304.7) [3573.5 – 4820.0]	4226.6 (309.9) [3592.8 – 4860.5]	0.1%	0.837	0.036
Total fat mass (%)	22.1 (1.0) [20.0 – 24.2]	23.6 (1.2) [21.2 – 26.0]	0.6%	0.586	0.095
Total lean mass (g)	13157.9 (274.5) [12596.5 – 13719.3]	13690.3 (314.1) [13047.9 – 14332.7]	0.2%	0.001	0.555*
BMD (g/cm2)	1.253 (0.01) [1.22 – 1.28]	1.265 (0.01) [1.24 – 1.30]	0.01%	0.002	0.543*
PAQ – Sport (A.U.)	4.0 (0.2) [3.6 – 4.3]	3.6 (0.2) [3.6 – 4.3]	- 0.6%	0.95	0.274
PAQ – Leisure (A.U.)	4.4 (1.2) [4.0 – 4.7]	3.6 (0.2) [3.2 – 3.9]	- 21.7%	0.002	0.538*
PAQ – Total (A.U.)	8.3 (0.3) [7.6 – 8.9]	7.2 (0.3) [6.7 – 7.7]	- 0.6%	0.003	0.519*

cm: centimetres; kg: kilograms; g/cm²: grams per square centimetre; g: grams; BMD: bone mineral density; PAQ: Physical Activity Questionnaire; A.U.: arbitrary units; 95%CI: confidence interval at 95%; ES: effect size; * significant differences comparing first and second assessment; $p<0.05$

significantly increased, with a large effect size, while total percent of fat decreased (moderate effect size). Lean mass is the sum of body water, total body protein, carbohydrates, non-fat lipids, and soft tissue minerals at the molecular level (Prado & Heymsfield, 2014). Therefore, these changes can be considered positive for women's weight status because they are associated with significant reductions in the percentage of body fat (-3.7%). This data clearly indicates an increase in weight as a result of increases in lean mass.

Men exhibited a significant reduction in total habitual *PA* and leisure habitual *PA* levels, which

Table 3. Motor competence assessments before and after 12 months for female.

	1st Assessment Mean (SD) [95%CI]	2nd Assessment Mean (SD) [95%CI]	% difference	p-value	ES
MC stability	86.2 (3.1) [79.5 – 93.0]	98.5 (3.8) [90.2 – 106.7]	0.3%	0.005	0.696*
Lateral jumps (n)	45.1 (1.6) [41.6 – 48.5]	49.0 (1.6) [45.6 – 52.4]	0.3%	0.016	0.605*
Shifting platforms (n)	28.7 (0.5) [27.6 – 29.8] P60	29.0 (0.9) [27.1 – 30.9] P60	1.4%	0.801	0.287
MC manipulative	73.1 (3.3) [66.1 – 80.2]	99.4 (5.6) [87.2 – 111.5]	1.1%	0.001	0.866*
Throwing velocity (m.seg-1)	14.7 (0.7) [13.2 – 16.3]	16.7 (1.4) [13.7 – 19.8]	3.6%	0.266	0.107
Kicking velocity (m.seg-1)	17.6 (0.8) [15.9 – 19.3]	17.2 (1.0) [15.1 – 19.2] P70	1.3%	0.679	0.089
MC locomotor	96.7 (1.1) [94.4 – 99.1]	98.1 (4.9) [87.6 – 108.6]	3.9%	0.730	0.008
Standing Long Jump (cm)	170.6 (5.9) [157.7 – 183.4]	189.6 (7.9) [172.7 – 206.6]	0.7%	0.041	0.511*
Shuttle run (n)	11.3 (0.2) [10.8 – 11.7]	11.0 (0.3) [10.4 – 11.6]	- 0.9%	0.510	0.170
Total MC	85.4 (1.9) [81.3 – 89.5]	98.6 (4.1) [89.8 – 107.5]	1.9%	0.005	0.699*

MC: motor competence = T score; Lateral Jumps and shifting platforms = number of repetitions; Throwing and kicking velocity = meter per second; Standing long jump = centimetres; Shuttle Run = seconds; ES: effect size; * significant differences comparing first and second assessment; p<0.05.

Table 4. Motor competence assessments before and after 12 months for male.

	1st Assessment Mean (SD) [95%CI]	2nd Assessment Mean (SD) [95%CI]	% difference	p-value	ES
MC stability	105.6 (3.3) [98.8 – 112.3]	98.5 (2.7) [92.9 – 104.1]	- 0.4%	0.304	0.165
Lateral jumps (n)	53.1 (1.4) [50.3 – 55.9]	51.9 (0.9) [50.0 – 53.8]	- 0.9%	0.981	0.004
Shifting platforms (n)	32.0 (0.8) [30.3 – 33.6]	30.9 (0.8) [29.2 – 32.5]	- 0.1%	0.476	0.114
MC manipulative	111.2 (1.7)* [107.6 – 114.7]	97.9 (2.0) [93.9 – 102.0]	- 0.5%	0.000	0.640*
Throwing velocity (m/seg-1)	22.4 (0.4)* [21.5 – 23.3] P25	19.7 (0.6) [18.5 – 21.0] P07	- 1.3%	0.003	0.473*
Kicking velocity (m.seg-1)	25.5 (0.4)* [24.7 – 26.3] P50	20.2 (0.5) [19.0 – 21.5] P07	- 1.4%	0.000	0.755*
MC locomotor	100.9 (2.8) [95.2 – 106.7]	98.4 (3.7) [90.9 – 105.9]	- 1.0%	0.950	0.101
Standing long jump (cm)	225.9 (4.0)* [217.6 – 234.1] P45	198.5 (5.7) [186.8 – 210.2] P05	- 1.1%	0.010	0.408*
Shuttle run (sec)	9.4 (0.3)* [8.7 – 10.1] P90	10.5 (0.2) [10.2 – 10.8] P30	1.3%	0.002	0.502*
Total MC	105.9 (1.8) [102.2 – 109.6]	98.3 (2.4) [93.4 – 103.1]	- 0.7%	0.050	0.363

MC: motor competence = T score; Lateral Jumps and shifting platforms = number of repetitions; Throwing and kicking velocity = meter per second; Standing long jump = centimetres; Shuttle Run = seconds; ES: effect size; * significant differences comparing first and second assessment; p<0.05.

were accompanied by significant increases in height (medium effect size), total lean mass, and *BMD* (large effect size). Lean mass excludes fat and bone mineral compartments (Prado & Heymsfield, 2014), thus leading to a *BMD* increase in height due to bone growth (height gains). Bone and muscle mass are proportionally related. Under disuse conditions, decreases in muscle mass are followed by the loss of bone mass; during recovery, muscle mass gains precede bone accretion (Sievanen et al., 1996). This circumstance might intermediate the evidenced gains in total lean mass (Table 2). Nevertheless, bone accretion begins at birth and continues throughout childhood and adolescence. Approximately 90% of one's bone mass is acquired by the age of 20 years (Henry et al., 2004). Females, on average, stop growing about two years earlier than males (Malina, 2014), and this partially explains the differences in body composition trajectories between the sexes.

The substantial decrease in men's habitual *PA* levels may be related to the daily routines that are adopted when one begins university and to students motivation (Buckworth & Nigg, 2004; Kondrič et al., 2013) or intentions of being physically active (Fernandez-Rio et al., 2018). Being sport science students and regarding the habitual *PA* questionnaire (table 1 and 2) an intention to be physically active is overtake. The motivational factors that most significantly contributed to participation in sports for university students contrast with those of other students from different age groups. These factors can be categorized as friends, supporters, environmental factors, the popularity of the sport, fitness, and health (Kondrič et al., 2013). Nevertheless, humans are motivated by their fundamental psychological needs for competence, autonomy, and relatedness (Murphy et al., 2019). Students' motivation in terms of physical education and organised sports can change (Buckworth & Nigg, 2004). Sports science students face some challenges because their curriculum is sports-practice-based, and this may lead to a diminution in habitual *PA* sports practice.

Considering the normative scores from the *MCA* (Rodrigues et al., 2019) and the average age of the participants (i.e., 20 years old for females and 22 years old for males), we can confer that females significantly improved in lateral jump from percentile (p) 60 to p80 and standing long jump from p60 to p85. Males significantly decreased in terms of throwing velocity, from p25 to p07; standing long jump, from p45 to p05; and shuttle run, from p90 to p30. These changes clearly illustrate that females significantly improve in total MC and the specific constructs MC stability and MC manipulative (large effect size). Still, the percentile differences also plainly demonstrate significant decreases in the construct of MC manipulative (large effect size). Likewise, standing long jump can be used as either an MC or a physical fitness measure (Utesch et al., 2019), a fact that probably mediated the findings in both the male and female groups. However, these changes occur at different magnitudes.

In accordance with habitual *PA* practice, males exhibited significant decreases in the amount of habitual *PA* and standing long jump performance, while females showed the opposite trend for standing long jump by maintaining similar habitual *PA* practice (Tables 1 to 4). Nevertheless, males also showed diminutions in shuttle run, throwing velocity, and the MC manipulative construct. The shuttle run (10 meters) assesses speed and/or agility (Ortega et al., 2008), and *MC* manipulative tasks typically involve a series of actions more challenging and complex than motor skills that do not involve objects (Gallahue et al., 2012). These motor skills require various levels of neuromuscular maturation, which is related to growth, physical proportions and experiences (Malina, 2014). This evidence, combined with the recorded significant increases in height, total lean mass, and *BMD*, can lead to a momentaneous decrease in one's proficiency in such tasks.

However, males also showed substantial diminution in habitual *PA* practice, and engagement in habitual *PA* positively influences both *MC* and various components of physical fitness (Stodden et al., 2008), which are not only linked directly via neuromuscular function but also indirectly via participation in *PA* (Cattuzzo et al., 2016). Indeed, females improved in all *MC* tasks and constructs, showing improvements in *MC* stability and manipulative while maintaining a stable habitual *PA* practice. It would be very interesting to further investigate the variations observed in this study after 12 months. Even with similar habitual *PA* practice, *MC* continuous variables can improve over time. Moreover, *MC* and habitual *PA* are closely linked even though they are theoretically distinct (Utesch et al., 2019).

Motor development has been defined as the overall adaptive change toward competence related to adjustment, compensation, and changes that continue throughout one's life (Bisi & Stagni, 2016). The changes in female *MC* observed in this study could be directly linked to new and/or more challenging motor experiences related to the implication of the curriculum practice, which demands the expertise in different sports/skills. In fact, even with no improvement in total habitual *PA*, during this period, all individuals were required to practice soccer, volleyball, handball, roller hockey, running, throwing, jumping, and rock climbing. Significant improvements in total *MC*, *MC* stability, and *MC* manipulative tasks are usually associated with lower performance in females and can be influenced by sports practice and social factors (Bardid et al., 2015; Luz et al., 2019; Luz et al., 2017b). However, when comparing females with males, it was seen that females tend to be less physically active than males (Thompson et al., 2003), suggesting that they practice less and have fewer motor experiences.

MC constructs can vary across performance levels and age (Utesch et al., 2019), and this fact supports the findings presented here. We can assume that, considering the motor development dynamic systems theory (Thelen, 2005), the observed variation among demanding and different inputs lead to new adaptations and improvements in general *MC*. Many specific neuromuscular comparable skills (e.g., dribbling, kicking, striking, jumping, running, and galloping) can be performed in most sports, and such skills involve neuromuscular coordination and control (Utesch et al., 2019), thus indicating the co-development of *MC*.

In addition to the limitations concerning sample size, the distribution between the groups, and being only sports science undergraduate young adults makes it impossible to generalise the results. Therefore, these topics require further research, as young adults' *MC* is largely unexplored (Utesch et al., 2019). The longitudinal design and the assessment used in this study is both a strength and a limitation because of the impossibility to compare the results with similar studies and because product-oriented (quantitative) measurement instruments tend to be more significantly influenced by biological factors than process-oriented (qualitative) instruments (Hardy et al., 2012). However, the MC battery used in the present study represents the three major latent variables of *MC* (stability, locomotor, and manipulative), all of which were evaluated without a ceiling effect (Luz et al., 2016).

Conclusion

In early adulthood, Sport Science undergraduate students *MC* can differ across a 12-month period, changing in accordance with habitual *PA* levels. It appears that the changes related to the growth and maintenance of *MC* continue throughout adulthood. These changes are directly linked to *PA* practice and exposure to new motor stimulus, especially in females. Changes in *MC* have implications regarding the trajectory of weight status. Physical fitness intervention targeting early adulthood must consider that *MC* is an important factor regarding the trajectory of weight status. It is also important consider that *MC* continues to change during adulthood and is directed linked to habitual *PA* stimulus.

Conflicts of interest

Authors state no conflict of interest.

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