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Changes in lifestyle and physical fitness in the first year of higher education: A longitudinal study with sports students

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ABSTRACT

This study aimed to monitor variations in physical activity and fitness levels throughout the first academic year in undergraduate Sports Science students. A prospective longitudinal design included 63 students (46 men, 17 women; 19.7 ± 1.4 years), assessed at four moments (September, January, February, and June). Sociodemographic data were collected, and instruments included IPAQ, anthropometry, body composition, strength, flexibility, and cardiorespiratory fitness tests. Repeated measures ANOVA with Bonferroni correction was applied. Screen time increased significantly over the year. Physical activity levels showed a non-significant decline. Body composition indicators such as fat mass, BMI, and visceral fat increased, while lean and bone mass remained stable. Cardiorespiratory fitness and lower limb flexibility decreased significantly. These findings suggest worsening fitness and increased adiposity over the duration of the first academic year, highlighting the importance of monitoring such indicators to prevent negative health outcomes.

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Introduction

The transition to higher education is a critical period of significant lifestyle changes that can negatively impact students' health and physical fitness. This period often coincides with leaving a familiar environment that provides social support and structured routines. At the same time, students begin a more independent life, which requires reorganizing eating habits, sleep patterns, physical activity, and time management (Deforche et al., 2015;

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Vadeboncoeur et al., 2015). Scientific evidence indicates that, during their first academic year, higher education students tend to reduce their regular physical activity and increase sedentary behavior, especially screen time. These changes, combined with unhealthy eating habits, result in critical increases in body mass, constituting a risk factor for various diseases, such as obesity, among others (Pullman et al., 2009). These changes can have a negative impact on various components of physical fitness, such as body composition and cardiorespiratory fitness, as well as metabolic and cardiovascular health (Deforche et al., 2015; Keating et al., 2005).

The causes of this behavior are multifactorial and result from the interaction between personal, social, and environmental factors (Müller et al., 2024). Academic overload, stress associated with adapting to a new environment, reduced time available for other activities of interest, and lack of parental supervision are determining factors in the adoption of less healthy behaviors (Deforche et al., 2015; Deliens et al., 2015). In addition, recreational and social opportunities in the academic environment tend to favor sedentary behaviors, such as prolonged use of screens, social media, and alcohol consumption, to the detriment of healthier activities, such as regular physical exercise (Edelmann et al., 2022; Guthold et al., 2020).

Regular physical activity is recognized as one of the main determinants of health and well-being, contributing to the regulation of body composition, the development and maintenance of physical fitness, as well as the prevention of chronic noncommunicable diseases (Bull et al., 2020). Physical fitness, in particular—including strength, cardiorespiratory endurance, and flexibility – has been considered an important marker of health and longevity (Ortega et al., 2008; Ruiz et al., 2009). On the other hand, reduced physical activity and increased sedentary behavior are associated with greater body fat, loss of muscle mass, and lower functional performance, which can compromise autonomy and quality of life (Owen et al., 2010; Tremblay et al., 2017).

Several studies have concluded that during their first year of enrollment in higher education, students gain between 1 and 4 kg of body mass, with significant increases in fat mass and reductions in cardiorespiratory fitness and flexibility (Crombie et al., 2009; Lloyd-Richardson et al., 2009). This phenomenon has been described and evidenced in different cultural contexts, reflecting a global trend toward physical inactivity and sedentary behavior in this age group and the effects on body composition (Vadeboncoeur et al., 2015).

However, despite its scarcity, research on this topic has focused on higher education populations, without focusing on these changes in students enrolled in Sports Science courses and related areas. This represents a significant gap in literature. Sports Science students are expected to have greater literacy in health and physical exercise, curricular exposure to physical exercise and sports training content in the educational/academic context. They are also exposed to exercise-related content in their curriculum and are more likely to engage in

physical activity outside the academic context. Therefore, they would theoretically be more aware of the importance of regular physical activity and, therefore more likely to maintain active behaviors throughout their academic career, compared to students from other courses (Kljajević et al., 2021). Paradoxically, recent studies show that this protection may only be partial, since these students, similar to studies of other courses, also face adversities in time management, habit autonomy, and increased digital sedentary behavior (Edelmann et al., 2022). Thus, investigating this population allows us to understand whether exercise literacy is sufficient to mitigate the typical decline observed in higher education students (Yin et al., 2025).

Understanding these changes is essential, as entering higher education is a decisive phase for the consolidation of lifestyle behaviors that can negatively influence health and tend to persist throughout life. Monitoring body composition and physical fitness during this period can provide essential information for the development of health promotion and inactivity prevention strategies. Thus, the present longitudinal study aimed to monitor changes in physical activity levels, sedentary behavior, body composition, and physical fitness in students enrolled in a bachelor's degree program in sports science during their first academic year. We hypothesized that during the first academic year, students would experience: (1) increased screen time (Kaewpradit et al., 2025; Rosenthal et al., 2021); (2) reduced levels of physical activity (Lalović et al., 2025; Wilson et al., 2021), (3) increased adiposity (Alves, 2015; Pullman et al., 2009; Vadeboncoeur et al., 2015); (4) reduced physical fitness (Dong et al., 2023; Tang et al., 2024).

Methods

This prospective longitudinal study was approved by the Ethics Committee of the Polytechnic Institute of Leiria, after the protocol was submitted and evaluated by its members. It was developed in accordance with the Declaration of Helsinki for human studies (World Medical Association, 2013), ensuring that ethical values are respected and that participants are protected at all stages of this study.

Participants

Volunteer students from the Sports and Wellness course at the School of Education and Social Sciences – Polytechnic Institute of Leiria, located in Leiria, Portugal, participated in the study. They were recruited using the non-probabilistic convenience method and were interested in participating voluntarily. Randomization was not applicable due to the observational longitudinal design.

First, an explanation was given about the objectives and procedures of the study, as well as the potential benefits, risks, and time required for its

development. Second, participants signed an informed consent form, thereby agreeing to participate in the study.

The following inclusion criteria were defined: (1) students enrolled in higher education; (2) ability to perform movements such as pulling/pushing and walking/running; (3) availability to perform all assessments; (4) enrollment in the Sports and Wellness degree program. Exclusion criteria were defined as follows: (1) cognitive inability to answer the questions asked; (2) failure to submit a signed informed consent form; (3) lack of proficiency in Portuguese; (4) not being enrolled in higher education for the first time.

The sample size was calculated a priori using the G*Power 3.1 program (Faul et al., 2009), based on a repeated measures ANOVA (within factors). The following parameters were considered: anticipated effect size = 0.25 (consistent with previous longitudinal studies in university population: Gardani et al., 2022; Lorenzo et al., 2023), probability of error = 0.05, statistical power = 0.95. The output indicated that a minimum of 36 participants was necessary to obtain sufficiently robust statistical power to consider the results reliable. The sample consisted of 63 individuals who agreed to participate in the study, aged 17–26 years, with a mean age of 19.66 ± 1.36 years, 17 of whom were female and 46 males, completing the four assessment moments.

Instruments

International Physical Activity Questionnaire (IPAQ) - short version

To assess the participants' physical activity levels, the short form of the International Physical Activity Questionnaire (IPAQ), validated for 12 countries, including Portugal, was used (Craig et al., 2003). The questionnaire consists of a total of nine questions related to activities carried out in the last seven days prior to the questionnaire being administered. The questions assess principles of physical activity, such as walking, moderate intensity activities, and vigorous activities, including their frequency and duration. Coding involves estimating energy expenditure based on physical activity levels. The data obtained is converted into MET (Metabolic Equivalent of Task) minutes per week. To calculate the MET minutes per week, the MET values (walking = 3.3; moderate intensity physical activity = 4; vigorous physical activity = 8) are multiplied by the number of minutes of activity performed daily over the last 7 days.

Anthropometry and body composition

Body mass was assessed using a portable scale (Seca 213), to the nearest 0.1 kg, wearing minimal clothing. Height was measured using a portable stadiometer (Seca Bodymeter 208, Germany), according to standardized procedures (Lohman et al., 1988). The body mass index (BMI) was calculated as weight/height². Body composition values (fat mass, muscle mass, bone mass, and

visceral fat) were estimated using a bioimpedance (Tanita Body Composition Analyzer BC-420MA). Bioimpedance assessments are always carried out in the morning.

Hand grip test

A hand dynamometer (Jamar, Lafayette Instrument Company, USA) with an accuracy of 0.1 kg was used to assess handgrip strength. Prior to testing, the grip bar was adjusted to each participant so that the second joint of the fingers fitted under the grip. The test was applied with the participants standing in a bipedal posture with their arms aligned with their body. After proper instruction, participants pressed down with their maximum voluntary force on the handgrip dynamometer, without holding their breath. The handgrip assessment was carried out twice for each hand, with the final score being the best of the repetitions for each hand (accurate to the nearest kilogram) (American College of Sports Medicine, 2021).

Cooper test

The Cooper test was carried out in a large hall, and participants were encouraged to run or walk as far as possible in 12 min (walking or running, depending on their physical fitness). The Cooper test exhibits high test-retest reliability, with intraclass correlation coefficients generally exceeding 0.90, making it a reliable tool for assessing and monitoring cardiorespiratory fitness over time (American College of Sports Medicine, 2021; Cooper, 1968; Penry et al., 2011). The test was carried out in a sports complex (at standard room temperature), on a track approximately 20 meters lengthy. The total distance covered in 12 min (in meters) was calculated by multiplying the number of routes by their distance. The distance in meters was converted into kilometers to estimate the general aerobic capacity (Chatterjee et al., 2004; Cooper, 1968). Prior to the test, the participants did a brief 5–10 min warm-up to increase their body temperature and prepare them for the activity ahead.

Sit and reach test

The sit and reach test to assess hamstring and lower back flexibility was used in this study (Ayala et al., 2012b; Hoeger & Hopkins, 1992). To carry out the test, a sit and reach box (30.5 centimeters) and a ruler (70 centimeters) were used. Participants were instructed to sit on the floor with their head, back, and hips in contact with the wall and their feet with the box. They were asked to overlap their hands (middle fingers at the same level) and perform scapular abductions to reach the level of the measuring scale. Slowly, participants leaned forward, reaching as far as possible. The distance reached by the fingertips was recorded, considering the start of the box. Two measurements were taken, and the final score was the average of the two measurements (to the nearest half cm).

Reach behind your back test

The reach behind the back test, developed by Rikli and Jones (2013) to measure flexibility in the right and left shoulder joints, was used in this study. Participants had to place one hand on the shoulder of the same arm towards the floor, and the other hand in the middle of the back towards the head, trying to touch or overlap the fingers of both hands. The values to be recorded relate to the distance in centimeters (+ or -) between the tips of the extended middle fingers of each hand. Two attempts were made for each side (right and left arm overlapping), and the final score corresponded to the average of the two measurements (to the nearest half centimeter).

Procedures

The study was approved by the Ethics Committee of the Polytechnic Institute of Leiria, and all interested parties who met the inclusion criteria were invited to participate in the research. During the first week of classes, a thorough explanation of the study (including materials, methods, and procedures) was provided by the researcher. This ensured that participants/family members/legal representatives were fully informed. This explanation took place during a class. Subsequently, sufficient time was allowed for participants to decide on their participation (approximately one week).

The students were recruited when they first enrolled and were assessed at the beginning and end of the first and second semesters of the first academic year (September 2024, January 2025, February 2025, and June 2025). Participants could withdraw at any time. All students were enrolled in the Bachelor's Degree in Sport and Well-being at the School of Education and Social Sciences - Polytechnic Institute of Leiria.

To conduct this study and collect information, an online form was developed using *Google Forms*, which was completed individually by each participant. The form included a first part on sociodemographic characteristics and a second part with questions about physical activity. A physical fitness assessment was also carried out, specifically in the areas of anthropometry, body composition, and physical fitness. These assessments always took place in the morning. The data collected in all assessments were transcribed to a specific record sheet, ensuring compliance with all ethical procedures. To ensure the safety and comfort of the participants, pre-test instructions were provided. The evaluators were junior researchers and received prior training to apply the physical tests in a standardized manner, ensuring inter-evaluator consistency. Each researcher was responsible for assessing the same participants at different moments. The assessments were supervised by the principal investigator.

Statistical analysis

Descriptive statistics were used to characterize the sample, expressed as mean \pm standard deviation. The Shapiro–Wilk test was used to assess the normality of the distributions, and the results confirmed that there was no deviation from normality. Subsequently, one-way analysis of variance (ANOVA) with repeated measures was used after temporal alignment of the data. The assumption of sphericity was tested using Mauchly's test; in cases where this was not verified, the Greenhouse-Geisser correction was applied. For the multiple comparisons between conditions, the Bonferroni post hoc test was applied. Missing data were handled using listwise deletion, which is consistent with the requirements of repeated measures ANOVA. The magnitude of the effect was presented using partial eta squared (η^2_p) and classified as small (<0.06), moderate (0.06 – 0.14), or large (≥ 0.14) (Cohen, 1988). The level of statistical significance was set at $p < 0.05$. All statistical processing was performed using SPSS software, version 31 for Windows (IBM SPSS Statistics, Chicago, IL, USA).

Results

Sociodemographic characterization

The number of students working for pay increased from 18.5% in Moment 1–31.5% in Moment 4, while those not working decreased from 81.5% to 68.5% (Figure A1). Similarly, the percentage of displaced students who need their own accommodation (away from their parents'/relatives' residence) increased consistently (Figure A2). Most respondents eat between 3 and 5 meals a day, maintaining a regular eating pattern over time. It is noted that there are students who eat 2 meals and that, throughout the school year, some students started eating one meal (Figure A3). On the other hand, *fast food* consumption is mostly low or non-existent, with the majority of respondents reporting that they do not consume it or only eat one meal of this type per day. The stability over the four moments suggests the maintenance of a dietary pattern with reduced incorporation of pre-cooked meals or fast food (Figure A4). Coffee consumption remains stable over moments, with most respondents consuming between 0 and 2 servings daily (Figure A5). The consumption of energy/sugary drinks is predominantly occasional or rare, remaining stable over moments. It should be noted that there is a considerable number of students who do not consume these drinks and that the frequency of consumption has decreased (Figure A6). Alcohol consumption remains consistent, with most respondents reporting “Rarely” or “Occasionally” (which increased from moment 1–2). The “I don't consume” category represents a considerable number of students. “Frequent” (which decreased from moment 1–2) and “Very frequent” consumption remain a minority throughout all moments (Figure A7). The “No

consumption” category in the tobacco variable is the most predominant (above 80%) at all moments. Frequent or very frequent consumption is residual, representing a very small minority of the sample. Throughout the four moments, there is remarkable stability in this pattern, with no fluctuations (Figure A8). Similarly, the consumption of addictive substances (e.g. drugs) is characterized by an extremely low prevalence, with the “No consumption” category representing the overwhelming majority of respondents at all moments. Occasional or frequent consumption is marginal, remaining at a minimal percentage throughout the study. The “Very frequent” category is practically residual, with remarkable temporal stability, without peaks or trends of increase in consumption (Figure A9).

Screen time and physical activity

Table 1 shows the repeated measures analysis for the screen time and physical activity variable. It is supported by the descriptive analysis performed in Appendix 1.

Table 1. Global sample repeated measures ANOVA for screen time and physical activity variables.

Variables	F	df1	df2	p	η_p^2	Pairwise comparisons
Screen Time						
Time (min)						
Time	6,909	1,610	99,79	.003	.100	1 \neq 2 (mean difference = -556.29^* ; $p < .001^a$; 95% CI [$-798.022, -312.565$]); 1 \neq 3 (mean difference = -455.55^* ; $p < .001^a$; 95% CI [$-698.519, -212.592$]); 1 \neq 4 (mean difference = -607.09^* ; $p = .008^a$; 95% CI [$-1097.67, -116.52$])
Light physical activity						
Time	1,501	2,131	127,883	.2268	.024	ns
Moderate physical activity						
Time	.322	3	183	.809	.005	ns
Vigorous physical activity						
Time	4,276	3	183	.006	.066	2 \neq 4 (mean difference = 1401.677^* ; $p = .008^a$; 95% CI [$267.599, 2535.756$])
Total physical activity						
Time	2,280	3	183	.081	.036	ns
Sedentary time (min)						
Time	6,813	3	183	<.001	.100	1 \neq 3 (mean difference = 533.871^* ; $p = .001^a$; 95% CI [$163.065, 904.676$]); 1 \neq 4 (mean difference = 573.355^* ; $p = .003^a$; 95% CI [$148.378, 998.332$]); 2 \neq 3 (mean difference = 337.774^* ; $p = .041^a$; 95% CI [$8,485, 667,063$])

Note. F = test results; df1 = degrees of freedom of the four conditions; df2 = degrees of freedom of error; p = significance; η_p^2 = partial eta-square; ns = no differences detected; * = The mean difference is significant at the .05 level; ^a = Adjustment for multiple comparisons: Bonferroni.

The repeated measures analysis of variance revealed a statistically significant main effect of the moments factor on weekly screen time, indicating that screen time varied significantly across the four assessment moments. Post-hoc tests with Bonferroni correction identified statistically significant differences between the following pairs of moments. Screen time at moment 1 ($M = 1700.52 \pm 631.10$) was significantly lower than at moment 2 ($M = 2256.81 \pm 685.96$), with a mean difference of -556.29 min ($p < .001$); screen time at moment 1 was also significantly lower than at moment 3 ($M = 2156.07 \pm 811.03$), mean difference = -455.55 min ($p < .001$), and lower than at moment 4 ($M = 2307.61 \pm 1551.77$), mean difference = -607.09 min ($p = .008$).

No significant differences were observed over moments for light physical activity ($M1 = 1348.13 \pm 2169.51$; $M2 = 1037.87 \pm 1582.98$; $M3 = 761.43 \pm 915.25$; $M4 = 1033.27 \pm 1561.90$), moderate physical activity ($M1 = 1314.51 \pm 1292.43$; $M2 = 1306.77 \pm 1166.49$; $M3 = 1222.25 \pm 1520.01$; $M4 = 1129.03 \pm 1093.34$) and total physical activity ($M1 = 5464.85 \pm 4237.69$; $M2 = 5903.36 \pm 4359.74$; $M3 = 5336.07 \pm 5115.43$; $M4 = 4168.51 \pm 3298.95$), despite decreasing trends being observed. Vigorous physical activity differed between moments ($F = 4.276$, $p = .006$; $\eta^2 p = .066$). Post-hoc tests with Bonferroni correction identified statistically significant differences between the following pairs of moments: Vigorous physical activity at moment 2 ($M = 3548.38 \pm 2809.07$) was significantly lower than at moment 4 ($M = 2146.70 \pm 2043.84$), with a mean difference of -1401.677 METs ($p = .008$).

Sedentary time showed a significant main effect ($F = 6.813$, $p < .001$; $\eta^2 p = .100$), decreasing over the assessment moments. Moment 1 ($M = 2089.35 \pm 716.71$) was significantly higher than moment 3 ($M = 1555.48 \pm 764.11$; mean difference = 533.87 min; $p = .001$) and moment 4 ($M = 1516 \pm 972.02$; mean difference = 573.36 min; $p = .003$). It was also observed that Moment 2 ($M = 1893.25 \pm 868.94$) was significantly higher than moments 3 (mean difference = 337.77 min; $p = .041$).

Table 2 shows the repeated measures analysis for the body composition variable. It is supported by the descriptive analysis performed in Appendix 2.

Total body mass showed significant differences between some moments: moment 1 ($M = 69.96 \pm 12.86$ kg) was significantly lower than moment 2 (mean difference = -1.391 kg; $p < .001$) and moment 4 (mean difference = -1.492 kg; $p = .025$). For fat mass (Fat Mass kg), Moment 1 ($M = 11.50 \pm 6.32$ kg) was significantly lower than moment 2 (mean difference = -1.167 kg; $p < .001$), 3 (-2.685 kg; $p = .037$), and 4 (-1.384 kg; $p = .003$). The percentage of lean mass (Free Fat Mass %) increased significantly from moment 1 ($M = 83.94 \pm 6.63$) to moment 2 (mean difference = 1.444% ; $p < .001$) and 3 (1.928% ; $p = .026$).

Visceral fat increased significantly from moment 1 ($M = 1.80 \pm 1.88$) to moment 2 (mean difference = -0.693 ; $p = .008$) and moment 4 (-0.698 ; $p = .010$). BMI increased over time, with moment 1 ($M = 23.18 \pm 3.44$ kg/m²)

Table 2. Global sample repeated measures ANOVA for body composition variables.

Variables	F	df1	df2	p	η_p^2	Pairwise comparisons
Body Mass (kg)						
Time	1,649	2,547	157,898	.187	.026	1 \neq 2 (mean difference = -1.391^* ; $p < .001^a$; 95% CI [$-2.166, -.616$]); 1 \neq 4 (mean difference = -1.492^* ; $p = .025^a$; 95% CI [$-2.858, -.127$])
Fat Mass (%)						
Team	4.817	1.904	118.07	.011	.072	ns
Fat Mass (kg)						
Time	4,988	1,317	81,663	.020	.074	1 \neq 2 (mean difference = -1.167^* ; $p < .001^a$; 95% CI [$-1.826, -.509$]); 1 \neq 3 (mean difference = -2.685^* ; $p = .037^a$; 95% CI [$-5.269, -.101$]); 1 \neq 4 (mean difference = -1.384^* ; $p = .003^a$; 95% CI [$-2.404, -.364$])
Free Fat Mass (kg)						
Time	.797	2.565	159.045	.480	.012	ns
Free Fat Mass (%)						
Time	4,792	2	124.01	.01	.072	1 \neq 2 (mean difference = 1.444^* ; $p < .001^a$; 95% CI [$.751, 2.136$]); 1 \neq 3 (mean difference = 1.928^* ; $p = .026^a$; 95% CI [$.150, 3.706$])
Muscle Mass (kg)						
Team	.529	2.605	161.509	.637	.008	ns
Bone Mass (kg)						
Time	.267	3	186	.849	.004	ns
Visceral Fat (rating)						
Team	7,617	1,694	105,039	.002	.109	1 \neq 2 (mean difference = $-.693^*$; $p < .008^a$; 95% CI [$-1.237, -.128$]); 1 \neq 4 (mean difference = $-.698^*$; $p = .010^a$; 95% CI [$-1.279, -.118$])
BMI (kg/m ²)						
Team	7.279	3	186	<.001	.105	1 \neq 3 (mean difference = $-.654^*$; $p < .001^a$; 95% CI [$-1.094, -.214$]); 1 \neq 4 (mean difference = $-.752^*$; $p = .005^a$; 95% CI [$-1.331, -.172$])
Waist circumference (cm)						
Time	7.642	2.394	148.45	<.001	.110	1 \neq 3 (mean difference = -1.859^* ; $p < .001^a$; 95% CI [$-3.012, -.706$]); 2 \neq 3 (mean difference = -2.775^* ; $p < .001^a$; 95% CI [$-4.179, -1.370$]); 3 \neq 4 (mean difference = 2.143^* ; $p = .015^a$; 95% CI [$.287, 3.998$])

Note. F = test results; df1 = degrees of freedom of the four conditions; df2 = degrees of freedom of error; p = significance; η_p^2 = partial eta-square; ns = no differences detected; * = The mean difference is significant at the .05 level; ^a = Adjustment for multiple comparisons: Bonferroni.

significantly lower than moment 3 (mean difference = -0.654 ; $p < .001$) and 4 (-0.752 ; $p = .005$). Waist circumference showed significant variations: moment 1 was lower than moment 3 (mean difference = -1.859 cm; $p < .001$), moment 2 was lower than moment 3 (-2.775 cm; $p < .001$), and moment 3 was lower than moment 4 (2.143 cm; $p = .015$). On the other hand, no significant differences were found in the variables fat-free mass (%), muscle mass (kg), and bone mass.

Table 3 shows the repeated measures analysis for the physical fitness variable. It is supported by the descriptive analysis performed in Appendix 3.

Table 3. Global sample repeated measures ANOVA for physical capacity variables.

variables	F	df1	df2	p	η_p^2	Pairwise comparisons
Hand Grip strength right (kg)						
Time	3.733	2.777	172.189	.015	.057	2 ≠ 3 (mean difference = -3.400*; $p = .006^a$; 95% CI [-6.068, -.732])
Left hand grip strength (kg)						
Time	3.899	3	186	.010	.059	2 ≠ 3 (mean difference = -3.167*; $p = .023^a$; 95% CI [-6.044, -.290])
Shoulder flexibility right (cm)						
Team	2.16	1.883	116.749	.123	.034	ns
Shoulder flexibility left (cm)						
Time	2.385	1.613	100,005	.108	.037	ns
Lower Limb Flexibility (cm)						
Team	8.592	3	186	<.001	.122	1 ≠ 2 (mean difference = 2.610*; $p = .017^a$; 95% CI [.327, 4.892]); 1 ≠ 3 (mean difference = 2.430*; $p = .017^a$; 95% CI [.297, 4.563]); 1 ≠ 4 (mean difference = 4.176*; $p < .001^a$; 95% CI [1.748, 6.604])
Cardiorespiratory Fitness (m)						
Time	6.369	2,733	169.428	<.001	.093	1 ≠ 3 (mean difference = 133.476*; $p < .001^a$; 95% CI [53.868, 213.084]); 1 ≠ 4 (mean difference = 121.111*; $p = .008^a$; 95% CI [23.215, 219.007])

Note. F = test results; df1 = degrees of freedom of the four conditions; df2 = degrees of freedom of error; p = significance; η_p^2 = partial eta-square; ns = no differences detected; * = The mean difference is significant at the .05 level; ^a = Adjustment for multiple comparisons: Bonferroni.

For handgrip strength, Moment 2 showed lower values than Moment 3 in the right hand (mean difference = -3,400 kg; $p = .006$) and left hand (-3,167 kg; $p = .023$). Lower limb flexibility decreased significantly from Moment 1 to Moments 2 (mean difference = 2,610 cm; $p = .017$), 3 (2,430 cm; $p = .017$), and 4 (4,176 cm; $p < .001$). Cardiorespiratory fitness showed a significant decrease from Moment 1 to Moments 3 (mean difference = 133.476 m; $p < .001$) and 4 (121.111 m; $p = .008$).

No significant differences were observed over moment in the flexibility of the right and left shoulders ($p > .05$), despite the downward trend.

Discussion

The results of this study demonstrated significant changes in some components of physical fitness during the first academic year of higher education students enrolled in a degree program in Sports Science. There was an increase in total fat mass and visceral fat, accompanied by a decrease in cardiorespiratory fitness and lower limb flexibility, while other variables remained stable.

Lifestyles

The increase in students working during the academic year can be interpreted in two ways: as a desire for financial independence or as a sign of economic insecurity, forcing students to fill gaps in the financing of their studies (McCloud & Bann, 2019). These additional workloads are associated with poorer academic results (Darolia, 2014) and poorer mental health, with higher levels of stress, exhaustion, and symptoms of burnout (McCloud & Bann, 2019). What at first glance appears to be a practical solution may, paradoxically, compromise students' academic success and well-being.

Eating patterns reveal that most students eat 3–5 meals/day, however, a minority report only 1 meal/day. Although this may reflect different types of diets (e.g. intermittent fasting), the literature warns that, in students, this pattern is more often associated with financial constraints or disorganized schedules than with conscious dietary choices (Shi et al., 2021). This is a potential warning sign for risky eating behaviors. On the other hand, *fast food* consumption remains low, contrasting with studies that associate the higher education environment with poorer food choices and increased fast food consumption (Bernardo et al., 2017; Oliveira & Raposo, 2024).

Coffee consumption is moderate. The literature reports the use of coffee as an academic *coping* strategy, i.e. as a way to increase energy, concentration, academic performance, and deal with stressful situations, adversity, or emotional demands (Di Martino et al., 2024; Jirjees et al., 2024; Viado, 2024). Energy/sugary and alcoholic drinks are mostly consumed “Rarely” to “Occasionally,” which may be related to academic events. Tobacco shows a high percentage of “No consumption,” reflecting trends toward reduced smoking among young people. The consumption of addictive substances is residual, but the presence of categories such as “Frequently” and “Very frequently” at specific moment suggests risk subgroups, corroborating the literature that identifies occasional use in recreational contexts or due to academic pressure (Welsh et al., 2019).

The significant increase in screen time during the first academic year confirms trends described in the literature. During the transition to higher education, students tend to increase time spent on sedentary activities, particularly those involving electronic device, namely cell phones (Castro et al., 2020; Deforche et al., 2015; Keating et al., 2005; Kljajević et al., 2021). Recent studies in European higher education populations show that the average daily screen time often exceeds 8 h (Rodríguez-Larrad et al., 2021), exceeding the threshold considered a metabolic risk by the World Health Organization (2020). From a physiological point of view, increased screen time may be associated with reductions in total daily energy expenditure, greater accumulation of adiposity, and hormonal changes linked to glucose and insulin metabolism (Ekelund et al., 2019; Tremblay et al., 2017), as well as a decline in physical fitness.

Physical activity

The results obtained through the IPAQ did not show significant differences, except for vigorous intensity, which decreased significantly from moment 2 to moment 4. The trend for all variables was downward. This trend suggests a gradual decrease in the practice of light (despite having increased from moment 3 to moment 4), moderate, vigorous, and total activities, which contrasts with the profile usually associated with Sports Science students, traditionally described in the literature as more active than other higher education students (Kljajević et al., 2021; Varela-Mato et al., 2012). Despite having, on average, higher levels of physical activity, recent studies have shown that these students are not immune to reductions in practice throughout their academic career, especially with regard to structured training, competitive participation, and involvement in extracurricular activities (Edelmann et al., 2022; Rodríguez-Larrad et al., 2021). Among the factors contributing to this decline are the academic workload, the transition from a guided practice regime to a more autonomous context, the lack of opportunities to practice in the same way as they did in their hometowns, the lack of transportation, as well as changes in motivation and personal priorities. Additionally, behavioral barriers such as perceived lack of time, fatigue, and increased sedentary digital behaviors are similar to those observed in other higher education students (Alkhalwaldeh et al., 2024).

On the other hand, regarding sedentary behavior, we found a decrease, contrasting with the decrease in physical activity. It is also important to note that, even among physically active individuals, high levels of sedentary behavior can mitigate the metabolic benefits associated with exercise, negatively influencing body composition and cardiometabolic risk (García-Hermoso et al., 2020; Stockwell et al., 2021). Thus, even if minimum physical activity recommendations are met, it may not be sufficient if the total time spent in sedentary activity remains high and is associated with unhealthy lifestyles, such as poor diet or poor sleep quality.

Physical fitness

Body composition

The results showed significant changes in body composition during the first academic year, namely an increase in total body mass, total fat mass, visceral fat, Body Mass Index, and waist circumference, accompanied by stability in muscle and bone mass. These results corroborate previous evidence describing the transition to higher education as a critical period of risk for adverse changes in body composition (Deforche et al., 2015; Deliens et al., 2015; Vadeboncoeur et al., 2015). This increase in body adiposity is consistent with the values reported in the literature, which identified a similar trend in first-year students (Vadeboncoeur et al., 2015). These changes may be directly related to an overall

decrease in physical activity levels and, above all, to screen time, also observed in this study, since the literature shows that these behaviors are associated with adverse metabolic changes, regardless of occasional physical activity (Owen et al., 2010; Tremblay et al., 2017). In young adults, prolonged periods of inactivity lead to greater accumulation of visceral fat and reduced insulin sensitivity, which contributes to a less favorable metabolic profile (Ekelund et al., 2019; Owen et al., 2010; Tremblay et al., 2017).

This imbalance in energy balance, resulting from high caloric intake combined with lower total energy expenditure, may also explain the increase in body fat.

Despite these changes, some variables, such as muscle mass and bone mass, remained stable throughout the study. This pattern may reflect the initial level of physical fitness of the participants, who, as sports science students, may have a more active baseline profile and greater exercise literacy than other students. In addition, involvement in occasional practical activities, even if unstructured, may have had a protective effect on lean mass (Booth et al., 2012). The stability of bone mass is also consistent with the literature, as variations in this parameter require prolonged exposure to adequate mechanical and nutritional stimuli. Recent studies show that bone tissue responds slowly to lifestyle changes, and significant changes are unlikely to occur in less than 12 months (Nikander et al., 2010).

Cardiorespiratory fitness

The progressive decline in cardiorespiratory fitness observed between the first and second semesters is a worrying indicator. This result is consistent with previous studies documenting sharp declines in cardiorespiratory endurance in university students, associated with a reduction in structured training and an increase in sedentary behaviors (García-Hermoso et al., 2020; Rodríguez-Larrad et al., 2021; Zhang, 2025). According to the American College of Sports Medicine (2021) and the World Health Organization (Bull et al., 2020), young adults should engage in at least 150 min of moderate physical activity or 75 min of vigorous activity per week, combining strength and flexibility training to maintain physical, functional, and cardiovascular balance. Apparently, the average levels of self-reported physical activity in this sample were insufficient to compensate for increased screen time and daily sedentary behavior, which explains the declining trend in Cooper test performance.

From a physiological point of view, this reduction in cardiorespiratory fitness may reflect adaptations that are the opposite of those promoted by regular aerobic training, including decreased stroke volume, muscle capillarization, oxidative enzyme activity, and mitochondrial efficiency (Booth et al., 2012). These changes contribute to a decrease in VO_2 max and an increase in the energy cost of submaximal tasks, reducing exercise tolerance and metabolic efficiency (García-Hermoso et al., 2020). These physiological mechanisms can

occur within a few weeks of inactivity, and their reversal requires prolonged periods of training.

Muscle strength

In contrast, a transient recovery in handgrip strength was observed between the second and third assessment moments, in both the right and left hands. These results may indicate that during the semester break, when students may have exercised more effectively (despite the decrease in the amount of physical activity practiced) to the point of increasing their handgrip strength. This increase led to students achieving higher values compared to when they entered higher education, which may be the result of more literature on exercise prescription.

Handgrip strength is recognized as a robust marker of overall strength, musculoskeletal health, and quality of life (Ortega et al., 2008; Ruiz et al., 2009), and strategies are needed to prevent values from decreasing during school terms.

Flexibility

The results showed a significant decrease in lower limb flexibility, while shoulder flexibility showed only occasional variations. This reduction may be related to less involvement in activities that require joint mobility and an increase in the time spent on static postures, especially in an academic context.

Prolonged sitting, associated with studying and the use of electronic devices, promotes adaptive shortening of musculotendinous structures and myofascial stiffness, with consequent limitation of range of motion (Wong et al., 2017). Physiologically, this phenomenon translates into a decrease in sarcomere length and a reduction in muscle fiber extensibility, compromising functional performance and increasing the risk of musculoskeletal injuries (Ayala et al., 2012a).

Although, hypothetically, the participants in this study have a higher level of literacy regarding physical activity and its benefits, sports science students may experience a decline in physical fitness during their first academic year. These results may stem from various factors. The transition to higher education often involves a shift from structured exercise settings to more informal and irregular patterns, leading to a reduction in physical activity, particularly of moderate to vigorous intensity (Bray & Born, 2004; Clemente et al., 2016). From a physiological perspective, the decrease in physical activity is associated with a reduction in maximum oxygen uptake, cardiovascular efficiency and muscle oxidative capacity (Booth et al., 2012). It is often accompanied by increases in body fat that negatively impact physical fitness during the transition to higher education (Deliens et al., 2013). The results of our study on the relationship between knowledge and behavior show that higher levels of physical

activity literacy do not guarantee the consistent adoption of healthy behavior (Rhodes & de Bruijn, 2013).

Practical implications and recommendations

The results of this study reinforce that the first academic year is a critical period for the adoption or abandonment of healthy behaviors, even among Sports Science students. Therefore, it is essential to implement institutional strategies to promote physical activity and prevent sedentary behavior, thereby mitigating the negative effects observed in physical fitness and contributing to the maintenance of healthy lifestyle habits (when these were present prior to entering higher education, for example, in the case of young athletes) or their adoption.

The *World Health Organization* (World Health Organization, 2020) and the *American College of Sports Medicine* (American College of Sports Medicine, 2021) recommend at least 150 min of moderate physical activity or 75 min of vigorous activity per week, combined with strength and flexibility training. Recent evidence indicates that brief, supervised interventions, such as combined training programs (resistance + aerobic), mobility sessions, and active breaks in theoretical classes, can significantly improve physical fitness and reduce sedentary time (García-Hermoso et al., 2020).

In addition, institutional policies – which ensure easy access to sports facilities, adjustment of class schedules, and appreciation of physical activity as a component of well-being – are essential to prevent functional decline and promote active and sustainable lifestyles.

In practical terms, it is recommended that higher education institutions structure regular supervised physical exercise programs (not only for students, but also for teaching and non-teaching staff), focusing on the balanced development of physical abilities, in order to preserve students' metabolic and functional health and encourage long-term active behaviors (Bull et al., 2020; World Health Organization, 2020). For institutions that do so, it is important to continue these programs and, if possible, reinforce them to continue the work that has been developed. The structure of the programs, as well as their schedules, should be appealing to encourage participation. At the same time, some external benefits for regular participation may also increase adherence to the programs (e.g. student-athlete status).

Limitations and future perspectives

The small number of participants, the absence of students from other areas and institutions (reducing representativeness), the use of subjective measures and anthropometric assessments using the bioimpedance method (which did not strictly control hydration status, meal times, diet or the menstrual cycle in female participants, factors that can influence estimates of fat mass and fat-

free mass) are limitations of the present study. Finally, although the evaluators were trained and the assessments were standardized and always performed by the same researchers, residual inter-evaluator variability cannot be ruled out.

Future research should incorporate objective measures of physical activity, such as accelerometry, and, in addition, it will be important to explore the role of psychosocial factors, such as mental health variables and sleep patterns, among others, in maintaining active behaviors during higher education. The integration of these factors may contribute to the development of personalized intervention programs based on health literacy, behavioral self-regulation, and institutional support, promoting the adoption of healthy and sustainable lifestyles among young adults.

Conclusion

The first year of higher education proved to be a period vulnerable to negative changes in physical health, even among Sports Science students. There was a significant increase in body fat and a decrease in cardiorespiratory fitness and flexibility, associated with an increase in screen time and a reduction in physical activity (albeit not significant). These results occurred even in a population with training in Sports Science, suggesting that exercise literacy and curricular practice are not sufficient to mitigate the negative impact of academic transition on active behavior.

These results highlight the need for institutional programs that promote regular physical activity and reduce sedentary time during the academic career. The integration of health and exercise literacy strategies, combined with regular opportunities for supervised practice, may be crucial to preserving students' metabolic, functional, and psychological health.

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Appendices

Appendix 1. Sociodemographic characterization

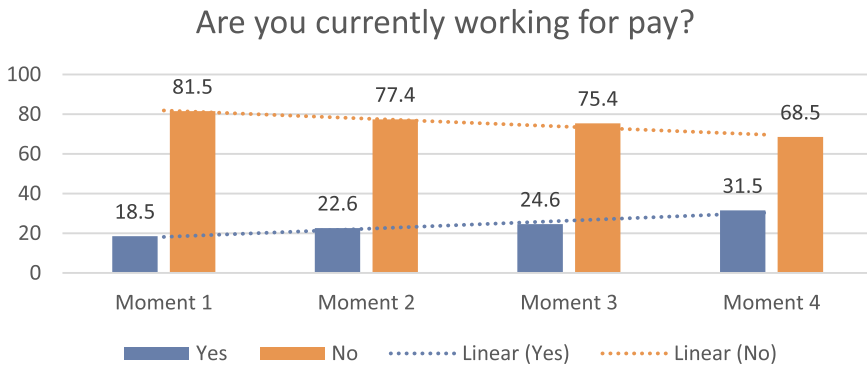


Figure A1. Are you currently working for pay?

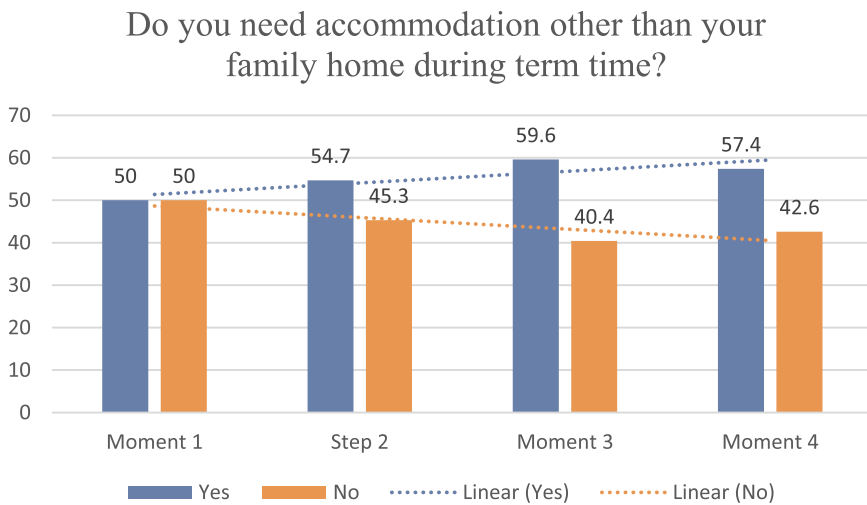


Figure A2. Do you need accommodation other than your family home during term time?

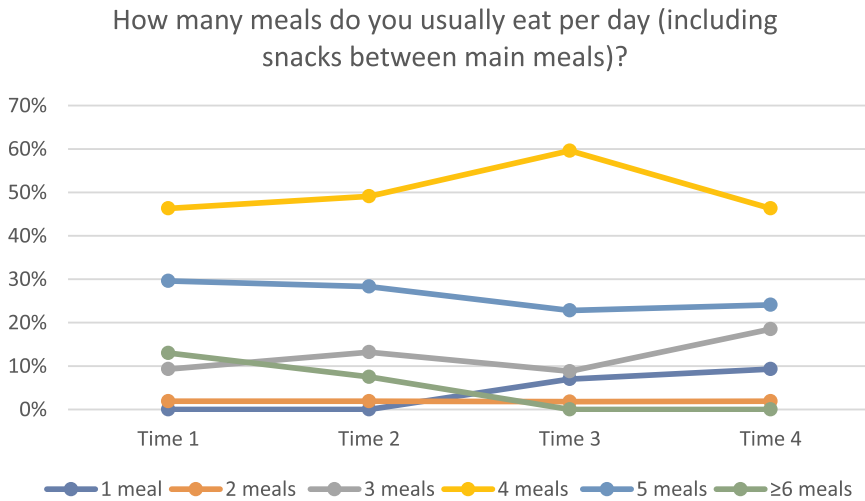


Figure A3. How many meals do you usually eat per day (including snacks between main meals)?

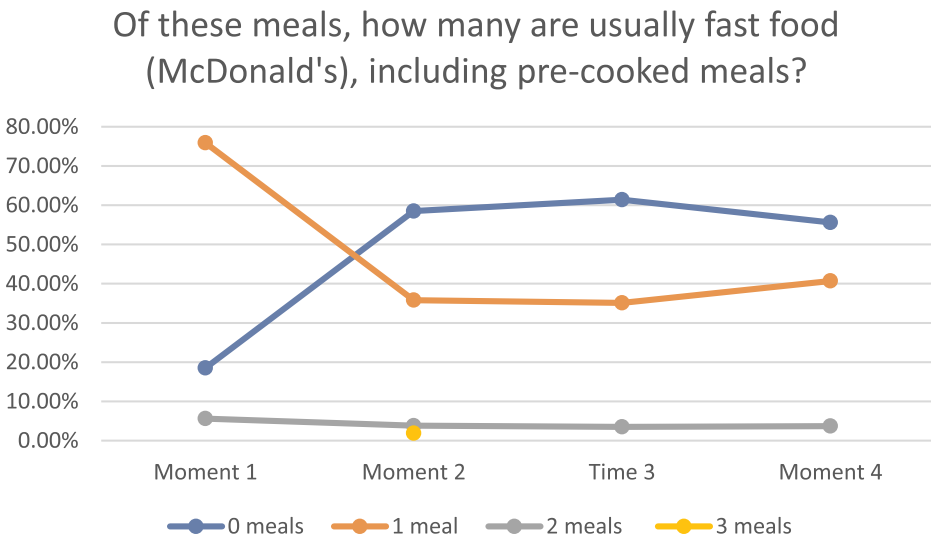


Figure A4. Of these meals, how many are usually fast food (McDonald's), including pre-cooked meals?

Regarding your daily coffee consumption, how many cups do you drink?

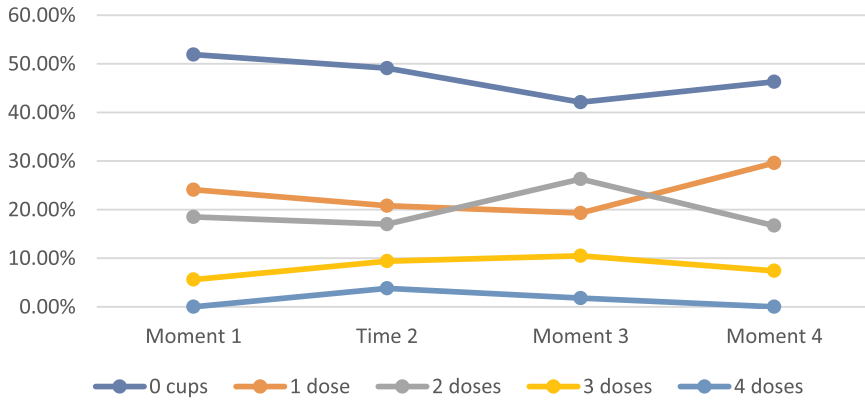


Figure A5. Regarding your daily coffee consumption, how many cups do you drink?

How often do you consume energy/sugary drinks (Coca-Cola, Red Bull, etc.)?

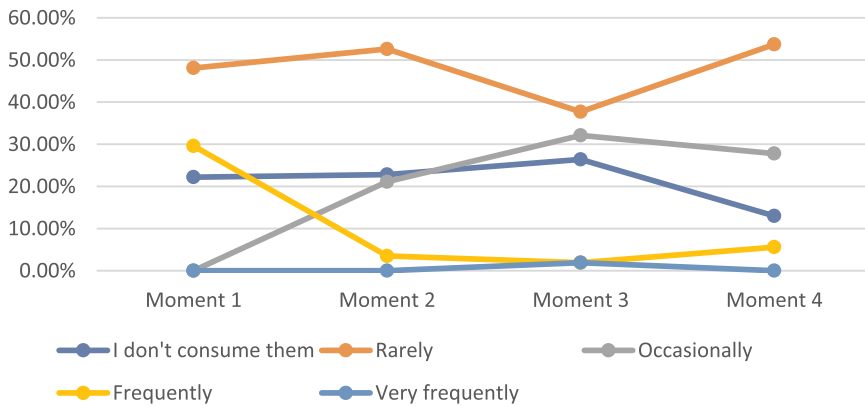


Figure A6. How often do you consume energy/sugary drinks (Coca-Cola, Red Bull, etc.)?

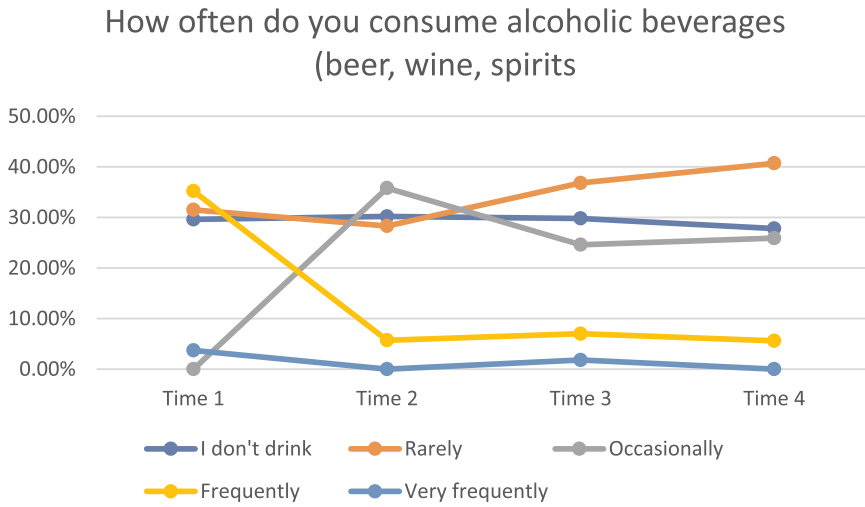


Figure A7. How often do you consume alcoholic beverages (beer, wine, spirits).

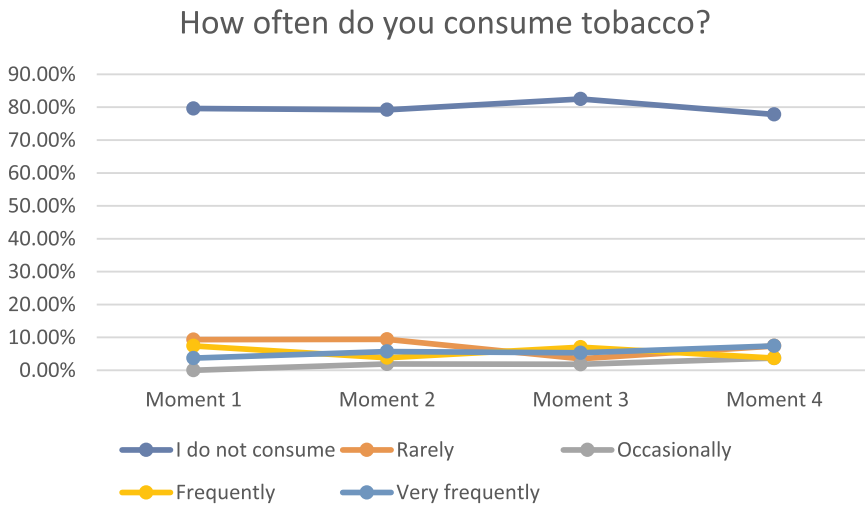


Figure A8. How often do you consume tobacco?

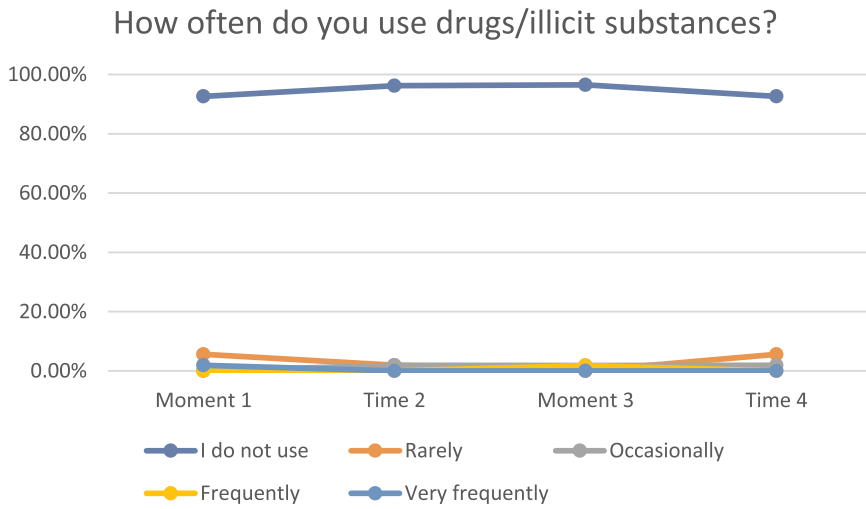
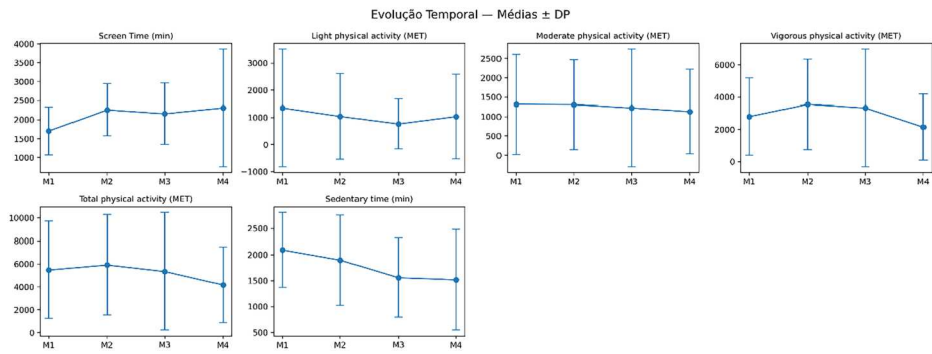


Figure A9. How often do you use drugs/illicit substances?

Appendix 2. Descriptive statistics of screen time and physical activity variables.

	Mean_M1	SD_1	Mean_M2	SD_2	Mean_M3	SD_3	Mean_M4	SD_4
Screen Time (min)	1700.52	631.10	2256.81	685.96	2156.07	811.03	2307.61	1551.77
Light physical activity (MET)	1348.13	2169.51	1037.87	1582.98	761.43	915.25	1033.27	1561.90
Moderate physical activity (MET)	1314.51	1292.43	1306.77	1166.49	1222.25	1520.01	1129.03	1093.34
Vigorous physical activity (MET)	2798.83	2392.18	3548.38	2809.07	3329.67	3650.49	2146.70	2043.84
Total physical activity (MET)	5464.85	4237.69	5903.36	4359.74	5336.07	5115.43	4168.51	3298.95
Sedentary time (min)	2089.35	716.71	1893.25	868.94	1555.48	764.11	1516	972.02

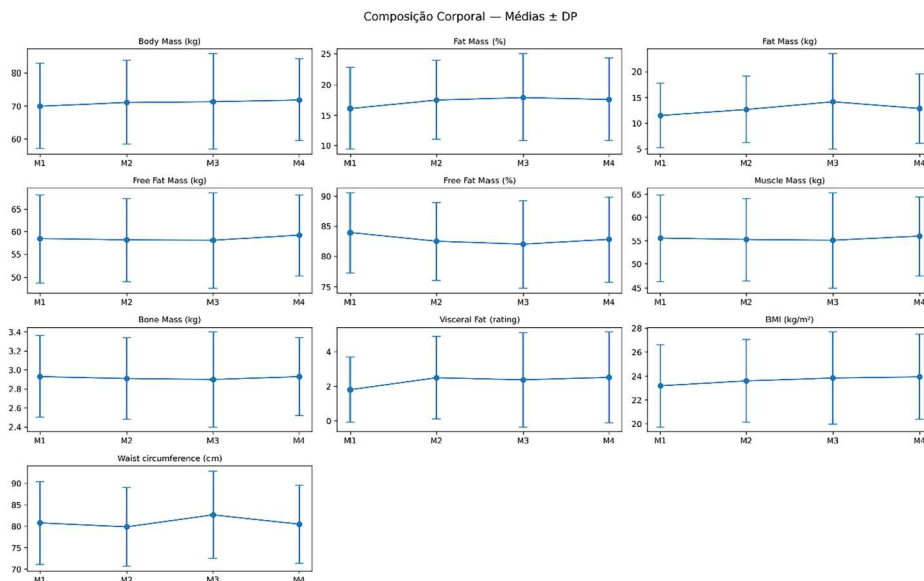
Variations over moments – Mean ± SD.



Appendix 3. Descriptive statistics of body composition variables.

	Mean_M1	SD_1	Mean_M2	SD_2	Mean_M3	SD_3	Mean_M4	SD_4
Body Mass (kg)	69.96	12.86	71.11	12.69	71.33	14.45	71.85	12.40
Fat Mass (%)	16.09	6.70	17.48	6.46	17.9	7.13	17.58	6.75
Fat Mass (kg)	11.50	6.32	12.67	6.50	14.19	9.29	12.88	6.77
Free Fat Mass (kg)	58.45	9.72	58.17	9.22	58.08	10.58	59.22	8.97
Free Fat Mass %	83.94	6.63	82.50	6.46	82.01	7.26	82.81	7.01
Muscle Mass (kg)	55.57	9.26	55.25	8.78	55.09	10.23	55.98	8.44
Bone Mass (kg)	2.93	.43	2.91	.43	2.90	.50	2.93	.41
Visceral Fat (rating)	1.80	1.88	2.49	2.38	2.37	2.72	2.51	2.62
BMI (kg/m²)	23.18	3.44	23.59	3.46	23.83	3.85	23.93	3.57
Waist circumference (cm)	80.79	9.67	79.87	9.16	82.65	10.19	80.50	9.07

Variations over moments – Mean ± SD.



Appendix 4. Descriptive statistics of physical fitness variables.

	Mean_M1	SD_1	Mean_M2	SD_2	Mean_M3	SD_3	Mean_M4	SD_4
Right hand grip strength (kg)	41.54	9.34	40.15	10.05	43.55	10.25	41.85	10.12
Left hand grip strength (kg)	39.86	9.01	38.92	10.23	42.08	10.84	40.81	8.91
Shoulder flexibility right (cm)	10.00	6.02	10.66	9.03	9.78	6.99	8.83	6.96
Shoulder flexibility left (cm)	6.67	5.78	7.88	8.93	6.08	6.15	6.03	6.73
Lower Limb Flexibility (cm)	9.64	7.39	7.03	7.54	7.21	7.77	5.47	7.09
Cardiorespiratory Fitness (m)	1861.06	274.08	1808.84	307.86	1727.59	237.03	1739.95	277.34

Variations over moments – Mean ± SD.

