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Analysis of motor competence and physical fitness in dancers: a pilot study

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ABSTRACT
Purpose. The aim of this study was to characterize and compare the motor competence and physical fitness in dancers of different styles considering age, body mass index, and physical activity level (min/week).
Methods. Overall, 17 female dancers aged 13–31 years (18.00 ± 4.80) participated in this study. The sample was divided into 2 groups: (1) dancers who practised up to 3 styles (n = 10); (2) dancers who practised 4 or more styles (n = 7). The Fit School and Motor Competence Assessment test batteries were applied to analyse physical fitness and motor competence, respectively. All variables were tested for normal distribution by using the Shapiro-Wilk test. For continuous variables, the t-test was used and for nominal variables, the chi-square test was employed. For those that did not follow normal distribution, the Mann-Whitney U-test was applied.
Results. For either motor competence or physical fitness, the number of dance styles did not exert any influence. Furthermore, no significant differences were found for between-group comparisons.
Conclusions. The total group fell within the average reference values in all the physical fitness tests, with the exception of the 20-m multistage maximum shuttle run test. With regard to the number of dance styles practised, no differences between groups were observed for either motor competence or physical fitness.
Key words: motor competence, physical fitness, age, young athletes

Introduction

The art of dancing naturally came to represent the profile of dancers, which over the years also had to be readjusted. A shaped body should be a concern, a body which would respond with elegance and technique to the intended movements; in this vision of body aesthetics, new resources were adopted by dancers. The performance on stage should be associated with physical abilities that complement the aesthetic value of the exhibitions [1].

According to Darby and Garret [2], there are many forms of dance and many require a combination of strength, power, flexibility, cardiorespiratory fitness, and motor coordination. Physical condition encompasses much more than specific dance steps. Darby and Garret [2] state that with improved physical condition, dance performance and self-confidence can be increased. The need to explore the concept of physical fitness (PF) in dancers shows up, which corresponds to the development of health- and skill-related attributes that are associated with the academic performance in youth [3]. In childhood, PF is taken as a marker of current and future health. For this reason, there is a need for simple but reliable tests to assess its different components [4].

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In a study conducted with 83 young females divided into 3 groups: classical dancers, non-classical dancers, and students aboard physical education classes, physical abilities related to both health and athletic performance were evaluated [5]. Cardiorespiratory capacity and horizontal jump showed no significant differences between groups. The classical and non-classical dancers exhibited higher performance than the schoolgirls in vertical jump, balance, coordination, and agility. Concerning flexibility, muscular resistance, and strength variables, the classical dancers obtained greater values [5]. A similar issue was deliberated in a study by Prati and Prati [6], who observed the levels of PF and postural tendencies in classical dancers. The sample was composed of 11 classical dancers with more than 7 years of practice from Maringá ballet schools. To verify the PF levels, body composition analysis by anthropometry, strength tests, arm flexion, abdominal resistance, muscular power, flexibility, and aerobic power was taken into consideration. The main results showed average levels of body composition adequate to the activity; in strength, endurance, muscle power, and aerobic capacity, on average, the results were lower than expected. It is believed that to obtain a better and long-lasting performance, with fewer risks of acquiring organic disorders, the development of general and specific PF, along with compensation work, could be important in ballet classes.

Motor competence (MC) describes the ability to execute goal-directed movements and is positively associated with physical activity and fitness levels in childhood and adolescence [7]. The importance of MC for physical activity and PF is further reinforced when one looks at children with low MC, where lower levels of moderate to vigorous physical activity and lower aerobic and musculoskeletal fitness are repeatedly found compared with children with typical development. The importance of athletes learning and automating the MC involved in the different sports is one of the main factors for the need of sports programs properly organized by technicians with specific knowledge [8]. The same is required in dance classes and, for this reason, it is extremely important that dancers have knowledge of their MC to improve their performance. According to Kim et al. [9], motor memory acquired during life through specific training in the ballet style can be maintained with additional training. A training-induced effect was also observed, with smaller responses in dancers than in sedentary groups of the same age. This study, therefore, is one of the first to demonstrate that motor memories acquired through ballet-specific training in early life can be maintained and carried into adulthood by weekly repeating the same training.

Nowadays, the type of injury, postural tendencies, and even the development of bone mineral density, for example, are widely discussed throughout literature on dance style [10–12]. However, there is not much information regarding the levels of MC in dancers, unless it is only directed to the classical dance area, excluding others, like contemporary and urban dance, for instance. Many dancers seek classical dance to complement their 'mother style,' that is, the one to which they are devoted and which they practise the most. It was observed that contemporary dance classes, for example, do not stick to the institutionalized technique. Nevertheless, in the execution of the improvisation exercises, we noticed very clean and clear movements performed with great precision and technical quality, which perhaps comes from classical dance classes. The demand for the classical dance style revolves around the idea that it is the base for the others, and from this style dancers search for technique and body discipline [13]. The relevance of the present study arises, then, from some gaps in the literature concerning the numerous areas of dance, with the purpose of including more information about the impact of MC and PF in dancers of several styles and not only classical dance. For this reason, a descriptive analysis of the PF and MC variables was made in a group of dancers practising different styles, comparing a group of dancers practising up to 3 styles with a group practising 4 or more.

Material and methods

Experimental approach to the problem

We followed an observational study design. Prior to the physical tests, information regarding physical activity was collected from the 17 dancers by using the International Physical Activity Questionnaire (IPAQ). Their MC and PF were evaluated by applying the Motor Competence Assessment and the Fit School program, respectively. The study data were collected on November 28, 2021.

Participants

A total of 17 female dancers (age: 18.00 ± 4.80 years [13–31 years], weight: 56.5 ± 6.67 kg, height: 161.00 ± 5.13 cm) with more than 5 years of practice from a Portuguese dance academy participated in this cross-sectional study. A big part of the sample was constituted by recreational athletes and only a few individuals (4) were professional dancers. The sample was divided into 2 groups: group 1 (15.5 ± 3.83 years of age) – dancers who practised up to 3 styles (classical, contemporary, urban, oriental, and acro-dance) (*n* = 10); and group 2 (17.0 ± 6.0 years of age) – dancers who practised 4 or more styles (*n* = 7). The inclusion criteria were as follows: practising at least 2 dance styles currently and having at least 5 years of experience in the practice. In turn, the exclusion criteria involved any medical contraindications that might have interfered with the performance in the practice tests. All the dancers were aware of the study methodology.

Instruments

Motor competence

There was no established instrument able to measure this 'new' construct along life span, and the ones usually cited in the literature that were mostly built for the diagnosis lack objectivity or fidelity in the assessment protocol or do not evaluate the 3 components of MC: locomotion, stabilization, and manipulation. Because of this, researchers have difficulty comparing their results and understanding the real effect of MC advance on the human development. Motor Competence Assessment has been recently presented to solve these problems [14]. Therefore, MC was evaluated in this study by applying the battery of Motor Competence Assessment tests, which include the following domains. Stabilization tests: (a) Sideways jumps: the subject was to perform the highest number of jumps with both feet together on a small wooden platform (60 × 50 × 0.8 cm) over a wooden stick (60 × 4 × 2 cm) in 15 s. For each correct jump, 1 point was added; 2 attempts were performed, and a short time interval (approximately 1 min) was allowed for the participant's recovery. The best performance of the 2 attempts (the highest score) was used as the final result of the test. (b) Shifting platforms: the subject moved laterally as fast as possible for 20 s, using 2 wooden platforms (25 × 25 × 2 cm). The participant was supposed to start with her feet on top of the right plate, grabbing the left plate with both hands and transporting it to her right side; then, she put her feet on the plate and so on. Each successful transfer from one platform to another was scored with 2 points (1 point for each step). Locomotion tests: (c) Shuttle run: the participants ran in a straight line at maximum speed between points 10 m apart, picked up a wooden block, and placed it behind the starting line. Then they repeated the procedure to retrieve a second block of wood. They made 2 attempts and the best result was considered. (d) Horizontal jump: the individuals jumped with their feet together as far as possible. The distance was recorded on the landing between the starting line and the back of the heel. The final score was the one corresponding to the greatest distance after 2 attempts. Manipulation tests: (e) Ball throwing: the subject threw a tennis ball (circumference: 22.86 cm; weight: 142 g) with as much force as possible against a wall using an over-the-shoulder throwing action, without a preparatory run. (f) Ball kicking: after a preparatory run, the participant kicked a soccer ball (#4; circumference: 64 cm; weight: 350 g). In the last 2 tasks, she performed 3 attempts and the result was recorded by the maximum speed in km/h obtained by using a radar gun (Stalker Pro II; Texas, USA). The purpose of this test is to analyse the 3 components of MC. All of the evaluations are quantitative motor tests without a marked development (age) ceiling effect and of feasible execution. The total MC score corresponded to the average results of the categories [15].

Physical fitness

In addition, the Fit School program tests of body composition were performed: (i) Body mass index (BMI): it is a measure of corpulence that is defined as the ratio between weight (kg) and squared height (kg/m^2) and tends to be associated with body composition indicators. It is the recommended test for body composition assessment and aims to determine whether the weight is appropriate to the stature. (ii) Perimeters: the measurements are taken with a measuring tape, with the same position on the skin and reaching the body segment that is being measured. Neuromuscular fitness: (iii) Abdominals: the highest number of abdominals are executed at a preset cadence. The purpose is to evaluate the resistance strength of the abdominal region muscles. (iv) Push-ups: the highest number of arm push-ups (movement of arm flexion and forearm extension) are executed at a pre-defined cadence. This test aims to evaluate the resistance strength of the upper limbs. (v) Vertical jump: also known as vertical thrust, the test consists in reaching the maximum distance in a vertical jump with feet together. Its objective is to evaluate the explosive strength of the lower limbs. (vi) 20/40-m speed: the speed of displacement is the maximum capacity of an individual to move from one point to another. The test consists in running 40 m or 20 m in the shortest time possible. It aims to measure the acceleration capacity and speed. (vii) Shoulder flexibility: the test consists in the contact of the fingers of both hands behind the back. This test aims to evaluate upper limb flexibility. (viii) Lower limb flexibility: the stand-in-reach test consists in the maximum flexion of the trunk in the sitting position on the floor; a measuring box is used. The aim is to evaluate the flexibility of the lower limbs. Aerobic fitness: (ix) A 20-m go-go test to predict VO_2max: It consists of the execution of the maximum number of runs over a 20-m distance at a predetermined cadence. For more details, see Henriques-Neto et al. [16].

Control variables

Age

The control variable of age was chosen because there are studies that examine how the relationship with MC and PF changes over time [17]. The older the child, the more it will differentiate a certain skill (understood as the ability to perform the task masterfully) [18]. Therefore, with the development, the individual's concept of skill tends to change, as do their perceptions [19]. Since our sample had a large age gap, it was important to control this variable.

Body mass index

We can deduce that with decreasing involvement in physical activities, there is an increase in BMI [14]. It is assumed that unhealthy weight gain may be associated with poorer fitness and lower levels of neuromuscular control, including balance and coordination, which could lead to high BMI, exhibiting interference with physical activity levels [20] Furthermore, obesity is associated with lower opportunities to engage in physical activity [21] and lower performance in fundamental motor skills [22], which may result in low MC values [23].

Co-variables

International Physical Activity Questionnaire

IPAQ (short version) concerning physical activity performed by each participant was filled in 15 days before the physical tests. The questionnaire follows a scale of excellent, very good, good, fair, and poor with regard to health status and describes such parameters as the average time that the subject spends per week in public transportation and on walking, along with moderate physical activity and vigorous physical activity they perform at work, indoors and outdoors, the time they spend walking for leisure, and, finally, the time per day that they spend sitting during the week and weekend [24]. Moderate physical activity involved activities that require medium physical exertion and make the individual breathe a little faster than normal, such as swimming, cycling at a medium pace, and playing sports for fun. In turn, vigorous physical activity includes activities that require high physical exertion and make the individual breathe much faster than normal, such as running, cycling at a fast pace, and playing competitive sports [25]. The level of physical activity was recorded in accordance with 4 intensity levels: (1) vigorous intensity activity, such as aerobics; (2) moderate intensity activity, such as leisure cycling; (3) walking; and (4) sitting [26]. Subsequently, the data were converted into metabolic equivalents (MET-min/week) on the basis of the equation by Ainsworth [27]. When combining moderate physical activity and vigorous physical activity to meet the current recommendation for a healthy adult, the minimum recommendation represents the range of 450–750 MET-min/week [28]. Therefore, the participants were classified as active if they could achieve those values.

Metabolic equivalents

The total amount of physical activity is a representation of its intensity, duration, and frequency [28]. To analyse the physical activity level of the sample, we used MET-min/week. Average values can be calculated for walking, moderate intensity activities, vigorous intensity activities, and the total value of combined physical activity. All continuous values are expressed in MET-min/week [29]. To create the variable 'physical activity,' we converted the data from the IPAQ questionnaire into metabolic equivalents (MET-min/week). For METs calculation, the following intervals were used: 8 METs (vigorous activity), 4 METs (moderate activity), and 3.3 METs (walking) [27]. The dancers were assessed for their level of physical activity/inactivity. The sample was considered inactive if they did not reach the minimum value corresponding to a healthy adult, which is within the range of 450–750 MET-min/week [28].

Statistical procedures

Univariate descriptive analyses were performed for the group of dancers. To analyse if the PF and MC variables presented statistically significant differences between the groups of dancers who practised 3 or less styles and those who practised 4 or more (Tables 1 and 2), we carried out *t*-test comparisons between the 2 groups.

Table 1. Dancers who practised ≤ 3 styles

Dancers	Classical	Contemporary	Urban	Oriental	Acro-dance
D1		x	x	x	
D2	x	x	x		
D3	x	x	x		
D4		x		x	
D5		x	x		
D6		x	x		
D7		x	x		
D8		x	x		

Table 2. Dancers who practised ≥ 4 styles

Dancers	Classical	Contemporary	Urban	Oriental	Acro-dance
D9		x	x		
D10		x	x		
D11	x	x	x	x	
D12	x	x	x	x	
D13	x	x	x	x	
D14	x	x	x	x	
D15	x	x	x	x	
D16	x	x	x		x
D17	x	x	x	x	

First of all, to test the normality, the Shapiro-Wilk test was used, recommended for small samples (< 30 observations); it was concluded that only 2 of the dependent variables followed normal distribution [30]. Effect size measures (Cohen's *d*/phi) were conducted to complement these analyses. The variables that did not follow normal distribution were: push-ups, horizontal jump, transposition on platforms, and shuttle run. For these variables, the Mann-Whitney *U*-test for non-parametric comparisons was used. For the remaining variables, which followed normal distribution, the comparison of means *t*-test was applied for continuous variables. For nominal variables (right shoulder flexibility and left shoulder flexibility), the chi-square test was used. The analyses were performed in the IBM SPSS 27 software.

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the ethics committee of Instituto Politécnico de Viana Do Castelo, Portugal (approval No.: CTC-ESDL-CE001-2021).

Informed consent

Informed consent has been obtained from all individuals included in this study or their legal guardians.

Results

No significant between-group differences were found for PF or MC measures (Tables 3 and 4).

Control variables

Regarding the control variables, age was not significant in any of the models. BMI was significant for horizontal jump and ball kicking (B = –0.063, B = 1.178, respectively), i.e., for each additional value in BMI,

Table 3. Physical fitness outcomes

Items	Total (*n* = 17)	Group 1 (≤ 3) (*n* = 10)	Group 2 (≥ 4) (*n* = 7)	$t/U/\chi^2$	*p*	Cohen's *d*/phi	95% CI
Body mass index (kg/m^2)	22.08 (2.34)	21.72 (2.50)	22.60 (2.16)	–0.752	0.464	–0.37	–1.339 to 0.610
Abdominal (*n* of repetitions)	56.41 (16.97)	52.40 (14.35)	62.14 (19.84)	0.257	0.257	–0.581	–1.560 to 0.416
Push-ups (*n* of repetitions)*	20.94 (9.35)	20.10 (8.53)	22.14 (11.01)	0.441	0.669	–0.213	–0.178 to 0.759
Vertical jump (m)	2.39 (0.09)	2.38 (0.10)	2.41 (0.06)	–0.716	0.485	–0.353	–1.321 to 0.627
Velocity 20/40 m (s)	4.19 (0.20)	4.16 (0.17)	4.23 (0.25)	–0.681	0.506	–0.335	–1.303 to 0.643
Right shoulder flexibility (yes) (%)	100	100	100	–	–	–	–
Left shoulder flexibility (yes) (%)	94.12	100	85.71	1.518	0.468	0.299	–0.180 to 0.663
Right leg flexibility (yes) (%)	38.65 (6.75)	38.29 (6.08)	38.29 (6.08)	0.179	0.86	0.088	–0.880 to 1.053
Left leg flexibility (yes) (%)	37.00 (6.89)	37.21 (5.73)	37.21 (5.73)	–0.104	0.919	–0.051	–1.016 to 0.916
Shuttle run (ml/kg/min)	31.24 (11.33)	31.43 (14.08)	31.43 (14.08)	–0.057	0.955	–0.028	–0.994 to 0.938

Data provided as mean and standard deviation.
* Variables that do not follow normal distribution

Table 4. Motor competence outcomes

Items	Total (n = 17)	Group 1 (≤ 3) (n = 10)	Group 2 (≥ 4) (n = 7)	$t/U/\chi^2$	p	Cohen's d/phi	95% CI
Sideways jumps (n of repetitions)	36.15 (4.55)	36.65 (5.05)	35.43 (3.99)	0.532	0.602	0.262	–0.712 to 1.228
Shifting platforms (n of repetitions)	14.53 (4.69)	15.35 (5.40)	13.36 (3.50)	–1.164	0.27	0.421	–0.563 to 1.392
Shuttle run (s)*	12.22 (1.17)	12.03 (0.82)	12.48 (1.58)	0.488	0.669	–0.382	–1.351 to 0.599
Horizontal jump (cm)*	1.75 (0.19)	1.73 (0.14)	1.77 (0.27)	0.781	0.475	–0.16	–1.124 to 0.811
Throwing ball (m/s)	11.20 (1.50)	11.14 (1.59)	11.29 (1.47)	–0.195	0.848	–0.096	–1.061 to 0.872
Kicking ball (m/s)	12.88 (1.87)	12.49 (1.98)	13.43 (1.69)	–1.018	0.325	–0.502	–1.476 to 0.489

Data provided as mean and standard deviation.
* Variables that do not follow normal distribution

Table 5. Dancers' accumulated physical activity

Physical activity intensity	Group 1 (≤ 3) (n = 10)	Group 2 (≥ 4) (n = 7)	t	df	p
Vigorous (min/week)	2942.18 ± 586.39	2921.98 ± 764.22	0.062	15	0.999
Moderate (min/week)	1993.82 ± 1120.01	1907.17 ± 1769.80	0.124	15	0.121
Walking (min/week)	566.02 ± 521.71	355.08 ± 297.31	0.960	15	0.220
Sedentary time (min/week)	790.08 ± 182.54	777.26 ± 197.14	0.138	15	0.789
Physical activity (min/week)	5502.02 ± 1751.98	5184.22 ± 2033.91	0.345	15	0.773

the individual had 0.063 less value in horizontal jump and 1.178 more values in ball kicking. In the remaining variables, BMI and METs were not considered significant for the calculations.

Co-variables: physical activity levels

With regard to the level of physical activity, all dancers were classified as active. As observed in Table 5, the minutes spent during the week on the different intensities of physical activity and sedentary time were similar in both groups, with no statistically significant differences recorded between them.

Discussion

This study aimed to evaluate and compare 2 groups of female dancers with different practices (numbers of dance styles) with regard to MC and PF. Although both groups were considered physically active, the results showed that the diversity of types of dance styles did not influence either MC or PF. In addition, the dancers presented MC values within the average reference ranges only for the horizontal jump test; among the PA tests, the exception was the shuttle run [31].

A dancer is commonly considered complete when they master several dance styles since this allows to achieve better result regarding artistic knowledge, physical condition, and motor skills. In this sense, motor behaviour becomes more efficient over time owing to consistency [32], as some difficulties appear with time that increase the demands experienced by the dancers [33]. However, the present study seems to suggest that the diversity of practice did not influence MC or PF values. This can be related to the very different range of styles and, consequently, the different levels of demands. In addition, although there was a group of dancers who practised fewer styles, they tended to practise their respective styles more often per week (2–4 times/week), and those who practised more modalities tended to perform them less often (1 hour/week). Therefore, despite the different styles and demands, regarding the results of the IPAQ questionnaire (Table 5), the workload seemed to be very similar between groups. Thus, the number of styles did not interfere with the results.

Regarding the MC results, it had already been expected that dancers would stand out in the locomotion tests because, among all the skills, locomotion abilities were those that they stimulated most. These abilities allow to identify body or body part position in space, to tune movements in space and time, to react promptly to different situations, to maintain balance even in difficult conditions, and to perform movements with predetermined rhythms. The results obtained by the dancers in horizontal jump may be due to the frequency with which they performed movement projection, to the techniques mastered, and to working with exercises that gave the opportunity to move in large displacements with amplitude [34]. Although it is not a regular movement in classical style, the horizontal jump can be the basis for all their horizontal projections, as the plié. On the other hand, although the dancers stimulated speed and agility, this was not enough to reach the reference values in the shuttle run test. Moreover, it is known that children and youth can present variations in the level of performance of certain fundamental motor skills depending on the demands of each context [35]. Therefore, motor skills, besides being determined by maturation, can also be influenced by practice, motivation, and instruction [36].

Goodway et al. [37] used the expression 'phylogenetic' to characterize locomotor skills and 'ontogenetic' to describe manipulative skills, arguing that the former are easier to perform in any space and at any time, unlike the latter, which require materials and spaces of their own. In the case of manipulative skills, if their development in girls is not properly stimulated during the early ages, when they are more permeable to their acquisition, their degree of competence in these skills may decrease with increasing age; in adolescence, learning with sports involving balls becomes much more complex, with repercussions on motor literacy and lifestyles [38]. For this reason, the dancers in the present study did not obtain favourable results in the manipulation tests since manipulative skills are those that they were not used to stimulating. The same is true for the stabilization tests, as there was not enough stimulation in the subjects' practices of this type of skill, both for lateral jumps and plate transposition. Moreover, the latter test has a greater complexity owing to the requirement of multiple abilities of several body elements in relation to the others [39]. Regarding PF, dance is characterized as a type of intermittent exercise, requiring energy from different metabolic pathways (aerobic and anaerobic, lactic or alactic). The maximum aerobic capacity of a dancer may be related to their dance style, the level of technical skill, and the role the dancer may have in a dance company. However, the cardiorespiratory demands of dancers during dance classes (primarily aimed at developing technical skills) are significantly lower than during dance performances, which indicates that there is a divergence between dance training and performance with regard to the PF demands of dancers. Although the dancers in this study were assessed at a time when they were preparing for shows and performances, they were evaluated in a classroom setting [40]. This can justify why they did not obtain favourable values in aerobic fitness tests.

It was concluded that supplemental physical training, in addition to the varied styles practised, is necessary to optimize dancers' abilities. Aerobic and strength training is commonly used to cover this possible lack of fitness in dancers. However, it seems likely that high-intensity interval training more adequately meets the requirements of today's choreographies. In the case of MC, dancers may not be highly interested in stimulating their manipulative skills; yet, it would be noteworthy if dancers started to include new stabilization stimuli as these may help complement their respective training and, consequently, improve their performance.

As a final reflection, it would be interesting to explore this issue further in the context of MC to understand, in fact, what is needed for dancers from different areas to still develop and in what way this development will bring benefits in their performances; this emphasizes the fact that all dancers should be evaluated, not only those specialized in the classical dance area.

Despite the study shortcomings, associated with the large differences in the participants' age and the small sample size, this research allowed for a descriptive analysis that had not previously been done among dancers, thus adding to the diversity of the literature. Furthermore, it is suggested for future studies that these same methods be tested but with a specialized group in the area, such as professional dance companies, as it is believed that in this way, the results will be more cohesive and precise.

As mentioned above, the study limitations involved a small sample size and a very wide age range of the participants (the within-group age difference was very significant as a 13-year-old was compared with a 31-year-old).

Conclusions

The results of the study allow to conclude that, although it had already been expected that the dancers would obtain better results in the locomotion tests, they only fell within the reference ranges of MC in one of the tests: horizontal jump. In none of the analysed variables were statistically significant differences found between the groups of dancers who practised 3 or fewer styles and those who practised 4 or more. Despite the results and the fact that the study involved a reduced sample in a single moment of evaluation, the MET-min/week data suggest that the dancers were considered physically active.

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Conflict of interest
The authors state no conflict of interest.

References
1. Ansaloni AS, do Carmo Salles JG, da Silva LC, Rosado DG, Sodré da Silva FA. Training program for professional dancers of contemporary dance – Grupo Êxtase de dança, Viçosa – MG [in Portuguese]. Coleção Pesquisa em Educ Física. 2008;7(3):337–344.
2. Darby LA, Garret K. Physiology of dance [in Portuguese]. A Ciência; 2001.
3. Santana CCA, Azevedo LB, Cattuzzo MT, Hill JO, Andrade LP, Prado WL. Physical fitness and academic performance in youth: a systematic review. Scand J Med Sci Sports. 2017;27(6):579–603; doi: 10.1111/sms.12773.
4. Vaccari F, Fiori F, Bravo G, Parpinel M, Messina G, Malavolta R, et al. Physical fitness reference standards in Italian children. Eur J Pediatr. 2021;180(6):1789–1798; doi: 10.1007/s00431-021-03946-y.
5. Grego LG, Monteiro HL, Gonçalves A, Padovani CR. Physical fitness and health of dance practitioners and school children [in Portuguese]. Salusvita. 2006;25(2): 185–200.
6. Prati SRA, Prati ARC. Levels of physical fitness and analysis of posture tendencies in classic ballerinas [in Portuguese]. Rev Bras Cineantropom Desempenho Hum. 2006;8(1):80–87; doi: 10.1590/%25x.
7. King-Dowling S, Proudfoot NA, Cairney J, Timmons BW. Motor competence, physical activity, and fitness across early childhood. Med Sci Sports Exerc. 2020;52(11): 2342–2348; doi: 10.1249/MSS.0000000000002388.
8. Gomes AR. Influence of psychological factors in the teaching and learning of motor skills [in Portuguese]. In: Machado AA, Gomes AR (eds.), Sports psychology: from school to competition [in Portuguese]. Várzea Paulista: Fontoura 2011; 213–248.
9. Kim GH, Ogawa T, Sekiguchi H, Nakazawa K. Acquisition and maintenance of motor memory through specific motor practice over the long term as revealed by stretch reflex responses in older ballet dancers. Physiol Rep. 2020;8(2):e14335; doi: 10.14814/phy2.14335.
10. Steinberg N, Siev-Ner I, Peleg S, Dar G, Masharawi Y, Zeev A, et al. Injuries in female dancers aged 8 to 16 years. J Athl Train. 2013;48(1):118–123; doi: 10.4085/1062-6050-48.1.06.
11. Mayes S, Ferris A-R, Smith P, Garnham A, Cook J. Bony morphology of the hip in professional ballet dancers compared to athletes. Eur Radiol. 2017;27(7):3042–3049; doi: 10.1007/s00330-016-4667-x.
12. Wewege MA, Ward RE. Bone mineral density in pre-professional female ballet dancers: a systematic review and meta-analysis. J Sci Med Sport. 2018;21(8):783–788; doi: 10.1016/j.jsams.2018.02.006.
13. Assumpção ACR. Classic ballet and contemporary dance in human development: paths to freedom [in Portuguese]. Pensar Prat. 2003;6:1–19; doi: 10.5216/rpp.v6i0.52.
14. Abbott RA, Davies PSW. Habitual physical activity and physical activity intensity: their relation to body composition in 5.0–10.5-y-old children. Eur J Clin Nutr. 2004;58(2):285–291; doi: 10.1038/sj.ejcn.1601780.
15. Aires Soares ÍA, de Lucena Martins CM, Nobre GC, Cattuzzo MT. Evidences of construct validity, criteria and validation of the Motor Competence Assessment battery of tests in preschoolers. J Phys Educ. 2020;31(1): e3176; doi: 10.4025/jphyseduc.v31i1.3176.
16. Henriques-Neto D, Minderico C, Peralta M, Marques A, Sardinha LB. Test-retest reliability of physical fitness tests among young athletes: the FITescola® battery. Clin Physiol Funct Imaging. 2020;40(3):173–182; doi: 10.1111/cpf.12624.
17. Robinson LE, Stodden DF, Barnett LM, Lopes VP, Logan SW, Rodrigues LP, et al. Motor competence and its effect on positive developmental trajectories of health. Sports Med. 2015;45(9):1273–1284; doi: 10.1007/s40279-015-0351-6.
18. Duda JL. Motivation in sport: the relevance of competence and achievement goals. In: Elliot AJ, Dweck CS (eds.), Handbook of competence and motivation. New York: Guilford Press; 2005; 318–335.
19. Villwock G, Valentini NC. Perceived competence, motivational orientation and motor competence in public schools children: developmental and correlational study [in Portuguese]. Rev Bras Educ Fis Esp. 2007;21(4): 245–257; doi: 10.1590/S1807-55092007000400001.
20. Carter CW, Micheli LJ. Training the child athlete: physical fitness, health and injury. Br J Sports Med. 2011; 45(11):880–885; doi: 10.1136/bjsports-2011-090201.
21. Souza MS, Spessato BC, Valentini NC. Do perceived motor competence and body mass index influence physical activity levels? [in Portuguese]. Rev Bras Ci Mov. 2014;22(2):78–86; doi: 10.18511/0103-1716/rbcm.v22n2p78-86.
22. Berleze A, Haeffner LSB, Valentini NC. Motor performance of obese children: an investigation of the process and product of basic motor abilities [in Portuguese]. Rev Bras Cineantropom Desempenho Hum. 2007;9(2):134–144; doi: 10.1590/%25x.
23. Stodden DF, Goodway JD, Langendorfer SJ, Roberton MA, Rudisill ME, Garcia C, et al. A developmental perspective on the role of motor skill competence in physical activity: an emergent relationship. Quest. 2008;60(2): 290–306; doi: 10.1080/00336297.2008.10483582.
24. Lee PH, Macfarlane DJ, Lam TH, Stewart SM. Validity of the International Physical Activity Questionnaire Short Form (IPAQ-SF): a systematic review. Int J Behav

Nutr Phys Act. 2011;8:115; doi: 10.1186/1479-5868-8-115.
25. Dumith SC, Maciel FV, Borchardt JL, Alam VS, Silveira FC, Paulitsch RG. Health predictors and conditions associated to moderate and vigorous physical activity among adults and elderly from Southern Brazil [in Portuguese]. Rev Bras Epidemiol. 2019;22:e190023; doi: 10.1590/1980-549720190023.
26. Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, et al. International Physical Activity Questionnaire: 12-country reliability and validity. Med Sci Sports Exerc. 2003;35(8):1381–1395; doi: 10.1249/01.MSS.0000078924.61453.FB.
27. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, et al. Compendium of physical activities: an update of activity codes and MET intensities. Med Sci Sports Exerc. 2000;32(9 Suppl.):S498–S504; doi: 10.1097/00005768-200009001-00009.
28. Haskell WL, Lee I-M, Pate RR, Powell KE, Blair SN, Franklin BA, et al. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Circulation. 2007;116(9):1081–1093; doi: 10.1161/CIRCULATIONAHA.107.185649.
29. Fan M, Lyu J, He P. Chinese guidelines for data processing and analysis concerning the International Physical Activity Questionnaire [in Chinese]. Zhonghua Liu Xing Bing Xue Za Zhi. 2014;35(8):961–964.
30. Vetter TR. Fundamentals of research data and variables: the devil is in the details. Anesth Analg. 2017;125(4): 1375–1380; doi: 10.1213/ANE.0000000000002370.
31. Rodrigues LP, Luz C, Cordovil R, Bezerra P, Silva B, Camões M, et al. Normative values of the motor competence assessment (MCA) from 3 to 23 years of age. J Sci Med Sport. 2019;22(9):1038–1043; doi: 10.1016/j.jsams.2019.05.009.
32. Ferraz OL. Physical education at school: knowledge and specificity of the pre-school issue [in Portuguese]. Rev Paul Educ Fis. 1996;Suppl. 2:16–22; doi: 10.11606/issn.2594-5904.rpef.1996.139639.
33. Costa CVF. Dancing with pain: a qualitative study on the experience of classical dancers [in Portuguese]. Porto: Universidade Fernando Pessoa; 2017.
34. Mendonça LL. Classical dance technique in contemporary performance [in Portuguese]. Lisbon: Instituto Politécnico de Lisboa; 2013.
35. Nazario PF, Vieira JLL. Sport context and the motor development of children. Rev Bras Cineantropom Desempenho Hum. 2014;16(1):86–95; doi: 10.5007/1980-0037.2014v16n1p86.
36. Pinto Duarte J. Motor development [in Portuguese]. J Pediatr. 1974;39:267–269.
37. Goodway JD, Robinson LE, Crowe H. Gender differences in fundamental motor skill development in disadvantaged preschoolers from two geographical regions. Res Q Exerc Sport. 2010;81(1):17–24; doi: 10.1080/02701367.2010.10599624.
38. Quitério A, Costa J, Martins M, Martins J, Onofre M, Gerlach E, et al. Physical education: assessing motor skills in 6-year-old, first-year pupils [in Portuguese]. Retos. 2017;31:259–263; doi: 10.47197/retos.v0i31.53500.
39. Nunes AS, Kemper C, Lemos CAF. The effect of classes in volleyball improves motor coordination of children of early years [in Portuguese]. Vivências. 2011;7(13):155–162.
40. Rodrigues-Krause J, Krause M, Reischak-Oliveira Á. Cardiorespiratory considerations in dance: from classes to performances. J Dance Med Sci. 2015;19(3):91–102; doi: 10.12678/1089-313X.19.3.91.