

Study of the body dimensions of elite professional ballet dancers

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ABSTRACT

The similarities and differences in the body dimensions of a group of ballet dancers compared with those of modern or folklore dances are indicators of corporal heterogeneity or homogeneity and of the spatial volume occupied by a group of dancers. The present study aimed to analyze the kinanthropometric similarities and differences among elite professional ballet dancers compared with modern and folklore dancers. The anthropometric profiles of dancers from the National Ballet, National Dance and National Folkloric companies in Cuba were determined. Following the selection criteria of expert teachers on figure and technical-artistic performance, the best dancers, aged between 18 and 40 years, were measured. To determine body dimensions, an anthropometric protocol of 16 measurements was applied. There was lesser variability in stature in both male and female ballet dancers than in modern and folklore dancers. Female ballet dancers occupied a smaller physical space than female modern and folklore dancers, while male folklore dancers occupied a larger physical space than male ballet dancers. The differences found among the three kinds of dancers revealed greater corporal homogeneity among ballet dancers.

KEY WORDS: Somatology. Kinanthropometry. Body dimensions.

RESUMEN

Las diferencias o similitudes referidas a los tamaños absolutos de un grupo de bailarines de ballet frente a bailarines de danza moderna y folclórica son indicadores de variabilidad o de la homogeneidad corporal y de la expresión del volumen espacial que ocupa un grupo de danzantes. Este trabajo se propuso analizar las similitudes y las diferencias cineantropométricas de los tamaños absolutos entre los bailarines profesionales de elite de ballet respecto a los de danza moderna y folclórica. Se estudiaron antropométricamente bailarines de las compañías Ballet Nacional, Danza Nacional y Folclórico Nacional de Cuba. Siguiendo el criterio de selección de los maestros, en cuanto a figura y desempeño técnico artístico, se midieron los mejores bailarines de cada compañía, con edades entre 18 y 40 años. Para determinar los tamaños absolutos se aplicó un protocolo antropométrico de 16 mediciones. Se obtuvo una variabilidad de la estatura reducida en los bailarines de ballet de ambos sexos respecto a los de danza moderna y folclórica. La bailarina de ballet ocupó un espacio físico menor que la bailarina de danza moderna y folclórica, en tanto que los varones de danza folclórica ocuparon un volumen mayor en el espacio físico que los de ballet. Las diferencias cuantificadas entre los tres tipos de bailarines refieren una homogeneidad corporal mayor para los de ballet.

PALABRAS CLAVE: Somatología. Cineantropometría. Tamaños absolutos.

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INTRODUCTION

Expert dance teachers empirically describe the morphofunctional similarities and differences between ballet dancers and modern and folklore dancers. The degree to which these differences manifest themselves, rather than the numerous physical similarities, is fundamental, as these differences allow us to identify and empirically define dancers from one style of dancing or another. The dancer's morphofunctional differences are also the physical manifestation of the selection processes, training and professional performance associated with each dance style.

All aspiring dance students must undergo an initial morphofunctional assessment and are classified depending on the final mark.¹ The morphofunctional assessment does not specify the differences between modern or folklore dancers compared with ballet dancers.

The type of technical-artistic work that students and professional dancers do depends on the style of dance.² The specific training involved is reflected in the morphofunctional changes that a dancer experiences during his/her professional education³⁻⁵ which are observed by teachers from the field of dance who are responsible for producing professional elite dancers that are morphofunctionally different depending on the style of dance they specialise in. The training programs have different technical objectives that specifically mould the shape and volume of the soft tissues and the growth of bone segments.⁶⁻⁸

The fundamental role of the dance teacher in the selection, training and professional development of the dancer is to ensure that the morphofunctional differences are compatible with the aesthetic standard set and the technical-artistic level of performance associated with each style of dancing.

Unlike the ballet teacher's qualitative morphofunctional assessment, the kinanthropometric analysis of a ballet dancer should examine the extent of the morphofunctional similarities and differences with regard to other dance styles. Only with this information will it be possible to reliably judge the kinanthropometric characteristics of professional ballet dancers. This leads to the following question: "Which morphofunctional characteristics differentiate ballet dancers from modern and folklore dancers?" This question can only be answered from a kinanthropometric perspective by assessing each element separately, given that the methods used in different studies do not permit a holistic analysis.^{9,10}

The similarities or differences of the body dimensions of a group of ballet dancers compared with those of a modern and

folklore dance group should be studied as indicators of variability or physical homogeneity and of the space occupied by a group of dancers.

The empirical evidence of greater morphological linearity in ballet dancers is directly linked to being narrower in size compared to dancers from other disciplines. Consequently, the question "Do ballet dancers have narrower measurements than modern and folklore dancers?" is a pertinent one given that it links a specific trend with significant empirical evidence regarding the qualitative assessment of aesthetic standards.

The length values (height, sitting height, arm length) express the vertical dimensions of the dancer, while the relationship between these values and the transverse body dimensions indicates greater or lesser morphological linearity for the dancer.

Elite dancers should physically be very similar or the same as they represent an aesthetic standard on stage that is limited in range, with a maximum of one or two options for each element that defines it. However, modern and folklore dancers exhibit a wider variability of body types considered aesthetically beautiful for artistic expression of dance movements. This raises the following question: "Are ballet dancers more homogenous in their body dimensions than modern and folklore dancers?" The answer to this question would throw light on the types of differences that exist between the groups and the extent to which they are apparent.

The aim of this study is to analyse the kinanthropometric similarities and differences of the body dimensions of elite professional ballet dancers compared with modern and folklore dancers.

MATERIALS AND METHODS

Cross-sectional studies were carried out on professional Cuban ballet dancers from the BNC, DNC and CNF. Expert dance teachers selected the best dancers from each company according to aesthetic standards and technical-artistic performance, and the kinanthropometric study was carried out in these subjects (table I.)

This was done in accordance with the applicable ethical principles (Declaration of Helsinki 1975) that provide guidance in medical research involving human beings. The subjects were informed of the objectives of the study and written consent to participate was obtained.

The anthropometric measurements were obtained using the standardised procedures established by Lohman et al in 1988.¹¹ The anthropometric data set used was made up of 16

Table I Dancers studied from each professional dance company

Professional company	Sample size	
	Female	Male
Cuban National Ballet	10	10
Cuban National Dance Company	13	12
Cuban National Folkloric Company	9	9

measurements: weight, standing height, sitting height, arm length; breadth: biacromial, biiliac, humerus, femur; circumferences: arm relaxed, arm flexed and tense, forearm, chest, waist, hip, thigh at the midpoint, maximum thigh circumference.

The statistical software package SPSS 10.5 for Windows was used for the statistical analysis. Variables were normally distributed according to the sex of the dancers from each style of dancing. The ballet dancers' indicators were statistically compared with those of modern and folklore dancers using the Student's t- test for independent samples ($p < 0.05$.)

RESULTS

Tables II and III show the body dimensions of the groups studied as well as the univariate comparisons ($p < 0.05$) of the ballet dancers compared with the modern and folklore dancers.

Weight and height

Significantly lower absolute body weight values were recorded for female ballet dancers compared with female folklore dancers. Results for the female ballet dancers indicated smaller standard deviation and body weight range (7.9kg), in comparison with the modern (14.1kg) and folklore dancers (14.0kg.) The positive or negative variations, in relation to the mean value for modern and folklore dancers, are practically the same as the total range of variation of body weight in female ballet dancers.

The results for male ballet dancers showed even smaller standard deviation and a smaller body weight range (15.2kg) compared with modern and folklore dancers. The weight values of lightest ballet dancers did not overlap with those of modern and folklore dancers and a maximum difference in weight of 6.1kg was recorded.

In height, female ballet dancers presented a small standard deviation and a smaller range of variation (9.5cm) in comparison with modern and folklore dancers. The majority of female ballet dancers fall within the 160.0-164.0cm height interval. Female modern and folklore dancers were statistically similar in height; folklore dancers were taller. All male ballet dancers measured over 170.0cm in height, with the lowest range of variation (12.5cm) out of all the different dancers.

Length, breadth and circumference measurements

Similar standard deviation values and ranges for sitting height and biiliac breadth were recorded for female ballet dancers and modern and folklore dancers. Similarities with folklore dancers were only limited to the biacromial breadth values, since the humerus and femur breadths of these dancers were greater and statistically significant.

The arm length results consisted of a lower range of values (4.3cm) in ballet dancers compared with modern dancers (8.0cm) and folklore dancers (11.6 cm.) The mean values, standard deviation and ranges for most of the circumference measurements were smaller for female ballet dancers.

Standard deviation and the ranges of biacromial, humerus and femur breadth measurements were similar for all types of dancers. These variables were also similar to those of modern dancers in the arm length results, but different for folklore dancers as their results showed greater intervals (12.6cm.) In sitting height and biiliac breadth the ranges obtained for modern dancers were greater than those of ballet dancers; folklore dancers obtained the same results in biiliac breadth. The relaxed arm, forearm, thigh at midpoint, chest and waist circumferences were similar in range for both the modern dancers and ballet dancers; although the flexed arm and hip circumferences were greater for the former. The results for folklore dancers indicated greater intervals in all circumferences except in maximum thigh circumference.

DISCUSSION

Weight and height

The absolute body weight is a figure of little relevance when evaluating whether a ballet dancer is *bulky or lean*.¹² In the field of dance, the empirical evidence surrounding *leaner* ballet dancers is often linked to preconceived ideas about lower body weight.¹³ These ideas exist because of a tendency to establish a direct link between being lean and having a

Table II Body dimensions of elite ballet dancers from the BNC, DNC and CFN companies

Body dimensions	Female			independent t-test	
	BNC (n = 10)	DNC (n = 13)	CFN (n = 9)	Versus DNC	Versus CFN
	Mean \pm SD; min-max	Mean \pm SD; min-max	Mean \pm SD; min-max	Sig.	Sig.
Weight (kg)	48.9 \pm 2.4; 44.7-52.6	51.4 \pm 4.6; 43.2-57.3	56.1 \pm 4.2; 47.5-61.5	NS	**
Height (cm)	161.9 \pm 2.5; 157.0-166.5	163.2 \pm 5.8; 151.8-173.2	166.1 \pm 3.4; 160.9-171.2	NS	**
Sitting height (cm)	86.6 \pm 1.7; 83.5-88.5	85.8 \pm 2.1; 82.7-89.1	87.8 \pm 2.1; 84.2-90.3	NS	NS
Arm L. (cm)	68.40 \pm 1.4; 66.2-70.5	70.5 \pm 3.5; 64.9-76.5	72.2 \pm 2.4; 67.3-75.3	NS	NS
Biacromial B. (cm)	34.8 \pm 1.5; 32.7-37.9	36.5 \pm 1.5; 34.2-39.2	36.8 \pm 1.7; 34.4-39.9	**	NS
Billiac B. (cm)	26.6 \pm 0.7; 25.1-27.8	26.2 \pm 1.3; 24.0-28.2	26.4 \pm 1.1; 25.3-29.0	NS	NS
Humerus B. (cm)	5.8 \pm 0.2; 5.4-6.1	5.8 \pm 0.3; 5.3-6.2	6.0 \pm 0.2; 5.6-6.5	NS	**
Femur B. (cm)	8.6 \pm 0.3; 8.0-8.9	8.5 \pm 0.3; 8.0-9.0	8.9 \pm 0.3; 8.2-9.2	NS	**
Rel. arm C. (cm)	21.1 \pm 0.7; 19.7-22.0	22.5 \pm 1.4; 20.5-24.1	23.8 \pm 1.5; 21.1-26.1	**	**
Forearm C. (cm)	20.3 \pm 0.6; 19.3-21.1	21.3 \pm 1.0; 19.0-23.2	22.4 \pm 1.1; 20.9-24.1	**	**
Flex. arm C. (cm)	22.5 \pm 1.1; 21.2-24.5	25.2 \pm 1.3; 23.6-26.9	26.0 \pm 1.5; 23.2-28.2	**	**
Chest C. (cm)	76.7 \pm 1.9; 74.3-80.0	79.4 \pm 2.2; 75.3-82.1	80.9 \pm 3.4; 76.4-85.2	**	**
Waist C. (cm)	60.7 \pm 2.0; 58.2-64.6	63.1 \pm 2.8; 57.5-67.4	65.8 \pm 2.3; 63.2-70.1	**	**
Hip C. (cm)	83.9 \pm 1.9; 81.5-86.5	86.7 \pm 2.7; 81.5-89.6	90.7 \pm 4.0; 82.8-96.9	**	**
Thigh midpoint. C. (cm)	48.1 \pm 2.1; 44.5-51.2	48.6 \pm 2.6; 45.5-55.8	50.5 \pm 3.2; 44.8-55.1	NS	NS
Maximum thigh C. (cm)	33.6 \pm 1.3; 31.5-35.5	33.6 \pm 1.7; 30.1-35.8	34.5 \pm 4.0; 31.4-44.6	NS	NS

** p < 0.05

C: circumference; B.: breadth; flex.: flexed and tense; L.: length; rel.: relaxed; sig.: significance.

lower body weight.¹⁴ The data highlights that female ballet dancers are the *leanest*. The wide range of body weights in modern and folkloric dance is linked to the possibility of being able to occupy a greater physical volume within a space than ballet dancers are able to. These results do not imply a link between modern/folkloric dancing and *gracelessness or bulkiness*, but they do imply a different standard of morphological linearity.

With regard to male ballet dancers with a body weight below 60.0kg, these are generally classified as *very thin, weak and less masculine*. This classification is also applied in modern and folkloric dance because it is directly associated with a limited increase in muscle mass affecting dancers of any height. The body weight range for male ballet dancers was lower which indicates a greater probability of occupying a smaller space in terms of the audience's two-dimensional viewing perspective.¹⁵

With regard to height, the majority of female ballet dancers generally found themselves between the 50-75 percentile of the Cuban population.¹⁶ Results for female ballet dancers from international companies indicate average height values of 165.9¹⁷ and 168.0cm.¹⁸ The wide range in height variation among modern dancers (21.4cm) confirmed the limited value of this measurement when evaluating aesthetic standards in the field of dance.

There are defined height ranges for professional ballet dancers in the BNC: 157.0- 171.0cm for women and 170.0-183.0cm for men.¹⁹ The DNC and CFN dance companies do not impose height restrictions for aspiring dancers, while in the BNC it is used as an inclusion/exclusion mechanism. However, teachers of modern and folkloric dance use the terms *average, short or tall* when referring to dancers, which indicates that height is important when selecting positions and couples in an artistic choreography (information supplied by Miguel Iglesias

Table III Body dimensions of elite ballet dancers from the BNC, DNC and CFN companies

Body dimensions	Male			independent t-test	
	BNC (n = 10)	DNC (n = 12)	CFN (n = 9)	Versus DNC	Versus CFN
	Mean \pm SD; min-max	Mean \pm SD; min-max	Mean \pm SD; min-max	Sig.	Sig.
Weight (kg)	67.8 \pm 5.3; 61.0-76.2	64.7 \pm 6.4; 54.9-73.7	69.9 \pm 9.9; 55.9-88.6	NS	NS
Height (cm)	176.1 \pm 3.8; 170.9-183.4	173.8 \pm 4.1; 165.1-180.0	175.8 \pm 5.7; 165.5-183.2	NS	NS
Sitting height (cm)	92.3 \pm 1.7; 88.7-94.7;	91.4 \pm 2.9; 85.4-95.7	91.1 \pm 2.4; 87.5-94.6	NS	NS
Arm L. (cm)	77.2 \pm 2.7; 73.9-81.0	76.0 \pm 2.8; 71.7-82.0	79.2 \pm 6.1; 71.6-91.8	NS	NS
Biacromial B. (cm)	40.8 \pm 1.0; 39.2-42.4	40.3 \pm 1.5; 37.9-42.6	40.6 \pm 1.8; 37.0-42.6	NS	NS
Billiac B. (cm)	27.2 \pm 0.7; 26.4-28.5	26.5 \pm 2.1; 22.3-29.3	27.0 \pm 1.6; 24.8-29.1	NS	NS
Humerus B. (cm)	7.0 \pm 0.3; 6.4-7.5	6.8 \pm 0.3; 6.4-7.2	7.0 \pm 0.4; 6.4-7.7	NS	NS
Femur B. (cm)	9.5 \pm 0.5; 9.1-10.5	9.5 \pm 0.5; 8.8-10.4	9.9 \pm 0.6; 9.0-11.1	NS	NS
Rel. arm C.(cm)	28.1 \pm 1.3; 26.4-30.0	28.2 \pm 1.7; 25.9-31.3	29.7 \pm 2.9; 24.7-34.7	NS	NS
Forearm C. (cm)	25.7 \pm 1.2; 23.7-27.5	26.1 \pm 1.8; 23.3-28.8	27.1 \pm 2.1; 23.1-29.9	NS	NS
Flex arm C. (cm)	30.6 \pm 1.3; 28.7-32.0	31.9 \pm 1.6; 29.3-34.4	32.6 \pm 3.4; 26.2-37.8	NS	NS
Chest C. (cm)	94.0 \pm 2.8; 90.0-97.7	91.5 \pm 2.9; 87.0-96.9	96.2 \pm 5.0; 89.8-105.2	NS	NS
Waist C. (cm)	73.2 \pm 2.2; 69.5-77.8	71.9 \pm 3.1; 66.6-75.8	74.9 \pm 3.8; 70.0-81.9	NS	NS
Hip C. (cm)	88.1 \pm 2.0; 84.3-90.4	88.3 \pm 4.0; 82.0-92.8	91.4 \pm 6.1; 83.4-103.8	NS	NS
Thigh midpoint C. (cm)	53.4 \pm 2.5; 49.0-56.8	52.5 \pm 2.5; 47.6-56.3	53.7 \pm 3.6; 48.4-61.4	NS	NS
Maximum thigh C. (cm)	37.7 \pm 1.9; 34.9-40.0	35.4 \pm 1.8; 32.0-38.9	36.6 \pm 2.4; 31.4-39.3	**	NS

** p < 0.05

C: circumference; B.: breadth; flex.: flexed and tense; L.: length; rel.: relaxed; sig.: significance.

and Manolo Micler, directors of the DNC and CFN respectively.)

The wide range of heights among female modern dancers enable us to distinguish them from elite ballet dancers given that dancers that measure less than 157.0cm are not allowed to be part of the BNC. Height ranges among female folklore dancers were greater and fell within in the normal height range of the BNC. Consequently, the mean values of the elite female folkloric dancers are the values that differentiate them as *taller* when compared with ballet dancers. Few *tall* and *very tall* female ballet dancers have excelled in technical-artistic performance in history of Cuban ballet, a fact which is consistent with the limited subrange of height values for elite ballet dancers.

Height variability was reduced among male ballet dancers. The minimum height of male dancers that specialised in other styles of dancing was 165.0cm which would completely

exclude them from becoming professional dancers in the BNC.

This data confirmed that aesthetic standards in relation to height apply to ballet dancers in a different way in comparison with modern and folklore dancers. All the ballet dancers that were selected by the teachers were within the height range of the BNC. The mean values of ballet dancers of both sexes were similar to those recorded by Martínez et al (1989)²⁰ for professional dancers of the BNC: 160.6 \pm 4.20cm for women and 174.8 \pm 3.8cm for men. In this investigation, the height variation among women included the < 157.0cm range which by today's standards would not be accepted. Betancourt (1985)²¹ referred to mean heights of 164.2cm for women and 171.5cm for men in the DNC, which confirm height assessment in modern Cuban dance at that time.

Length, breadth and circumference measurements

Since similar ranges of sitting height values were obtained for all groups of female dancers, it is likely that the absolute leg length of the three different types of dancers is similar, although a proportional analysis could produce different results.

Greater homogeneity in the arm length of female ballet dancers reflects the influence that physical size has on ballet technique, given that the arms play a crucial role in maintaining balance en pointe as well as in technical-artistic coordination. The greater variations in arm length and the significant differences in the mean humerus breadth values indicate longer and wider arms at the midpoint (elbow) in folkloric dancers when compared with ballet dancers.

The biacromial and biiliac breadth values for ballet and modern dances indicated a different variability in *torso width*. For a ballet dancer, a *wider* shape incompatible with the aesthetic standard given that larger dimensions and increased width are associated with *bulkiness*. Female modern dancers on average were considered *more* broad-shouldered, and would be regarded as *bulky* according to ballet standards. The wide range in variability, as well as the statistical similarity, in terms of biiliac breadth increases the likelihood of female modern dancers having trapezoid-shaped torsos.

The absolute differences in femur length confirmed a *greater knee width* among female folkloric dancers compared with ballet dancers. A wide femur would cause aesthetic problems for a ballet dancer as it would affect the *line of the leg**, because a large knee interrupts the linearity of the leg. Folklore dancers generally wear costumes that cover the knees, and the differences observed in folklore dancers are compatible with the aesthetic standard regarding the *line of the leg* because aesthetic standards in folkloric dance and ballet are different.

The leg circumference measurements highlighted the most important differences as anthropometric hip and thigh measurements indicated greater *bulkiness* among female modern and folklore dancers. Many female modern and folklore dancers have more volume around the hips than ballet dancers. The statistical similarities between the circumference measurement of the thigh at the midpoint and the maximum thigh circumference did not minimise the significant differences between the more homogenous ballet dancers and the other dancers.

Higher volumes of soft tissue on the torso and arms were more common among modern and folklore dancers compared to ballet dancers. The greater hip circumference of modern and folklore dancers indicates a break with the *bulky/lean line of the*

leg concept in ballet. In conclusion, the conceptualisation of the aesthetic standard, that includes *bulkiness/leaness*, is different for a ballet dancer in relation to other types of dancers. In this study the female ballet dancer occupied a smaller physical space than the modern and folkloric dancers.

The fact that male modern dancers had the lowest range of leg lengths makes it possible to deduce that the visual impact of having *less stage presence*, linked to a shorter absolute length of this part of the body, is minimal in this type of dance.

The homogeneity of hip widths among male ballet dancers contributed to the only torso shape (trapezoidal) and the range of greater biacromial breadth values was smaller. Modern and folklore dancers have a wider range of biiliac breadth measurements which manifest themselves in different torso shapes, some of which are classified in ballet as *wide-bulky*, if the torso is also shorter in length. The small range of the biiliac breadth measurements for ballet dancers was the main difference regarding bone measurements and confirms the lack of physical homogeneity among modern and folkloric dancers.

Male modern dancers had torso and arm volumes similar to those of male ballet dancers. The larger leg volume of a modern dancer is probably consistent with less linearity when compared with a ballet dancer given that the difference in circumference measurements indicates an inverted cone-shaped leg. Much higher ranges of soft tissue volume were obtained from male folklore dancers compared with ballet dancers. Folklore dancers probably occupy a greater volume within the physical space than ballet dancers (except the calves.)

The differences observed between the three different types of dancers indicate greater physical homogeneity among ballet dancers. The smallest values from highest range of circumference measurements, as well as the small variability in biacromial and biiliac breadth, are positively linked to the empirical criteria of greater linearity in ballet dancers.

*According to Betancourt et al (2007),¹³ in order for dancer to be able to exhibit a good line of the leg, the leg should be proportionally longer and of a certain size and shape in relation to the hip muscles (these appear flat and only slightly developed), the thighs (slightly developed front upper thigh) and the calves (broad throughout the whole area) which are compatible with aesthetic standards regarding the linearity of this style of dance. The linear relationship between the thigh and calf volumes must be inverted so that the result is the opposite and the leg is no longer visualised as an inverted cone: this is observed when the thigh is very broad and long in relation to a short and lean calf. The linearity of the leg also involves marked hyperextension of the calf, plantar flexion and square-shaped feet which are proportionally large in relation to height.

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