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Sex and body composition influences the Quilombolas strength

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Abstract

Background Studies in ethnic minority communities with social isolation have low genetic variability. Furthermore, assuming that any attempt to determine ageing by chronological cuts is misleading, it is recommended that functional capacity assessments be performed especially during and at the end of adulthood. Specifically, muscle strength performance is an interesting screening measure of functional capacity because of its association with functional level. However, the behaviour of the muscle strength manifestation between sexes and its association with body composition (BC) parameters in a low genetic variability community are unknown. Therefore, the objective of this study was to verify the influence of BC and sex on the handgrip strength of mature remaining Quilombolas.

Methods Seventy Quilombola volunteers of both sexes (♀ = 39; ♂ = 31) were recruited. BC and muscle strength were tested by dual-energy X-ray absorptiometry (DEXA) and handgrip equipment (Jamar), respectively. Correlations between muscle strength and age and BC parameters were determined by Spearman equation. In addition, it has executed comparisons of BC and age between strongest and weakest men and women from the interquartile analysis by Mann–Whitney *U* test. The significance level was adopted: $P \leq 0.05$.

Results Of the 70 remaining Quilombolas, with a mean age 64.6 ± 7.07 years, 55.7% were women with a mean age of 63.77 ± 7.56 years and 44.3% men with 65.65 ± 7.87 years. Statistical differences were identified for all parameters of BC and performance evaluated between men and women, except for the ratio of appendicular and axial fat-free mass ($P = 0.183$). The evaluation of the influence of BC on strength identified that Quilombola men and women have different processes in the decline of strength, considering both the correlation's tests and the comparisons between groups of different degrees of strength.

Conclusions For Quilombola individuals, strength is a variable that can be modulated due to the influence of gender and BC.

Keywords Body composition; Muscle strength; Ageing; Group ethnic

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Introduction

Historically, since the arrival of the Portuguese in the Brazilian coast in 1500 until 1888, Black people were used as a slave labour force. Since that time, in the face of the indignation regarding the unfavourable situation, communities denominated by Quilombolas have emerged in order to constitute resistance to the Black enslavement.[1,2] This was done by means of self-sustaining social movements able to shelter and protect its remaining members until nowadays.[3,4] Throughout Brazilian territory, the main characteristic in the formation of Quilombola communities was isolation and inaccessibility.[5,6] Consequently, it is estimated that the low genetic variability, due to low family frequency in Quilombola communities, restricts the high combinatorial complexity of the various genes[7] that may influence the body composition and functional performance of these individuals.

Human ageing is characterized by decrease of performance of all organic systems in a process modulated by environmental and genetic factors,[8,9] especially those affecting the muscle strength performance, which reveals the nature of functional independence.[10–13] Therefore, on the basis of the assumption that some individuals or even communities are longer and more productive, that[14–16] there are differences in the manifestation of muscular strength performance between the genders, and knowing that performance of muscular strength is associated with several factors such as energy metabolism, autoimmune condition, and, mainly, body composition,[17–20] the objective of the present study was to verify the influence of body composition and sex on strength performance of mature subjects remaining Quilombolas.

Material and methods

Experimental design

This is an observational cross-sectional study composed of a sample of Black Quilombola individuals living in a rural community, near the city of Palmas, TO, Brazil. Participants were invited through the contact of their community leaders. Sample selection was for convenience because of the characteristics of the population belonging to an ethnic minority. Assessments of performance and body composition were performed by different evaluators in order to generate less influence between them.

Sample

Individuals of both genders, 52 years or older, considered physically active and without bone, muscle, and joint problems that could prevent evaluating handgrip strength (HGS) were included. Exclusion criteria were the inability to travel without assistance, existence of any metal prosthesis in the upper limbs, painful upper limb pain, or disease in the central or peripheral nervous system that would make it impossible to understand and/or comply with the controls performed during the evaluations.

Ethical considerations

This study was approved by the Research Ethics Committee of the University Center Euro American in accordance with opinion number 1.771.159. All participants signed the informed consent term.

Procedures

To verify the habitual degree of physical activity of each of the participants, the short version of the International Physical Activity Questionnaire[21] was used. Body mass was measured with 0.1 kg resolution using a digital scale. The waist circumference was performed using an inextensible metric tape of 150 cm, and the measurement was performed using a non-volumetric measuring tape (Filizola), using a stadiometer (CARDIOMED, Brazil). As reference the smallest circumference point between the last floating umbilical scar[22] rib. Body composition was assessed by means of absorptiometry (dual-energy X-ray absorptiometry), GE Lunar DPX brand equipment (Lunar Corporation, Madison, WI, USA). After the removal of metallic fittings, volunteers were placed in supine stance, in a fundamental position at the table, totally centralized in relation to equipment markings. Dual-energy X-ray absorptiometry was calibrated to perform the analysis of body composition of the whole body, fragmented in body fat (BF) mass and fat-free mass (FFM). Appendicular skeleton was isolated from the trunk and head by means of lines generated by the software, which were then manually adjusted according to the body morphology of each evaluated. In this way, it was possible to calculate the value of FFM [appendicular free fat mass (AFFM)], by means of the FFM summation of the lower and upper limbs. Instrument was calibrated at the beginning of each evaluation day, following the manufacturer's recommendations. Calculation of the relationship between MLGA and axial fat-free mass (AxFFM) was performed by the equation of subtracting the AFFM from the total FFM, followed by the division of AFFM by AxFFM, thus estimating the amount of AFFM for each kilogram of AxFFM.

The manual gripper dynamometer Jamar (Sammons Preston Roylan, Bolingbrook, IL, USA), as recommended by the American Society of Hand Therapists,[23] where three measurements were collected for the dominant hand with a 3 min interval for each stimulus. The stimulation then lasted 3–5 s, and verbal incentives were inferred for each subject during their attempts. The subjects were instructed to stand upright, with their elbows extended and the wrist in a neutral position. The highest score among the three attempts was used to assess muscle strength. Relative manual handgrip strength (RHGS) was determined by the ratio between the dominant hand strength scores and total body mass.

Statistical analysis

Statistical analysis was performed using the SPSS package (version 22.0, SPSS, Chicago, IL). Initially, the normal distribution of the sample was verified using the Kolmogorov–Smirnov test. Central trend measures of the continuous data were presented by means and medians, and their variations were expressed by standard deviation and quartile interval, respectively. The categorical variables were presented by absolute or relative frequency. An interquartile analysis of the anthropometric and strength variables was done in order to identify sample parameters for the same. Therefore, it was possible to categorize individuals, regarding FPMR, as weak and strong considering both sexes. In order to identify the possible correlations between AFFM, AxFFM, total FFM, waist circumference, HGS, relative handgrip strength (RHGS), body mass index, body fat percentage (% BF), and AFFM/AxFFM ratio, Spearman's test was used. The value of $P \leq 0.05$ was used for statistical significance.

Results

Of the remaining 70 Quilombolas, with a mean age 64.6 ± 7.07 years, 55.7% were women with a mean age of 63.77 ± 7.56 years and 44.3% men with 65.65 ± 7.87 years. The anthropometric and strength variables of both genders are found in *Table 1*, expressing significant differences for all variables ($P \leq 0.05$), except for the relationship variable between AFFM and AxFFM.

Table 1 Body composition and strength data of remaining Quilombolas stratified by sex and expressed by median and ± QI

	Men (n = 31)	Women (n = 39)	P*
	Median ± QI	Median ± QI	
Age (years)	65.65 ± 10	63.76 ± 10	0.24
BM (kg)	66.4 ± 1.61	63 ± 1.74	0.044
Height (m)	1.65 ± 0.14	1.52 ± 0.08	0.001
AFFM (kg)	21.4 ± 3.7	15.3 ± 3.30	0.001
Body fat (%)	22.2 ± 12.5	40.5 ± 6	0.001
FFM (kg)	51.87 ± 7.31	36.52 ± 6.10	0.001
AxFFM (kg)	29.86 ± 7.15	21.30 ± 3.56	0.001
BMI (kg/m^2)	25.23 ± 3.22	25.55 ± 6.93	0.04
AFFM/AxFFM (kg/kg)	0.42 ± 0.16	0.40 ± 0.1	0.183
WC (cm)	87 ± 5	84 ± 10	0.008
DAFFM (kg)	3 ± 0.7	2.10 ± 0.6	0.001
FFM/FM (kg/kg)	3.5 ± 2.59	1.47 ± 0.35	0.001
RHGS (kgf/kg)	0.48 ± 0.22	0.35 ± 0.10	0.001
HGS (kgf)	31.00 ± 11	22.00 ± 9	0.001

AFFM, appendicular fat-free mass; AxFFM, axial fat-free mass; BM, body mass; BMI, body mass index; DAFFM, dominant arm fat-free mass; FM, fat mass; FFM, fat-free mass; HGS, handgrip strength; QI, quartile interval; RHGS, relative handgrip strength; WC, waist circumference.
*For significant difference, $P \leq 0.05$.

The interquartile analysis identified that men with relative muscle strength below 0.48 kgf/kg body mass were considered weak (n = 16) and when above this value were considered strong (n = 15). The female body composition profile was stratified by RHGS values, where women with a score ≤0.35 kgf/kg were considered weak (n = 20), and those with a higher score were considered strong (n = 19). The comparison of body composition according to the strength classification in remaining Quilombola men and women is shown in *Table 2*.

Correlational tests were also carried out in order to identify mathematical parameters of proportionality between paired numerical variables between the variables of age, body composition, and strength of women (n = 39) and men (n = 31) (*Table 3*). Of the 136 possible correlations, 68 ($P \leq 0.05$) were found significant among the variables of body composition, age, and strength of women. Of these, none were considered negligible ($r < 0.3$), 31 were weak correlations ($r > 0.3$ and <0.5), 18 were considered moderate ($r > 0.5$ and <0.7), and 19 correlations were considered as strong or very strong ($r > 0.7$). In this investigation, 16 inversely proportional and 52 directly proportional correlations were detected.

For analyses made in men, 63 were considered significant ($P \leq 0.05$). Analysing correlations in the group of women, none can be considered negligible ($r < 0.3$), 27 are weak correlations ($r > 0.3$ and <0.5), 24 were considered moderate ($r > 0.5$ er < 0.7), and 12 correlations were considered as strong or very strong ($r > 0.7$). In this investigation, 24 inversely proportional and 39 directly proportional correlations were detected.

Discussion

Several studies have shown that body composition influences muscle strength and other health markers.[24–27] However, hitherto, no studies related to this effect have been conducted on an ethnic group of Afro-American people living in social isolation with little or no intervention of health professionals regarding routine life habits, such as is the case of the Quilombola communities studied.

In the present research, found himself significative difference in muscle strength between men and women, both in absolute HGS (men 31.00 ± 1.9 vs. women 22.00 ± 0.89 kgf, P = 0.001) and in RHGS (men 0.48 ± 0.03 vs. women 0.35 ± 0.01 kgf/kg, P = 0.001). Studies by Vaught[28] and Barry *et al*.[29] show that there is a consensus in the literature regarding the differences of strength between the genders in non-Quilombola elderly. As in other studies, it was decided to equalize muscle strength by total body mass (BM), assuming that body mass differences between the sexes (men 66.4 ± 1.61 vs. women 63 ± 1.74 kg, P = 0.044) are

Table 2 Age and body composition variables according to strength profile of men and women (median ± quartile interval)

	Men		Women	
	Weakest (*n* = 16)	Strongest (*n* = 15)	Weakest (*n* = 20)	Strongest (*n* = 19)
Age (years)*	68 ± 10.75	60 ± 5	64.5 ± 9.75	59 ± 9
Height (m)*	1.7 ± 0.12	1.61 ± 0.07	1.52 ± 0.08	1.52 ± 0.06
BM (kg)*	70.55 ± 12.3	62 ± 7.4	66 ± 13.7	58 ± 11.6
BMI (kg/m^2)**	25.46 ± 2.5	24.24 ± 3.76	28.06 ± 9.71	25.1 ± 3.75
WC (cm)	87 ± 6.5	87 ± 4	87.25 ± 8.13	82 ± 10.5
Body fat (%)	21 ± 14.95	22.9 ± 11.6	41.7 ± 11.53	39.3 ± 3.20
FFM (kg)*	53.28 ± 7.3	48.03 ± 7.67	38.02 ± 3.89	35.04 ± 6.78
AFFM (kg)	22.3 ± 4.18	21 ± 2	16.15 ± 3.5	15 ± 2.7
AFFM (%)*	30.34 ± 3.87	32.55 ± 2.75	24.37 ± 3.56	24.66 ± 3.14
AxFFM (kg)*	31.03 ± 13.61	28.24 ± 10.41	21.65 ± 7.52	20.54 ± 5.25
AxFFM (%)	46.28 ± 2.13	44.26 ± 1.88	33.06 ± 1.37	36.10 ± 0.81
AFFM/AxFFM (kg/kg)	0.72 ± 0.19	0.76 ± 0.15	0.7 ± 0.18	0.67 ± 0.05
FFM/FM (kg/kg)	3.76 ± 0.66	3.37 ± 0.78	1.4 ± 0.13	1.54 ± 0.06
DAFFM (kg)	3.25 ± 0.88	2.8 ± 0.7	2 ± 0.55	2.1 ± 0.7
DAFFM (%)**	4.51 ± 0.7	4.56 ± 0.62	2.96 ± 0.81	3.47 ± 0.45
RHGS (kgf/kg)*,**	0.41 ± 0.22	0.62 ± 0.22	0.31 ± 0.10	0.4 ± 0.12
HGS (kgf)*,**	30 ± 15.25	39 ± 19	19 ± 8.5	27 ± 7

AFFM, appendicular fat-free mass; AxFFM, axial fat-free mass; BM, body mass; BMI, body mass index; DAFFM, dominant arm fat-free mass; FM, fat mass; FFM, fat-free mass; HGS, handgrip strength; RHGS, relative handgrip strength; WC, waist circumference.
*$P \leq 0.05$ for men.
**$P \leq 0.05$ for women.

Table 3 Correlation between the variables age, body composition, and strength of women and men remaining Quilombola (*n* = 70)

		Age	*h*	BM	WC	BMI	% BF	FFM	AFFM	AxFFM	DAFFM	FFM/FM	AFFM/AxFFM	%DAFFM	% AxFFM	%AFFM
HGS	♂	−0.44*	−0.03	0.19	0.40*	0.31	0.51*	−0.23	0.03	−0.31	0.09	−0.51*	0.34	−0.10	−0.48*	0.03
	♀	−0.41*	0.54*	0.35*	0.26	0.13	0.13	0.32*	0.15	0.39*	0.36*	−0.13	0.10	0.19	−0.13	−0.14
RHGS	♂	−0.45*	−0.53*	−0.44*	−0.06	−0.12	0.10	−0.58*	−0.39*	−0.48*	−0.38*	0.74*	0.18	0.02	−0.14	0.19
	♀	−0.27	0.29	−0.23	−0.19	−0.36*	−0.33*	−0.10	−0.22	0.04	0.12	0.74*	−0.09	0.42*	0.27	0.15

AFFM, appendicular fat-free mass; AxFFM, axial fat-free mass; BM, body mass; BF, body fat; BMI, body mass index; DAFFM, dominant arm fat-free mass; FM, fat mass; FFM, fat-free mass; *h*, height; HGS, handgrip strength; RHGS, relative handgrip strength; WC, waist circumference; ♂, men; ♀, woman.
*Significant correlation, $P \leq 0.05$.

responsible for men generating more force than women, a result not found in this study, as well as in studies by Herrnstein[30] and Prestes,[31] where even the relative muscular strength of men is superior to that of women.

When we observe the theory of ageing and the evolution of the tissues that are responsible for the locomotor structures, we can notice the increase of fat tissue and the decreases of muscular and bone tissues in both sexes.[32,33] This phenomenon can, under extreme conditions, generate pathological patterns that interfere in morbidity and co-morbidity, which reduce the general health conditions of older individuals.[24,34–36]

Cachexia and sarcopenia are pathologies with great incidence in individuals older than 60 years.[37–38] Although these pathological outcomes have uncertain aetiology, their pathophysiological processes are well defined.[39,40] In these cases, changes in body composition result in loss of strength, autonomy, and physical independence.[39,41] In previously published studies conducted by our group, we did not identify the presence of any individual, in both genders, with severe sarcopenia.[8,42]

Research has shown that different body composition conditions are responsible for the discrepancies between the magnitudes of strength between men and women, because women carry greater reserves of adipose cells.[35,43] This theory corroborates with the findings identified in this study, because mature Quilombola women obtained a % BF of 40.5 ± 1.03% and men of 22.2 ± 1.41% and a $P = 0.001$. It should be noted that only the group of men meet the recommendations of the American College of Sports Medicine, whereas women are 8% higher than recommended.[44]

There is a theoretical side with good acceptance that attributes the differences of strength and body composition to the sex hormones, in which each sex produces predominantly a different type of hormone, thus generating kinetics of muscular strength development and discrepant body composition.[45–47]

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Because of the great differences between their anatomical and physiological conditions, the comparisons between genders become unviable and with little applicability in the praxis of gerontological attention.[35,48–50] In order to generate clinical inferential power, the comparisons were arbitrarily performed within strong and weak groups of women and men, with a statistical difference ($P \leq 0.05$) of force between them.

The differences between the weakest (RHGS = 0.41 ± 0.03 kgf) and strongest men (RHGS = 0.62 ± 0.03 kgf) were associated with morphological structures of body composition, such as FFM (53.28 ± 1.52 vs. 48.04 ± 1.3 kg), AFFM (30.34 ± 0.65% vs. 32.55 ± 0.77%), and AxFFM (31.03 ± 1.21 vs. 28.24 ± 1.16 kg), respectively ($P \leq 0.05$). These findings corroborate those of Pereira *et al.*,[26] who evaluated elderly Latin Americans regarding changes in body composition. However, the behaviour of the ratio of lean mass and fat mass was different, possibly attributed to the evaluation method used to measure body composition.

There are behaviours of variation of body composition acting in different ways.[35,48,51] In this study, from the comparison between groups, we observed that the amount of absolute FFM and absolute AFFM are antagonistic to the muscle strength showing an inversely proportional correlation. However, this effect can be attributed to the large variation of body mass found among men, even showing a significant difference ($P \leq 0.05$) when the comparison between the weakest men (70.55 ± 2.1 kg) and strongest men (62 ± 2.03 kg), being necessary to perform relative adjustment to obtain comparative inferential power in a supply process.

The correlations between the parameters of muscular strength and height of men and women obtained different results. Women had a positive and significant correlation ($r = 0.54$) for the variables of absolute strength and height. In other words, the higher, the stronger, in terms of absolute strength. This behaviour is not observed in men, because in this group, an inversely proportional behaviour ($r = -0.53$) was identified regarding height and relative muscular strength. Women thus enjoy a mechanical principle where the major lever arm is responsible for generating less force in the displacement of the resistance,[52] because men use the largest amount of muscle per centimetre,[3] thus increasing the physiological cross-sectional area of the muscle.[53,54]

Women group showed that body composition influenced muscle strength (strongest 0.31 ± 0.01 and weakest 0.40 ± 0.01 kgf, $P \leq 0.05$). Therefore, other mechanisms beyond changes in body composition can predict strength in Quilombola women, as well as in a study carried out in another Brazilian city,[55] where it was identified a higher incidence of decreased strength in women due to cultural, economic, and psychological factors. Another study points out that the differences between magnitudes of muscle strength are due to aspects related to economic, social, and cultural factors.[29]

Conclusions

From the findings, it can be concluded that for Quilombola individuals, strength is a variable that can be modulated due to the influence of gender and body composition. Nevertheless, in Quilombola women, the force only obtained correlational influence, not manifesting when we stratified the group according to the magnitude of force. For men, in addition to correlational manifestations, we observed a notable difference between body composition variables and groups of weak and strong men. Also, it was identified that for Quilombola male individuals, body composition variables seem to generate more influence on strength than for Quilombola women in this age group.

In order to identify the influence of body composition on muscle strength, other types of studies should be conducted in this population so that during the life of these individuals, changes in body composition and their responses to force magnitude can be recorded.

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Conflict of interest

And all authors declare no conflict of interest.

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Ethical statement

The authors certify that they comply with the ethical guidelines for publishing in the *Journal of Cachexia, Sarcopenia and Muscle*: update 2017.

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