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RESEARCH ARTICLE

EFFECTS OF A FOUR-WEEK RUNNING TRAINING PROGRAMME ON THE BODY COMPOSITION OF SEDENTARY YOUNG SENEGALESE ADULTS

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ABSTRACT

Introduction: Physical activity without a programme tailored to the individual's state of health and physical condition constitutes a risk for sedentary adults. ***Objective:*** To study the effects of a 4-week running training programme on body composition and resting heart rate in sedentary subjects. ***Protocol:*** 12 sedentary Senegalese adults underwent a 4-week running training programme with 4 sessions per week. Body composition parameters and resting heart rate were assessed before and after training. ***Results:*** With the exception of subscapular skin fold and calf circumference, all the body composition variables studied (weight, fat percentage, fat mass, lean mass, body mass index, bicipital, tricipital and suprailiac skin folds, thigh circumference, waist circumference) and resting heart rate were significantly reduced. ***Conclusion:*** Notwithstanding the limitations of our study, it can be said that a 4-week running training programme with 4 30-minute sessions per week would modify certain components of body composition in sedentary young Senegalese adults.

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INTRODUCTION

It has been shown that middle-distance runners (1/2 distance), long-distance runners and marathon runners are among the athletes who have the lowest percentage (%) of fat but also, and above all, a low lean body mass. They also have the lowest body mass (McArdle., Katch F & Katch V, 2001). To this end, running training programmes that aimed at improving body composition have mostly been carried out on European or American populations. However, it should be noted that the Senegalese population is also affected by the phenomenon of excess weight, which today is no longer the prerogative of rich countries.This phenomenon, which now affects almost every country in the world, is caused by physical inactivity the sources being the improved means of transportation as well as the development of technology, which substitutes humans for machines in industry, agriculture and everyday work. In 2022, 2.5 billion adults aged 18 and over were overweight (WHO, 2024) and 16% of the 43% of adults aged 18 and over who were overweight were obese (WHO, 2024). Today there is a real problem of sedentary lifestyles in Africa, particularly in our country (Senegal), to such an extent that we are seeing a marked upsurge in the number of people going to fitness centres to combat obesity, diabetes and high blood pressure, improve their physical condition and make their bodies more presentable. Gyms and fitness centres are not accessible to the majority of the Senegalese population, who have little purchasing power. That's why some Senegalese generally go off on their own, without any set programmes, to run around in the countryside, by the beach or in the desert lands of their neighbourhoods, to lose weight or reduce their body fat percentage. Sensitive to the concerns of our compatriots and anxious to provide them with physical activity programmes that could satisfy them, we decided to study the effects of a 4-week training programme of running, at an intensity ranging from 50 to 70% of the theoretical maximum heart rate, on the body composition and resting heart rate (RHR) of sedentary young Senegalese adults.

MATERIALS AND METHODS

Study sample: 16 male subjects from 20 to 28 who were not involved in any physical activity for maintenance, leisure or competition, and who did not suffer from any disease or disability took part in our study. We also made sure to exclude from our sample subjects who had not completed the training programme or who had modified their usual diet. This is why our sample was reduced to 12 subjects.

MEASURING BODY COMPOSITION BEFORE TRAINING

Body weight: The subject, dressed in a single pair of underpants, steps onto the scales and remains motionless, feet together, body straight, arms at his/her sides and looking straight ahead. After one minute, the laboratory nurse reads off the subject's weight, which is displayed on the scale's dial.

Height measurement: The subject stands on the support of the scale where the graduation begins. Their feet are together, their arms are at their sides, their shoulders are in the same plane and they are looking forward, horizontally. The nurse moves the cursor downwards until it touches the subject's head. The subject withdraws and the height indicated by the cursor is read.

Thickness of skin folds (McArdle., Katch F & Katch V, 2001)
Measuring the skin folds enables us to determine the subject's body fat percentage. The percentage of fat mass will enable us to calculate the weight of fat mass and then assess the weight of lean mass. The skinfold method is based on the fact that there is a relationship between fat located in deposits directly under the skin, internal fat, and body density. The procedure involves firmly grasping the skin fold between the thumb and forefinger, taking care to include the subcutaneous tissue and to exclude the underlying muscular tissue. The jaws of the forceps should exert a constant tension of $10g/cm^2$ at the point of contact with the skin. The thickness of the double layer of skin and subcutaneous tissue is then read off on the dial of the forceps. The reading is recorded in millimetres within two seconds of full application of the forceps.

Thickness of the bicipital skin fold: The thickness of the skin fold is taken from the radial mid-acromial line of the anterior surface of the upper arm. The upper arm forms a 90° angle with the forearm. The jaws of the adipometer are placed 1 cm from the thumb and index finger, to avoid the influence of their pressure. The reading is recorded within two seconds of the clamp tension being fully applied. The measurement is repeated three times and the most constant reading is taken.

Thickness of the tricipital skin fold: The skin fold is taken from the triceps on the back of the arm. We lift a skin fold between the thumb and forefinger at the mid-acromial line, with the arm always at a 90° angle to the forearm. The jaws of the adipometer are placed 1cm from the fingers to avoid the influence of their pressure. The reading in mm is recorded within two seconds of the clamp tension being fully applied. The measurement is repeated three times, with the most consistent measurement being retained.

Thickness of the sub-scapular skin fold: The arm is bent under the shoulder blade at a 45° angle to the horizontal. We lift a skin fold between the thumb and forefinger, with the jaws of the forceps always placed 1 cm from the fingers to avoid the influence of their pressure. The reading in mm is recorded in the two seconds following full application of the forceps tension. The measurement is repeated three times, after which the most constant measurement is taken.

Thickness of the suprailiac skin fold: The suprailiac region is the area above the iliac crest. Just above the iliac crest, a fold of skin is lifted between the thumb and forefinger, with the jaws of the adipometer pointing anteriorly towards the arm, one centimetre from the fingers to avoid the influence of their pressure.

The thickness in mm is recorded 2 seconds after the forceps are fully applied. The measurement is repeated three times and the most constant measurement is taken.

Muscle circumferences (McArdle., Katch F & Katch V, 2001)
Here we used the crossed hands technique to measure muscle circumference.

Thigh muscle circumference: The subject stands with his feet slightly apart. The tape is placed around the right thigh, 1 cm below the semicircular line of the buttock. The diameter is indicated by the reading taken at the intersection between the zero point on the tape and the scale on the other intersection point.

Calf circumference: We measured the circumference of the largest part of the calf. The tape is wrapped around the calf after fixing the zero graduation. The perimeter is read at the point of intersection marked by the tape's return to zero.

Waist circumference or perimeter of the abdomen: The subject stands with feet slightly apart. The tape is placed horizontally at the thinnest part of the waist. The reading is taken using the crossed hands technique at the end of the subject's normal exhalation.

N.B.: The nurse major took care not to pull on the tape to avoid deformation of the muscle under the pressure of the tape. This could distort the measurement.

Measuring heart rate at rest before training (Ader J.L & coll, 2006): To determine the subject's resting heart rate, we let them rest for 10 minutes in the supine position (lying on their back). We then wet the heart rate monitor electrode before placing it just above the plexus. We then place the receiver (polar watch) around the subject's wrist and start the polar watch's stopwatch. 15 seconds later, the subject's heart rate is displayed.

Training programme: The subjects underwent a four-week running training programme, with four 30-minute sessions per week. The training took place entirely in Dakar on the athletics track at Stade Iba Mar Diop.

The first week of training: As the subjects were sedentary, we proposed a fractional aerobic endurance workout of three 10-minute repetitions. After each 10 mm run, the subject recovered completely (heart rate returned to its resting value). The work intensity during each repetition is equal to 50% of the subject's theoretical maximum heart rate (Fc max = 220-Age) ± 10 beats/min. [Intensity = subject's Fc max x 50/100] ± 10 beats b/min (Astrand & Ryhming, 1954). So the subject's heart rate during the 10-minute run should fluctuate between 50% of the subject's maximum heart rate minus 10 beats per minute and 50% of the maximum heart rate plus 10 beats per minute.

Example: If a person is 20 years old, their theoretical maximum heart rate is therefore equal to (220 - 20) ± 10 beats/min. The subject's maximum heart rate is therefore 200 ± 10 beats/min. For this subject, his heart rate should vary between: 50% of (200 beats/min)-10 beats/min and 50% of (200 beats/min)+10 beats/min. For the first week of training, the heart rate of this 20-year-old subject should fluctuate between 90 beats/min and 110 beats/min.

As the subject is informed of the work intensity (heart rate between 90 beats/min and 110 beats/min) before the start of the training, he should regularly check the receiver on the heart rate monitor he wears on his wrist to ensure that his heart rate stays within this range. At the end of the 10-minute run, the subject walks until their heart rate returns to its resting value, which marks the start of the second repetition.

Second week of training: During this week, the work is divided into two 15-minute repetitions per session at an intensity equivalent to 60% of the subject's theoretical maximum heart rate. Example: for the same 20 year-old subject whose theoretical maximum heart rate is 200 beats/min ± 10, his heart rate should vary between 110 beats/min and 130 beats/min. Here too, the subject is informed at the start of the work intensity that he must control by regularly checking the receiver on the heart rate monitor he wears on his wrist so that his heart rate does not fall outside the defined range (110 beats/min ≤ fc ≤ 130 beats/min). After the first repetition, the subject recovers until their heart rate returns to rest, which marks the start of the second repetition.

Third week of training: 70% of the subject's theoretical maximum heart rate is the work intensity during this week. At each session, the subject does two 15-minute runs separated by a complete recovery (Fc returns to its resting value). For the same 20 year old subject whose theoretical maximum heart rate is 200 beats/min ± 10, his heart rate should vary between: 130 beats/min and 150 beats/min.

Fourth week of training: During this week, the subject runs for 30 minutes per session at an intensity equal to 70% of his theoretical maximum heart rate. During the 30 minutes, the subject's fc should fluctuate between 130 beats/min and 150 beats/min, i.e. 130 beats/min ≤ fc ≤ 150 beats/min.

NB: For each subject, we designed a weekly training sheet showing the four sessions and the work intensity.

Measurement of body composition parameters at the end of the training programme

At the end of the training programme (4th session of the 4th week), the subject is summoned the following day to undergo the same measurements as we carried out on him before the start of the training programme. The values obtained are recorded on a global form called a post-training evaluation form.

Statistical Processing: Our aim was to examine the effects of a four-week running training programme on body composition variables and resting heart rate. We first measured these variables before and after the application of the training programme. Then we compared the averages of each variable before and after training. We formulated the following hypothesis: Ho: 'there is a statistically significant difference between the means of each variable measured before and after training'. To test the hypothesis, we carried out a Student's t-test for comparison of means, after checking for homo-cedasticity (equality of variances) and normality, as the size of our sample was less than 30. In order to confirm or refute the hypothesis, we first need to compare the value of the t found in the test with the value of the t read from the table with a degree of freedom of N-l (ddl) and a certain probability of error (a). We have set a probability of error a = 0.001

NB: it should be noted that the hypothesis can be confirmed simply by comparing the value of the fixed probability of error (a) with that found in the t-test. If the probability of error (test power) found in the Student's t-test is lower than the fixed probability of error (a), Ho is confirmed. If the probability of error (test power) found in the Student test is greater than the fixed probability of error (a), Ho is rejected. We can see that, with the exception of the thickness of the sub-scapular skin fold and the circumference of the calf, the fixed probability of error (a = 0.001) is much greater than the probability of error found when comparing the means of each variable before and after training. Thus, with the exception of the thickness of the subscapular skin fold and calf circumference, Ho is accepted, i.e. there is a significant difference between the means of the variables measured before and after training.

RESULTS AND DISCUSSION

The discussion will focus on variations in body composition (weight, fat percentage, fat mass, lean mass, body mass index, skinfolds, muscle circumferences) and resting heart rate (RHR). The average weight of our sample before training was 63.42 Kg. This is lower than that of the reference man (70 Kg) reported by Behnke (1987). However, the concept of a reference standard does not necessarily imply that we should seek to copy these models. According to Behnke (Behnke, 1987), these models are useful only as a frame of reference for statistical comparison and interpretation of data from other studies. Thus, due to the orientation of our study program, after comparing the mean weight of our sample before training (63.42 kg) with that after training (59.92 kg), we find a statistically significant difference ($p < 0.001$). The weight reduction in our study seems greater than that of Wilmore & al. (1970) who used a 10-week running training program, with 3 sessions per week in sedentary European subjects aged 17 to 59.

Like Wilmore & al. (1970), our subjects were neither obese nor overweight. With this in mind, the average fat percentage of our sample before training (10.73%) is comparable to that of the reference man, which is 10.5% (Behnke, 1987). The average fat percentage of our subjects was significantly reduced by 2.72% at the end of the training program (8.01%). Our results are in line with those of Katch & al. (1985), who showed that a moderately strenuous 30-minute running training program, properly followed, could stimulate significant fat loss. The fat mass (FM) of our sample (6.79 kg) before training was lower than that of the reference man (10.5 kg) (Behnke, 1987). Indeed, after comparing the results obtained in the pre-test with those of the post-test, we found that body fat had changed favourably, dropping from 6.79 to 4.72 kg, a reduction of 2.72 kg. Our results therefore corroborate those of Wilmore & al. (Wilmore & al., 1970), who reported a reduction in average fat mass (F.M.) before training (15.03 kg) of 1.07 kg after training (13.96 kg). If we focus on the active mass (lean mass) that consumes energy, the average of our sample before training (56.56 kg) is comparable to that of the reference man (Behnke, 1987). However, a pre- and post-test comparison of this same parameter (lean mass) shows a significant variation ($p < 0.001$) of 1.47 kg, i.e. a decrease of 2.7%. Of course, as stated by Katch & Mcardle [Katch, F.I. & McArdle W., 1985], a gain in lean body mass is desirable in high-level athletes aiming for performance.

Table 1. Comparison of mean values of skinfold thickness recorded before and after the running programme

PC	PC Bicipital (mm)		PC Tricipital		PC Subscapular (mm)		PC Suprailiac (mm)	
Phases	Before	After	Before	After	Before	After	Before	After
Averages	3,67± 1,44	2,33± 1,23	5,83± 1,95	4,50± 1,88	8,75± 2,05	8,25± 2,38	5,75± 2,01	4,42± 1,98
P set	0,001		0,001		0,001		0,001	
P Found	P < 0,001		P < 0,001		P < 0,001		P > 0,001	
Decision	S		S		S		NS	

PC means Thickness of Skin fold

Table 2. Comparison of average muscle circumference values recorded before and after the running program

Circumferences muscle	Circumferences Thigh (cm)		Circumferences Calf (cm)		Circumferences Waist (cm)	
Phases	Before	After	Before	After	Before	After
Averages	21,33± 1,15	20,33± 1,15	10,58± 1,68	9,96± 1,74	29,38± 1,19	28,08± 1,18
P set	0,001		0,001		0,001	
P Found	P < 0,001		P > 0,001		P < 0,001	
Decision	S		NS		S	

Table 3. Comparison of average values for weight, fat percentage (%F), body fat weight (BFW) recorded before and after the running program

PC	Weight (kg)		%F		BFW (kg)	
Phases	Before	After	Before	After	Before	After
Averages	63,42± 5,90	59,92± 5,52	10,73± 3,26	8,01±4,05	6,79± 2,40	4,72± 2,59
P set	0,001		0,001		0,001	
P Found	P < 0,001		P < 0,001		P < 0,001	
Decision	S		S		S	

Table 4. Comparison of mean values for lean body mass (LBM), body mass index (BMI) and resting heart rate (RHR) recorded before and after the running programme

PC	LBM (Kg)		BMI (kg/m^2)		RHR (bat/mn)	
Phases	Before	After	Before	After	Before	After
Averages	56,56±5,22	55,099±5,49	20,44±1,61	19,26±1,22	85,17±7,41	65,92± 6,50
P set	0,001		0,001		0,001	
P Found	P < 0,001		P < 0,001		P < 0,001	
Decision	S		S		S	

However, in sedentary people working for their physical well-being, increasing lean body mass is not always an objective.

The pre-training body mass index of our subjects (20.44 kg/m^2) compared to WHO (2024) standards is well within the recommended range (18.5 kg/m^2 to 24.9kg/m^2). This range published by the WHO (2024) corresponds to what is known as the healthy weight zone, so our sample would fall within this healthy zone. However, it has to be said that this range offers a whole variety of silhouettes, because for the same height, we don't all have to weigh the same to be in good health. According to McARDLE & al (2001), it's up to each individual to find the right weight for him or her, and the further your BMI deviates from the upper or lower limits of a healthy weight, the greater the likelihood of health problems (McArdle, Katch F & Katch V, 2001). As with any index, BMI is not perfect and must be interpreted on a case-by-case basis. For example, a person may be slightly above a healthy weight without increasing their risk if, for example, they are very muscular or have a large bone structure. For example, our BMI (20.44) is slightly lower than that of the reference man (23.12) (Behnke, 1987). In fact, a comparison of our BMI results before and after training showed that there was a significant change in this parameter (BMI), as the results went from 20.44 to 19.26 respectively, a decrease of 5.9% in relative value.

Skin fold thickness measurements are reliable and provide important information on body fat and its distribution. We found that, apart from the subscapular skin fold, which showed no significant change, the most significant changes in skin folds were found in the bicipital (1.33mm), tricipital (1.33mm) and suprailiac (1.33mm) regions.

In addition, as with skin folds, muscle circumferences can be used to estimate body density and/or fat percentage. The application of this profile makes it possible to quantify the relative proportions of circumferences and to show changes due to factors such as short- and long-term training. In our study, we noted the following significant circumference changes:

- Thigh circumference went from 21.33cm to 20.33cm, a decrease of 0.99cm (p less than 0.001)
- Waist circumference (WC) decreased from 29.38cm to 28.08cm, i.e. a reduction of 1.29 cm (p less than 0.001).
- However, Student's t test results (p (0.003) > 0.001) showed that calf circumference did not change significantly (10.58cm vs. 9.96cm).

As for resting heart rate (RHR), the greatest training-induced decrease is reported in high-level athletes practising endurance disciplines: cross-country, skiers, cyclists, marathon runners (Saltin, 1969). Before training, the RHR of our sample was 85 b/nm, far higher than that of the trained athletes above. This proves that our subjects were truly sedentary. Nevertheless, their resting heart rate decreased significantly after training. This decrease in resting heart rate reflects the strengthening of vagal tone due to training (Saltin, 1969). Our results appear to be in line with those of Morganroth (Morganroth & al, 1975), who reported that from the very first days of training, RHR is the first parameter to be affected by training.

Limitations of our study: Our study presents some limitations. The number of subjects (12) poses a problem regarding the statistical laws that fix a minimum margin of tolerance of 30 subjects. However, it was very difficult for us to find sedentary young Senegalese adults willing to carry out our training program and undergo the measurements. The availability of subjects prevented us from putting them in the same temporal and climatological training courses because they did not all have the same daily occupations.

CONCLUSION

The objective of our study was to see the effects of a 4-week running training program on the body composition of sedentary young Senegalese adults. 12 adult subjects underwent the training program. Body composition parameters were measured before and after training. Except for the subscapular skin fold and calf circumference, the other parameters changed significantly. Despite everything, it must be said that our results cannot be generalized to the entire adult Senegalese population, because the subjects who participated in our study were not overweight.

Due to these considerations, we suggest to anyone who would like to try this program to contact a specialist to adapt it to their physical abilities but above all to have a health check-up.

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