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EFFECTS OF A 3-MONTH WALKING PROGRAMME ON BODY COMPOSITION, CARDIOVASCULAR PARAMETERS, BLOOD SUGAR AND VO2 max OF 13 SEDENTARY SENEGALESE WOMEN AGED 40 TO 50

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SUMMARY

Objective: To study the effects of a 3-month walking program on body composition, cardiovascular parameters, blood sugar and VO2 max in sedentary Senegalese women aged between 40 and 50.

Methods: We assessed weight, fat mass, lean mass, fat percentage, body mass index, muscle circumferences (thigh, calf, arm), resting heart rate, blood pressure, blood glucose and maximum oxygen consumption before and after a 3-month walking programme. The programme consisted of 3 one-hour sessions per week, performed at a comfortable speed.

Results: After 12 weeks of walking, we observed a slight decrease in all the variables studied, with the exception of blood sugar, lean body mass and VO2 max. However, this reduction was not statistically significant.

Conclusion: Our results suggest that one-hour walking sessions at a comfortable speed, three times a week for 3 months, may not be sufficient to induce significant changes in the variables assessed above in sedentary Senegalese women aged between 40 and 50.

key words: walking; blood sugar; maximum oxygen consumption; resting heart rate; blood pressure; comfort speed

INTRODUCTION

"Walking is the best medicine for man **(US DHHS, 1996).** This hypothesis, formulated by Hippocrates 2,000 years ago, is confirmed today, because no-one can ignore the benefits of walking, which are the result of rigorously conducted scientific studies. **Temple and al. (2008)** followed 3127 healthy adults aged between 19 and 94, including 2151 women and 976 men who wanted to control their weight by walking. They reported that men aged between 18 and 50 should take 12,000 steps a day and 11,000 steps from the age of 50 onwards, i.e. 8 to 10 km a day, to maintain an ideal weight. This idea is supported by **Vaclav Bunc (2022)** who maintains that one of the most effective and safest physical activities is walking, which, with sufficient intensity, considerably reduces the physical deficit.

The Canadian Centre for Occupational Health and Safety states that a person's weight reflects the balance between the calories they take in through eating and the calories they expend in their daily physical activities. Walking for 30 minutes covers a distance of 2.0 to 2.5 km and burns around 125 calories (520 kilojoules). That may not sound like much, but if you walk five days a week for a year, you burn more than 32,000 calories, which is equivalent to burning more than 5 kg of fat. Besides, walking provides even more benefits if you burn a minimum of 2,000 calories a week by walking (about 8 hours of walking a week) **(Canadian Center for ocupational Health and safety, 2006).** The risk of femoral neck fracture is reduced by 6% for each increase in energy expenditure equivalent to 1 hour's walking per week. Women who walk at least 4 hours a week have a 40% lower risk than sedentary women who walk less than 1 hour a week. According to an article published in 2006 by the Canadian Centre for Occupational Health and Safety, regular walking,
i.e. walking every day, or at least a few times a week, for at least 30 minutes, as well as other gentle, moderate physical activities that involve the whole body, can greatly improve aerobic capacity and cardiorespiratory function. Moreover, when you walk regularly, you reduce the risk of fracturing your leg or hand when you fall, because your bones are stronger; you also reduce the risk of injury, because your joints have a better range of movement and your muscles are more flexible (Canadian Center for ocupational Health and safety, 2006**).** The virtues of walking after a good meal are well known for helping digestion. A study by Norwegian researchers goes even further. It showed that walking after a meal is also an excellent way of regulating blood glucose levels after a meal. Post-meal hyperglycaemia is one of the factors favouring the onset of diabetes and cardiovascular disease. This study was carried out on women aged over 50. In these women, the effect of a slow walk lasting 15 or 40 minutes limited the rise in blood sugar levels following a meal. The longer the walk, the greater the effect. It now remains to be seen whether these results can be reproduced in all adults and children. In the meantime, this study provides us with good arguments to start walking, preferably after a meal

[Nygaard and al, 2009**].** Caught up mostly by age, lack of time or inability to take part in activities such as running or cycling, most Senegalese women are overweight and suffer from cardiovascular problems. As most of them cannot afford to go to a gym, the only simple, effective and accessible physical activity to get back into shape is walking. In addition, medical information on the prevention of cardiovascular disease, diabetes and obesity through walking has encouraged many women to take up sport. As a result, the number of walkers has increased, a provisional national walking committee has been set up as well as walking clubs in various districts of Dakar. However, in these clubs, women go walking without following a well thought-out program that will give them satisfaction. For all these reasons, we propose to study the effects of a three-month walking program, consisting of three one-hour walking sessions at comfort speed, on the body composition, cardiovascular parameters, blood glucose and maximum oxygen consumption (VO2 max) of sedentary Senegalese women aged between 40 and 50.

MATERIALS AND METHODS

1. STUDY POPULATION

The study population was made up of 13 Senegalese women aged between 40 and 50, free of any chronic illnesses that might affect their physical integrity, carrying out no other physical activity and have given their consent.

1.1. INCLUSION CRITERIA

The women included in the study were aged over 39 and under 51, who walked exclusively and were free of any chronic illness likely to affect their physical and/or psychological integrity during the walking programme.

1.2 EXCLUSION CRITERIA

Women under the age of 40 and over the age of 50, as well as women practising a physical or sporting activity for maintenance or maintenance other than walking, were excluded from the study. Also excluded were women suffering from any chronic illness or disability that might act as an obstacle on the walking programme. We also took care to exclude from this study women who did not complete the walking programme or who modified their walking programme; this reduced our sample to 13 women.

2. MEASUREMENTS OF THE VARIABLES STUDIED PRIOR TO THE WALKING PROGRAMME

2.1. MEASUREMENT OF BODY COMPOSITION VARIABLES

2.1.1. The size

The women's height was measured with a somatometer using a metal measuring rod. The measurement was taken without shoes. The woman had to rest her back and head directly on the somatometer. Once firmly in place, she was asked to breathe in as deeply as possible while stretching her neck upwards. The head was straight and the chin erect, pointing forward and parallel to the ground. As she withdrew her breath, the headgear was gently applied to the top of her head (vertex). Once the tape was firmly in place, the subject was asked to withdraw while keeping the tape pressed firmly against the wall. The height reading was taken directly under the base of the height gauge, with a desired accuracy of 0.1 cm.

2.1.2. Weight

The women's weights were measured using a SECA bathroom scale, a small square device with a small graduated scale in front of a needle that oscillates and gives the value that determines the weight. Each woman, wearing a minimum of clothing (a loincloth and a T-shirt), stood on the scales, remained motionless with her feet together, her body straight, looking straight ahead, distributing her weight over her feet. The reading was taken with an accuracy of 0.25 kg.

2.1.3. Thickness of skin folds

The sites measured were the tricipital, subscapular, suprailiac and quadricipital skin folds. The skin folds were measured using a specific adipometer from QUICK FIT BODY FAT CALIPER:

- To be precise, we reproduced the same finger pinches at each measurement and in the same places by applying pressure to the pliers,
- By convention, all measurements were taken on the right hemisphere,
- the subject was completely relaxed, with no contraction of the underlying muscle,
- the fold was printed between the thumb and forefinger,
- the jaws of the forceps were exerted with constant pressure at the points of contact with the skin,
- the pressure of the subject's fingers was released during the clamp measurement,
- To measure the thickness of a fold, the skin fold was grasped perpendicularly between the thumb and forefinger, making sure to include the subcutaneous tissue and exclude the muscular

tissue by applying isolated pressure for around 2 seconds to the selected site,

- the measurement was repeated at each site 3 times,

- the thickness of the double layer of skin was then read off on the clamp's dial.

- **Thickness of the tricipital skin fold** :

The thickness of the triceps skin fold was measured vertically on the posterior surface of the triceps with the arm fully relaxed, avoiding rotation of the limb, midway between the upper (shoulder acromion) and lower (elbow olecranon) insertions.

- **Thickness of the** sub-scapular**skin fold**

The subscapular crease was measured obliquely downwards and outwards on the posterior surface, with the arm relaxed. The fold is located just below the tip of the scapula (1cm).

- **The thickness of the suprailiac fold**

The thickness of the suprailiac skin fold was measured obliquely downwards and medially, just above the iliac crest, 2 cm from its intersection with the anterior axillary line.

- **Thickness of the quadricipital skin fold**

The quadricipital fold was measured while seated, with the knee bent at 90°. The fold is vertical on the anterior aspect of the thigh, midway between the inguinal line and the top of the patella.

2.1 .4 Calculating body mass index (BMI), fat mass and lean mass

- Body mass index (BMI)

We calculated the women's body mass index from the ratio :

$$\textbf{\textit{BMI = Weight / Height}}^2 .$$

- Percentage of fat (%G)

After summing the skin folds, we assessed the percentage of fat using the Wommersley and Durnin 4- fold formula **(**Wommersley and Durnin, 1977**)** and Dougall and al **(1985).**

%MG = a.log (Σ 4plis) - b (a and b vary according to age and sex)

- Body **fat**

The body fat (BF) of the subjects is obtained using the equations of DURNING and WOMERSLEY (1974) : MG = ((4, 95/d)-4, 50) x 100 d = C - (M x log Σ 4 folds) (M and C vary according to age and sex).

- Lean body mass (LBM)

We calculated the lean body mass (LBM) by subtracting the fat mass from the subject's weight;

MM = Weight - Body fat

2.2 MEASUREMENT OF CARDIOVASCULAR VARIABLES, BLOOD GLUCOSE AND VO2MAX

2.2.1. RESTING HEART RATE

To measure the subjects' resting heart rate, we used a POLAR heart rate monitor. The subjects' resting heart rate was measured as follows:

- the nurse left the subject at rest for at least 10 minutes in a decubitus position (lying on their back) and without any electrostatic underwear or underwear containing metal parts (bra),

- the nurse wetted the electrodes of the heart rate monitor and placed them just above the plexus,

- he cleaned the skin beforehand with a solvent (a mixture of ethanol and acetone, for example),

- it improved electrode contact with a conductive jelly tip,

- he then placed the receiver (polar watch) around the subject's wrist and triggered the polar watch's chronometer. 15 seconds later, the subject's heart rate was displayed.

2.2.2 BLOOD PRESSURE

To measure the subjects' blood pressure, we used a SPERGLER cuff-type blood pressure monitor. The measurement was carried out as follows:

- the subject was correctly positioned in a half-seated position,

- arms at your sides, after resting for 5 to 10 minutes,

- the subject kept the arm at heart level, because if the arm is too low the height of the pressure will be overestimated,

- the size of the cuff must be adapted to the size of the arm: if the cuff is too small, the pressure will be overestimated,

- the area of maximum beat of the humeral artery was located at the elbow crease,

- the cuff is fitted, ensuring that the centre of the inflatable bag is positioned opposite the course of the humeral artery, and that the lower edge of the cuff is 2 to 3 cm above the elbow crease,

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- the cuff was first inflated to estimate the systolic blood pressure (SBP) until the radial pulse disappeared,

- the stethoscope was placed over the humeral beat at the bend of the elbow,

- we inflated again to 30 mm Hg above the SAP,

- deflation was performed at a rate of 2 mm Hg per heartbeat, with simultaneous reading of the blood pressure on the manometer. Deflating too quickly could underestimate SAP and overestimate DBP,

- the PAS corresponded to the moment when at least the first 2 noises appeared for the first time (Korotkoff's I phase),

- the PAD corresponded to the moment when the noise disappeared (Korotkoff phase V),

- readings should be accurate to within 2 mm Hg. Published recommendations on blood pressure measurement maintain mm Hg as the unit of measurement for medical practice. The international unit for measuring blood pressure is the kilo pascal (kPa).

A total of 3 blood pressure readings were taken:

- 1 approximate pulse reading to identify PAS,

- 2 more accurate auscultatory readings for PAS and PAD, with heart rate.

2.2.3 BLOOD GLUCOSE LEVELS

Blood glucose levels were measured using a ONE CALL PLUS glucometer, ONE CALL PLUS test strips and lancing devices. The procedure was as follows:

- the subject washed his hands to avoid any infection and to prevent microscopic food debris or sweat from distorting the analysis,

- the nurse put a new lancet into the lancing device to reduce the sensation of pain,

- he prepared a strip and switched on the glucometer, with all the display segments lighting up for a few seconds so that he could check that there were not one or more faulty segments, which could lead to an inconsistent display or erroneous figures, - With the lancing device, the nurse pricks the side of the last phalanx (this is where there is the most blood and where it hurts the least) of the last three fingers of the left or right hand (the thumb and index finger are the fingers most often used to feel, touch or grasp objects; It is therefore important not to prick them). The painful sensation can be reduced at the time of micropitting by pressing the inner and outer edges of the second phalanx of the finger where the sample is taken with the thumb and other fingers of the same hand,

- the nurse moved the subject's finger close to the strip so that the lower end of the drop of blood came into contact with the deposit area on the strip. The drop of blood then slipped into the strip on its own.

NB: make a note of the indications given by the device (date, time) as well as the measurement conditions. Blood glucose is expressed in grams per litre (g.l-1) or (g/l), or in millimoles per litre (mmol.l- 1) or (mmol/l). The conversion from $g.l^{-1}$ to $mmol.l^{-1}$ is obtained by multiplying the $g.l^{-1}$ by 5.5. The conversion from $mmol.l^{-1}$ to $g.l^{-1}$ is obtained by multiplying the $mmol.l^{-1}$ by 0.18.

2.2.4 MEASURING VO2 max: WALKING TEST

The subjects' VO2 max was determined using the ROCKPORT **(Kline and al. 1987)**.

2.2.4.1. DESCRIPTION

The walking test was developed to assess cardiovascular fitness. It consists of a 1.6 km walk during which the subject tries to cover the distance as quickly as possible.

This is done after a warm-up, followed by a 1.6 km walk as quickly as possible, without risking injury. The walking time should be recorded to the nearest second.

-Immediately at the end of the walk, count the pulses for 15 seconds and multiply by four to obtain the heart rate per minute.

By using the duration of the walk and the heart rate after exercise, you can determine the classification using grid 1, or estimate the VO2max (in ml O2 $.kg^{-1}$ $.min^{-1}$) by solving the following equation:

VO2 max = 132.853 - (0.0769 x WEIGHT) - (0.3877 x AGE) + (6.3150 x SEX) - (3.2649 x TIME) - (0.1565 x HR).

NB: Weight in pounds (to transform kg into pounds, multiply the weight by 2.2); Age in years; Sex: Male = 1, Female = 0; Time in minutes and hundredths of a minute; Heart rate in beats per minute (b/min).

2.2.4.2- walking test procedure

To carry out the VO2 max test we used **:**

- 5 POLAR stopwatches to estimate the time taken by the subjects to cover the required distance (1.6 km),

- sheets of paper and ballpoint pens to record individual heart rate values and the time taken by each subject to reach the finish.

The V02 max test was carried out on the track of the Iba Mar Diop stadium, which covers a distance of 400 metres. The subjects, dressed in sports clothing, covered a distance of 1,600 metres, maintained at an average speed taken spontaneously without any constraint.

- The women were divided into 2 groups, one of 7 and one of 6, corresponding to the number (7) of stopwatches available (one stopwatch for each subject).

- Just at the finish, after having covered the distance of 1600 metres, the time taken and the heart rate of each woman were recorded by taking a carotid pulse for 15 seconds and multiplying the number obtained by 4, which gives the heart rate for each woman. Each woman's VO2 max was then calculated using the following formula:

VO2 max = 132.853 - (0.0769 x WEIGHT) - (0.3877 x AGE) + (6.3150 x SEX) - (3.2649 x TIME) - (0.1565 x HR).

NB: Weight in pounds (to transform kgs into pounds, the weight is multiplied by 2.2); Age in years; Sex/ Male =1, Female = 0; Time in minutes and hundredths of a minute; Heart rate in beats per minute.

3. RUNNING OF THE WALKING PROGRAMME

One week after the measurements were taken, the women began their three-month walking programme, walking for one hour a day, three times a week, at comfort speed. Comfort speed is the speed at which the subject experiences no cardiac or respiratory difficulties. At comfort speed, the subject can walk while chatting to their partner without breathing difficulties. The walk took place in different locations in Dakar: the Iba Mar Diop stadium, the Corniche Ouest, the Sicap Liberté and Yoff. The women met in the evenings at 5 p.m. under the guidance of representatives of the Dakar walking clubs and walked for an hour (30 minutes out and 30 minutes back), each subject determining her own walking speed and comfort level.

4. MEASUREMENT OF VARIABLES AT THE END OF THE WALKING PROGRAMME

2 days after the end of the walking programme, the women were asked to repeat the same measurements that had been taken before the walking programme. The variables measured were: weight, height, muscle circumferences (arm, thigh, calf), skin folds (tricipital, subscapular, suprailiac and quadricipital), resting heart rate, blood pressure (systolic and diastolic), blood glucose and VO2 max.

5. STATISTICAL PROCESSING

The aim of our study was to determine the effects of a three-month walking programme on the body composition, cardiovascular parameters, blood glucose and VO2 max of sedentary

Senegalese women. We first measured the above parameters before and after the walking programme, and then compared the means of each of these parameters before and after the walking programme, using a Student's t- test, a parametric test. As the number of subjects was less than 30, we checked that the variances were equal. We formulated the following hypothesis: Ho: there is a statistically significant difference between the mean values recorded before and after the walking programme. Our probability of error α is set at α = 5% (0.05). α is the error we are prepared to make in deciding on the difference in mean values. If the probability of error P found in the Student's T test is less than α (P < α), we confirm our hypothesis: there is a statistically significant difference between the means compared. If the probability of error P found in the Student's T test is greater than α (P >α), we reject our hypothesis,

i.e. there is no statistically significant difference between the averages compared.

RESULTS

COMPARISON OF AVERAGE VALUES OBTAINED BEFORE AND AFTER THE WALKING PROGRAMME

Table 1: Comparison of mean values for weight, percentage fat (% G), body fat (MG), lean body mass (MM) and body mass index (BMI) before and after the walking programme.

Variables	Weight (kg)		%G		MG (kg)		MM (kg)		BMI (kg/m) ^{2}	
	AV	AP	AV	AP	AV	AP	AV	AP	AV	AP
Average	70,03 ±12,40	68,83 ±12,16	36,71 ±3,24	36,23 ±3,08	25,58 ±5,87	24,83 ±5,96	43,51 ±7,19	43,44 ±6,72	25,94 ±4,03	25,56 ±3,93
α = 0,05	0,05		0,05		0,05		0,05		0,05	
P (found)	0,71		0,56		0,63		0,97		0,71	
Decision	N S		NS		NS		NS		NS	

AV = before running programme

AP = after running programme

P (found)= probability of error found in Student's T-test
α = fixed probability of error

NS = Difference in mean not significant

Table 2: Comparison of mean values for muscle circumference in the thigh (CC), calf (CM) and biceps (CB), before and after the walking programme.

Variables	CC (cm)		CM (cm)		CB (cm)	
	AV	AP	AV	AP	AV	AP
Average	46,2±6,43	43,95±5 ,00	37,2±3,69	36,43±3,16	28,63±3,36	27,93±3,37
α = 0,05	0,05		0,05		0,05	

P (found)	**0,14**	**0,39**	**0,42**
Decision	**NS**	**N S**	**N S**

Table 3: Comparison of mean values for resting heart rate (HRR), systolic blood pressure (SBP) and diastolic blood pressure (DBP) before and after the walking programme.

Variables	**HRR (beats/min)**		**SBP (mm Hg)**		**DBP (mm Hg)**	
	AV	**AP**	**AV**	**AP**	**AV**	**AP**
Average	**74,93±11,92**	**71,73±8,55**	**12,43±1,83**	**11,6±1,40**	**7,33±1,**06	**7,3±1,15**
α = 0,05	**0,05**		**0,05**		**0,05**	
P (found)	**0,24**		**0,05**		**0,91**	
Decision	**NS**		**NS**		**NS**	

Table 4: Comparison of mean values for blood glucose and VO2 max (maximum oxygen consumption) before and after the walking programme.

Variables	**Blood glucose (g/l)**		**VO2 max ($ml.mn^{-1}.kg)^{-1}$**	
	AV	**AP**	**AV**	**AP**
Average	**0,90±0,37**	**0,90±0,48**	**23,3 ± 9,77**	**24,81± 6,47**
α = 0,05	**0,05**		**0,05**	
P (found)	**0,97**		**0,41**	
Decision	**NS**		**NS**	

DISCUSSION

Our discussion will revolve around 3 main points:

-body composition variables (weight, fat percentage, fat mass, lean mass, muscle circumferences of the biceps, calf and thigh),

-cardiovascular parameters (resting heart rate, systolic and diastolic blood pressure), blood glucose and maximum oxygen consumption (VO2 max).

I/ Body composition variables

The average weight of our sample before the walking programme (70.03 kg) exceeded that of the reference woman (57.03 kg) from Behnke **(**Behnke and Kutch, 1985**)** by 12.33 kg. After the walking programme, the mean weight of our sample fell to 68.83 kg, a reduction of 1.20 kg in absolute value, which was not statistically significant (P > 0.05; table 1).

Our results (non-significant reduction in weight) are not in agreement with those of the Canadian Centre for Occupational Health and Safety **(**Canadian Center for ocupational Health

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and safety, 2006**)** and Trapp et al. **(2008)**.

This difference in results could be explained by the difference in intensity and duration of our programme compared with those of the above-mentioned authors.

The Canadian centre for occupational and safety **(2006)** suggested a programme of 8 hours' walking a week, resulting in a loss of 2000 calories and a significant loss of weight.

Trapp et al. **(2008)** used a split training programme lasting a total of 20 minutes in the form of alternating 8-second sprints followed by 12-second passive recovery, 3 times a week for 15 weeks. This resulted in significant weight loss in the 45 women in their study sample.

However, our subjects walked for only 36 hours over 12 weeks, at a rate of 3 hours per week, at comfort speed, the speed spontaneously assumed by the subject and which does not cause any cardio- respiratory strain.

The non-significant reduction in the weight of our subjects could also be explained by the low energy expenditure of each of the subjects in our sample, as Brooks and **Mercier (1994)** have shown that to lose 1 kg, you need to expend 8000 to 9000 kilocalories (kcal).

We doubt very much that each of the subjects in our sample expended so much energy to lose 1 kg. The average body fat percentage of our sample before the walking programme (36.71 kg) did not decrease significantly (P > 0.05; table 1) after the walking programme (36.23 kg). This would also explain the non-significant reduction in average body fat at the end of the walking programme (25.58 kg before and 24.83 kg after). These values of fat percentage and fat mass of our subjects before and after the walking programme are higher than those of Behnke's reference woman **(**Behnke and Kutch, 1985**).** This shows that our subjects were fat before the walking programme and are still fat after the walking programme.

In addition to the short duration and low intensity of our walking programme, the non-significant reduction in percentage fat and fat mass could be explained by the adipose content of the subjects before the walking programme, as Wilmore **(1882)** reported that a significant loss of fat mass is obtained as quickly as possible with subjects who are not fat at the start.

In addition, the non-significant reduction in body fat could be explained by the fact that our subjects were not making an optimal effort during their walking sessions. According to Brooks and Mercier **(1994),** optimal effort is between 50 and 80% of maximum heart rate. During our study, our subjects walked only at their comfort speed.

Essentially responsible for vital and working functions, lean mass is everything that is not fat mass. Its mean value before the walking programme (43.51 kg) did not vary significantly (P > 0.05; table 1) at the end of the walking programme (43.44 kg). It could be said that she did not work very hard during the walking programme. It should be noted that at the end of a physical activity programme, there may be a reduction in fat mass and lean mass or an increase in lean mass. In our study, lean body mass neither increased nor decreased significantly at the end of the walking programme. This would suggest that it did not use lipids during the effort.

Although our subjects did not expect an increase in lean body mass for their physical well-being **(**INSERM, 2008**)** the mean values of lean mass before and after the walking programme were lower than those of Behnke's reference woman (Behnke and Kutch, 1985) which was 48.5 kg.

Furthermore, while fat mass and lean mass can provide partial information on a subject's body composition, one of the most valid criteria, defined by **the WHO (2007)** is the body mass index or BMI.

BMI is a simple, objective indicator of nutritional status that combines the simple anthropometric measurements of weight and height **(Quételet, 1869).**
The mean BMI value before the walking programme (25.94 kg/m^2) did not fall significantly ($P > 0.05$; table 1) at the end of the walking programme (25.56 kg/m^2).
These 2 values fall within the range described by the WHO as an overweight zone **[WHO, 2007].** This further justifies the fact that our subjects were overweight before the walking programme and the programme as carried out did not lead to a reduction in body mass index, hence the absence of reduction in weight.

Most of our subjects should control their body mass, as Katch and Mc Ardle **(1985)** have shown that health risks increase when we move away from the healthy weight zone (18.5 ≤IMC≤ 24.9).

Muscle circumference and skin folds are also simple and reliable methods for assessing fat content **(Katch and Mc Ardle**1,983**)**.

None of the muscle circumferences studied decreased significantly at the end of the walking programme ($P > 0.05$; table 2).
However, we did note a slight decrease in the average circumference of the subjects' thighs (table 2). This result may be consistent with that of Trapp and al. **[2008]** who reported a loss of volume in the thighs during their split training programme in 45 women.

Trapp and al. **(2008)** explain this loss of volume by a significant hormonal secretion (adrenalin, noradrenalin, dopamine) responsible for fat absorption.

II / Cardiovascular parameters

The resting heart rate (RHR) partly determines the overall physical condition of the heart. It generally fluctuates between 50 beats per minute in high-level athletes practising endurance sports and 80 beats per minute in sedentary people (Garnier and Rouillon, 1991).

The mean CRF of our sample before the walking programme (74.93 beats/min) did not fall significantly ($P > 0.05$; table 3) at the end of the walking programme (71.73 beats/min).

However, in absolute terms, there was a reduction of 3 beats, which could be attributed to the strengthening of vagal tone due to physical activity **[**De Saltin, 1969**].** This strengthening of the vagus nerve, the cardiomodulator, could be more pronounced if the intensity and duration of the walking programme were greater.

The blood pressure of our subjects before the walking programme (SBP = 12.43 cmHg and DBP = 7.33 cmHg) shows that they are not hypertensive, as these values are below the limits (SBP = 14 cmHg and DBP = 9 cmHg) above which a subject is classified as hypertensive by the WHO.

At the end of the walking programme, the average blood pressure of our subjects did not fall significantly ($P > 0.05$; table 3) (SAP = 11.6 cmHg and DBP = 7.3 cmHg).

However, a slight decrease of 0.8 mm Hg was noted in SBP. This result may corroborate those of **Saejong Park and al. [2010]** and Bacon and al. **[2004]** who recorded a reduction in blood pressure even though their walking programmes were different from ours (Saejong Park and al. 40 minutes of walking per session divided into 4 repetitions of 10 minutes; Bacon et al.: 30 minutes of walking, 3 times a week).

III / Blood glucose and maximum oxygen consumption (VO_2 max).

Slow walking is an excellent way of limiting the rise in blood sugar levels after a meal **(Nygaard and al, 2009).**

The mean blood glucose level before the walking programme (0.90 g/l) showed that our subjects were not diabetics. This blood glucose level did not change ($P > 0.05$; table 4) at the end of the walking programme (0.90 g / l).

This consistency in blood sugar levels could be explained by the fact that :

-the subjects maintained eating habits that compensated for the depletion of sugar after their walking sessions,

-the subjects did not burn much sugar during the walking session, even though they reduced the sugar content of their post-exercise meal.

Measuring VO_2 max is still one of the best tests for quantifying a person's physical condition (**Nadeau and Péronnet, 1980**). It is an accurate indicator of physical fitness, because the higher its value, the greater the individual's oxidative capacity.
Wyndham and al. (1963) reported VO_2 max values of between 40 and 49 $ml.mn^{-1}.kg^{-1}$ in melano-African men. These values are 10 to 20% lower in melano-African women because of the excess fat.
The average VO_2 max recorded in our subjects before the walking programme (23.3 $ml.mn^{-1}.kg^{-1}$) was well below those of the women above. This shows that our subjects were not enduring. This mean value recorded before the walking programme increased but not significantly ($P > 0.05$; table 4) at the end of the walking programme (24.83 $ml.mn^{-1}.kg^{-1}$).
This non-significant increase in the average VO_2 max of our sample at the end of the walking programme could be explained by the fact that our subjects did not walk during all the sessions at an intensity equivalent to 80% of the maximum heart rate, as **Laukkanen and al [2000], Laukkanen and al. (1992)** reported that 80% of maximum heart rate is the right intensity to obtain a significant improvement in VO_2 max at the end of a walking programme.

CONCLUSION

The aim of our study was to investigate the effects of a walking programme on body composition, cardiovascular parameters, blood glucose levels and maximal oxygen consumption in sedentary Senegalese women aged 40-50 years.

13 senegalese women took part in this 3-month study, walking for 1 hour at a comfortable speed 3 times a week. Body composition (weight, fat percentage, fat mass, lean mass, muscle circumference, BMI), cardiovascular parameters (resting heart rate and blood pressure) as well as blood glucose and VO_2 max were assessed before and after the walking programme.

Our study showed that one hour's walking at comfort speed, 3 times a week for 12 weeks, had no statistically significant effect on body composition variables (weight, percentage of fat, fat mass, lean mass, body mass index, muscle circumferences of the thigh, calf and biceps), cardiovascular parameters (resting heart rate, systolic blood pressure and diastolic blood pressure), blood sugar levels and maximum oxygen consumption, in the 13 sedentary senegalese women in our sample.

It would be interesting to continue this study by modifying the intensity and duration of the walking programme and combining it with a controlled diet to see if the effects are different from those observed in our study.

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