



DELIVERABLES REPORT

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Calculate the impact of the use of electric vehicles for the adoption of more active lifestyles

1. Introduction

This report presents the results of the data analysis of anthropometric measurements, skinfold measurements, and the Ruffier-Dickson test conducted on a group of participants at two points in time: baseline (initial) and post (after several days of healthy mobility by bicycle or walking). The report includes measurement data obtained at Camilo José Cela University and the University of Coimbra.

2. Methodology

Measurements were taken at two different times:

- Baseline: Initial measurement before starting the healthy mobility program.
- Post: Measurement after several days of healthy mobility by bicycle or walking, including commutes between home and university.
- Participants: A total of 38 participants were measured at Camilo José Cela University, of which 17 were women (44.74%) and 21 were men (55.26%). To be precise, participants who regularly cycled or were high-performance athletes were excluded from the study. Those participants, as well as those who indicated any type of medical pathology, were excluded. This way, we aimed to approach a sample of participants with comparable characteristics and lifestyles. Additionally, homologous results obtained from 16 additional participants at the University of Coimbra were included. Therefore, the total sample consists of 54 participants, of which 58.33% were male and 41.77% were female participants.

The measurements included:

- Anthropometrics: Weight, height, body mass index (BMI), etc.
- Skinfold: Measurement of subcutaneous fat in different parts of the body.
- Ruffier-Dickson Test: Evaluation of cardiovascular capacity.

2.1 Results Comparison of Anthropometric Measurements

- Weight:
 - Baseline: Average of 72 kg, with a standard deviation of 12.8 kg
 - Post: Average of 71.8 kg, with a standard deviation of 12.8 kg





- Variation: No appreciable changes in weight
- By gender, for male participants, the average weight was estimated at 73.28 kg at the beginning of the measurement and 72.96 kg at the end of the measurement. On the other hand, for female participants, the average weight measured was 69.69 kg at the beginning of the measurement and 69.70 kg at the end.
- Height:
 - Baseline: Average of 170 cm, with a standard deviation of 10 cm
 - Post: Average of 170 cm, with a standard deviation of 10 cm
 - Change: No changes observed
 - By gender, the average height for male participants was 174 cm and for female participants was 169 cm.
- BMI: Body Mass Index
 - Baseline: Average of 24.3, with a standard deviation of 4.1 points
 - Post: Average of 24.1, with a standard deviation of 4.0 points
 - Variation: No significant changes in body mass index after exercise. No changes in body mass index by gender were observed. In this case, the test did not influence this parameter.

2.2 Comparison of Skinfold Measurements

- Triceps Skinfold:
 - Baseline: Average of 19.1 mm, with a standard deviation of 9.0 mm
 - Post: Average of 19.2 mm, with a standard deviation of 8.4 mm
 - Variation: 0.1 mm average increase. This variation is almost imperceptible
- Subscapular Skinfold:
 - Baseline: Average of 21.6 mm with a standard deviation of 8.4 mm
 - Post: Average of 16.0 mm with a standard deviation of 5.9 mm
 - Change: 5.6 mm average decrease
- Suprailiac Skinfold:
 - Baseline: Average of 21.1 mm with a standard deviation of 8.4 mm
 - Post: Average of 19 mm with a standard deviation of 6.8 mm
 - Change: 2.1 mm average decrease
- Abdominal Skinfold:
 - Baseline: Average of 23.1 mm with a standard deviation of 9.6 mm
 - Post: Average of 18.8 mm with a standard deviation of 5 mm
 - Variation: A slight decrease of 4.3 mm is observed.
- Thigh Skinfold:
 - Baseline: Average of 21.1 mm with a standard deviation of 9.1 mm
 - Post: Average of 18.8 mm with a standard deviation of 5.1 mm
 - Variation: A slight decrease of 2.3 mm on average is observed.

Regarding the overall sum of skinfolds, the sample of participants resulted in a slight decrease, from an overall average of 108.8 mm to 91.3 mm at the end of the measurement.





The average standard deviation is around 39.5 mm at the beginning of the test and 24.4 mm after the active healthy mobility test. Based on the characterization tables for body fat percentage, the following was observed:

(a) Male participants:

- 3 participants (10.7%) are classified as “Lean” at the beginning of the test, with no change in condition once the test is completed.
- 15 participants (53.6%) are classified as “Ideal” both at the beginning and at the end of the test, with no significant changes.
- 8 participants (28.6%) are classified as “Average” at the beginning of the test. All of them maintain their classification at the end, except for one who moves to the “Ideal” category.
- Another 2 participants (7.1%) are classified above average. In the case of male participants, the body fat percentage slightly decreased from 13.85% at the beginning of the test to 12.99% at the end of the active healthy mobility test.

(b) Female participants:

- 6 participants (24.0%) are classified as “Lean” at the beginning of the test, with no change in condition once the test is completed, except for one case that moves to the “Ideal” category.
- 12 participants (48.0%) are classified as “Ideal” both at the beginning and at the end of the test, with no significant changes.
- 4 participants (16.0%) are classified as “Average” at the beginning of the test. Both maintain their classification at the end.
- 3 participants (12.0%) are classified “Above Average” at the beginning of the test, moving to an “Ideal” classification at the end. In the case of female participants, the body fat percentage slightly decreased from 22.81% at the beginning of the test to 22.1% at the end of the active healthy mobility test.

2.3 Ruffier-Dickson Test

- Resting Heart Rate (HR_{rest}):
 - Baseline: Average of 72.9 beats with a standard deviation of 10.3
 - Post: Average of 74.1 beats with a standard deviation of 8.6
 - Variation: A slight increase of 1.2 points is observed between the beginning and the end of the measurement period.
- Heart Rate after performing squats (HR_{post}):
 - Baseline: Average of 110.7 beats with a standard deviation of 23.1 beats
 - Post: Average of 119.4 beats with a standard deviation of 19.2 beats
 - Variation: An average increase of 8.7 beats is observed between the beginning and the end of the measurement period.
- Heart Rate 1 minute after exercise (HR_{1min}):

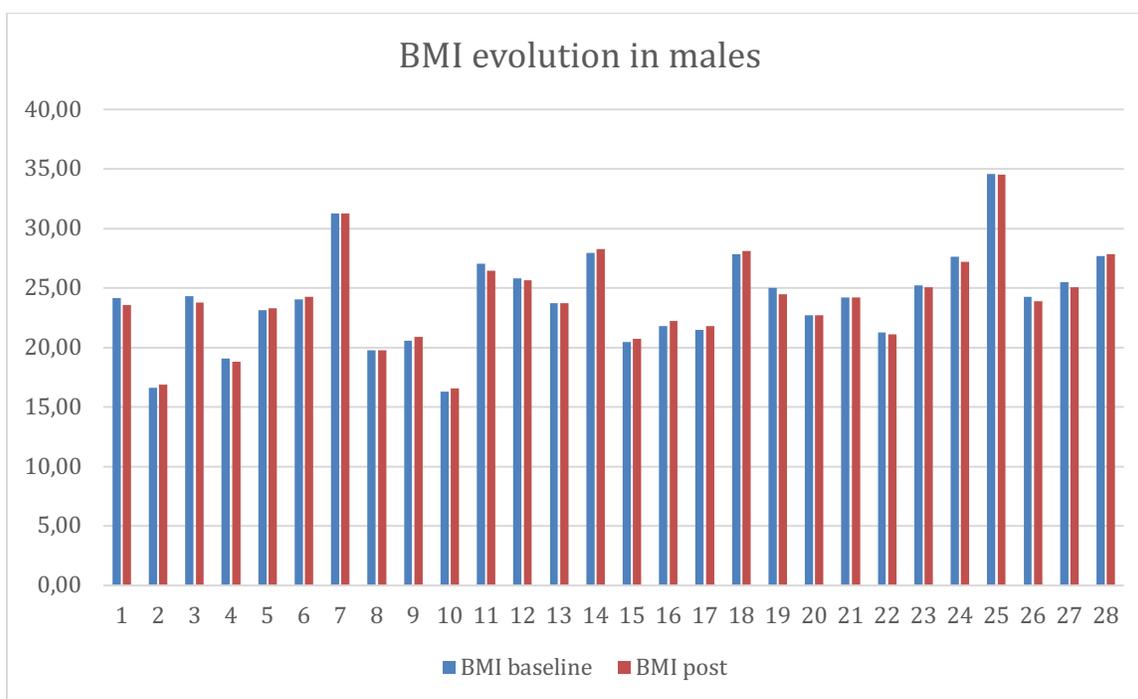


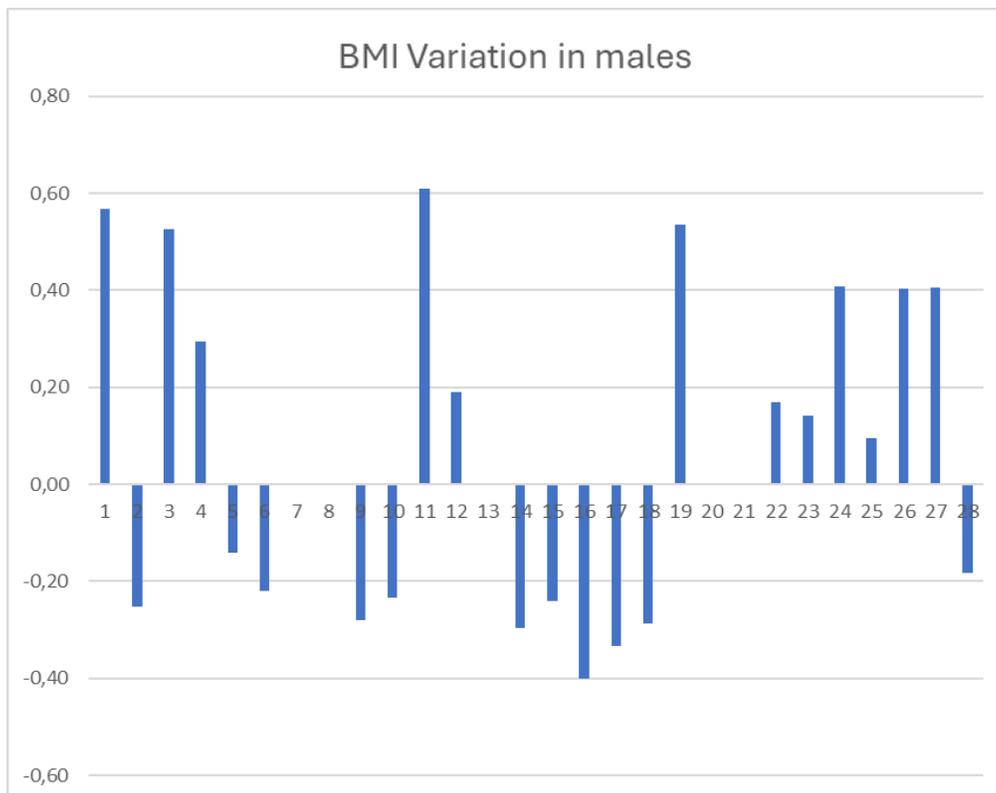


- Baseline: Average of 75.1 beats with a standard deviation of 17.5 beats
- Post: Average of 85.4 beats with a standard deviation of 12.3 beats
- Variation: A significant average increase of 10.3 beats is observed between the beginning and the end of the measurement period.
- Ruffier-Dickson Index:
 - Baseline: Average of 4.5 points with a standard deviation of 4.0
 - Post: Average of 7.2 with a standard deviation of 2.9
 - Variation: A significant increase of 2.7 points is observed.

3. Discussion

In general, the results indicate that there were significant changes in anthropometric measurements.

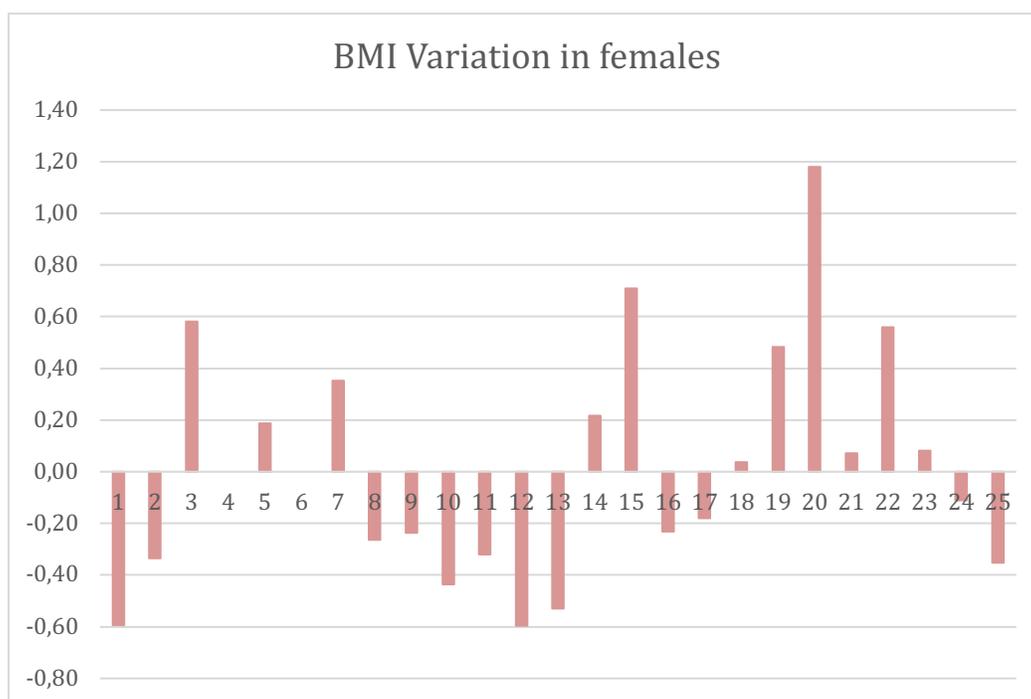
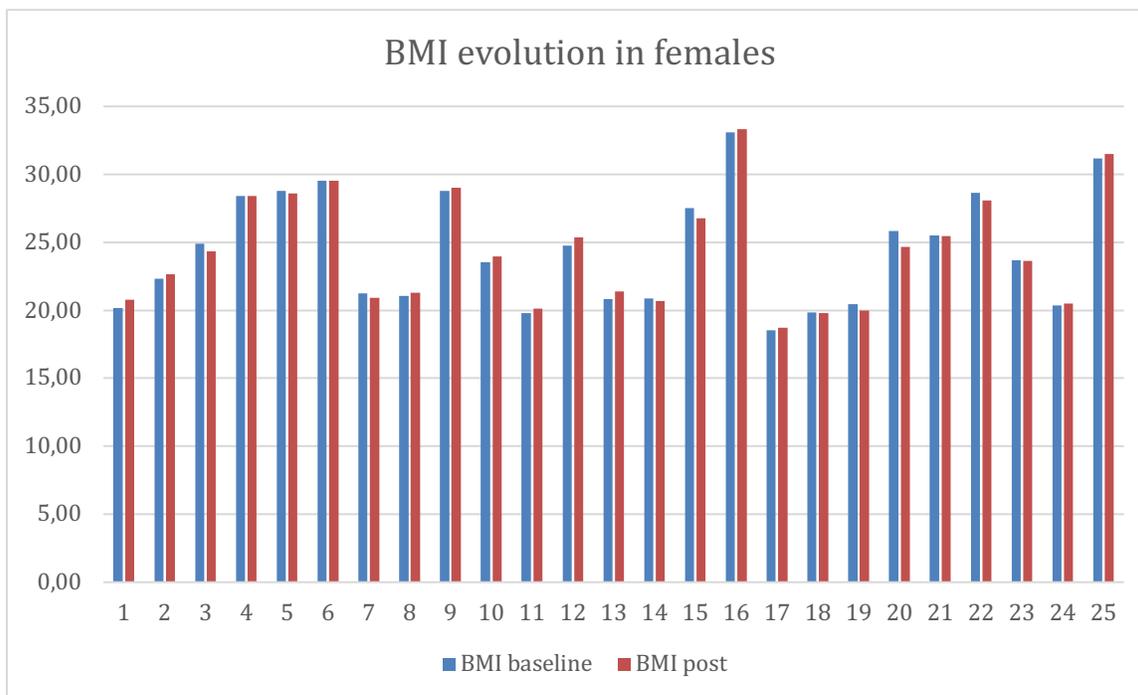




In the case of male participants, it has been observed that the practice of healthy mobility has a positive impact. The sample average indicates an average decrease in body mass index of about 0.05 points after the measurement period. However, 17.9% of the participants did not experience significant changes; 39.3% achieved an average decrease of more than 0.2 points, while the remaining 42.8% experienced an increase in muscle mass, even above 0.4 points.

In the case of female participants, the following are the results corresponding to the evolution of body mass.





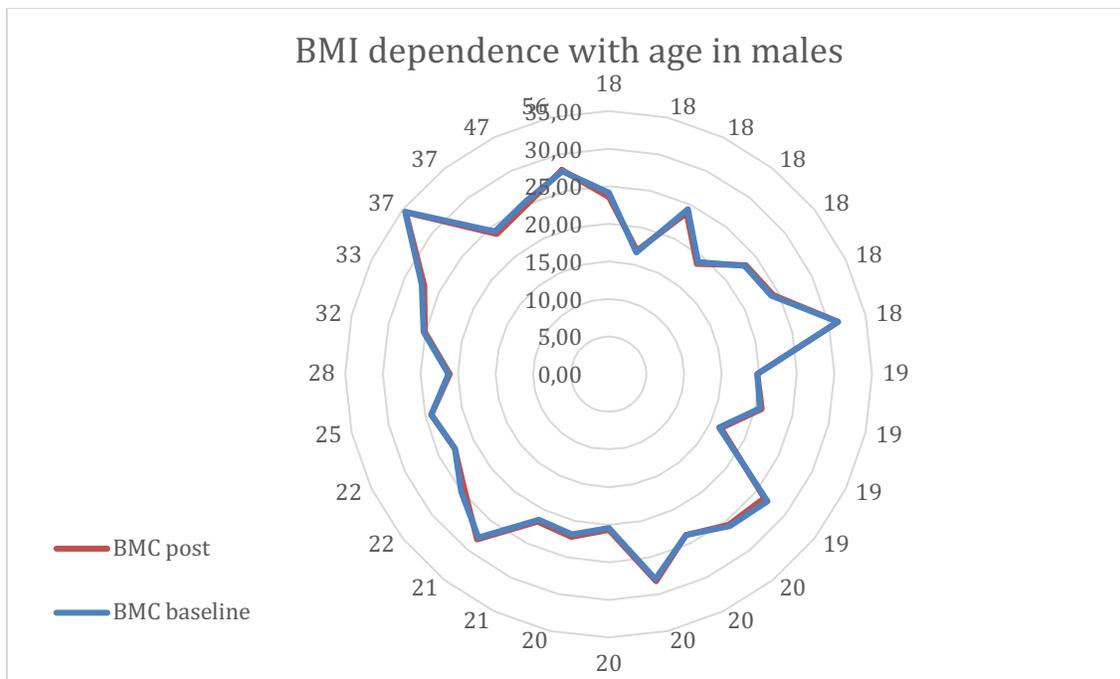
In the case of female participants, the results were less remarkable. It can be said that the practice of healthy mobility did not affect the body mass index during the measurement period. The sample average indicates that the observed variation is about 0.01 points after the measurement period. In this case, 20% of the participants did not experience significant





changes; nearly 48% achieved an average decrease of more than 0.35 points, while the remaining 32% experienced an increase in muscle mass, averaging above 0.4 points.

If we consider the age of the participants, we can observe the following analysis:

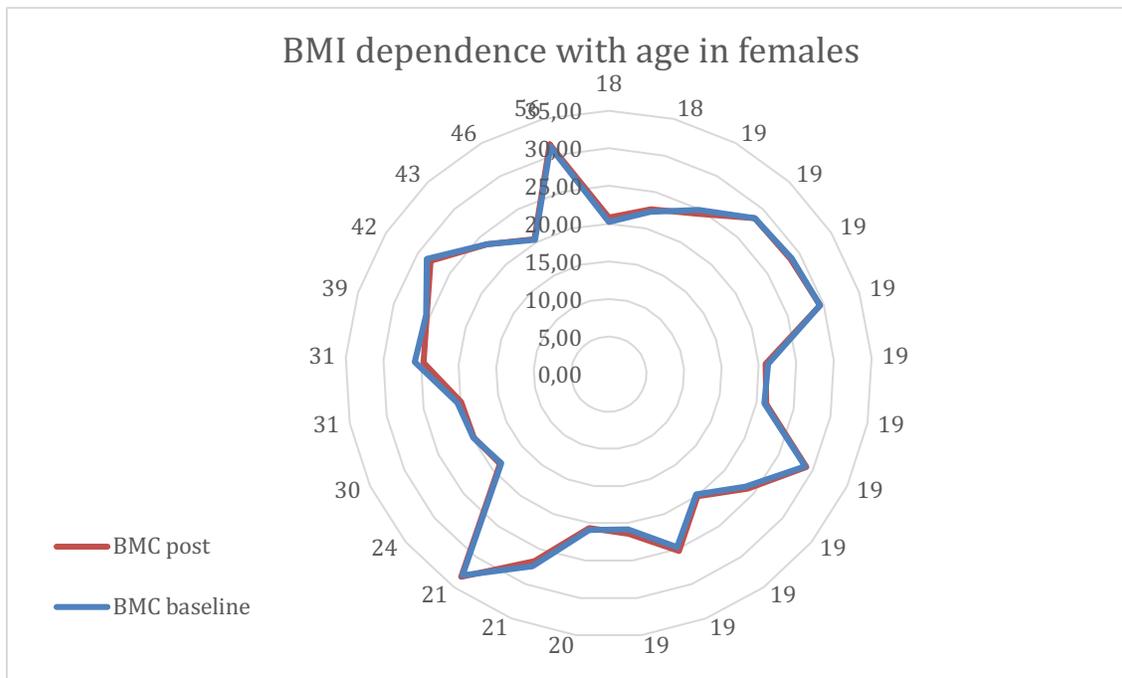


In male participants, no trend was observed in body mass index changes based on their age.

A similar situation occurs with female participants. When representing the results before and after being subjected to active healthy mobility tests for more than four weeks, no age-related biases are observed.

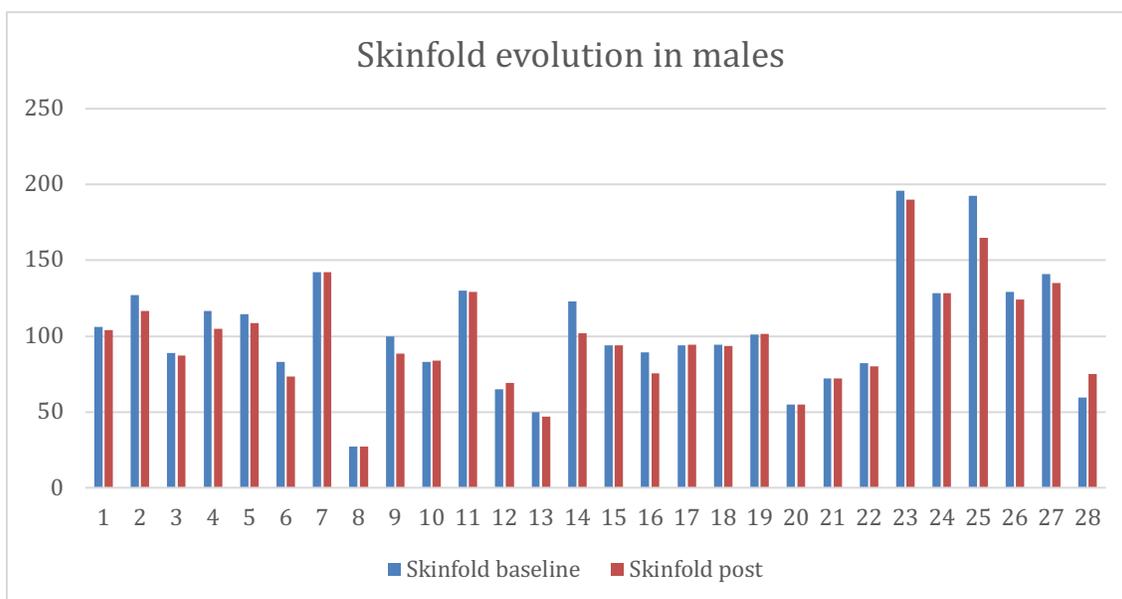
Therefore, the variations in body mass index do not show dependence on either the gender or the age of the participants. It is likely a function of the intensity and frequency of the exercise performed, healthy habits, and the diet of each participant.





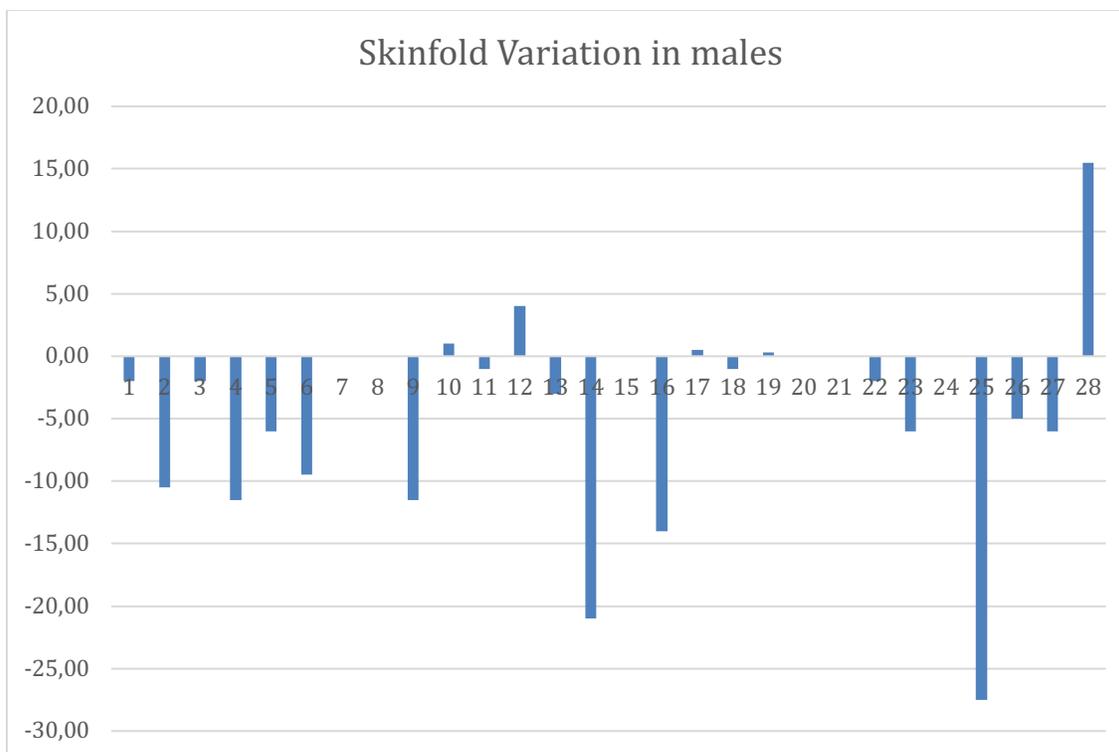
3.1 Influence of Healthy Mobility on Skinfold Capacity

Continuing with the next measured parameter, the skinfold capacity of the participants in the active healthy mobility program is addressed below. The results obtained for male participants are shown below.





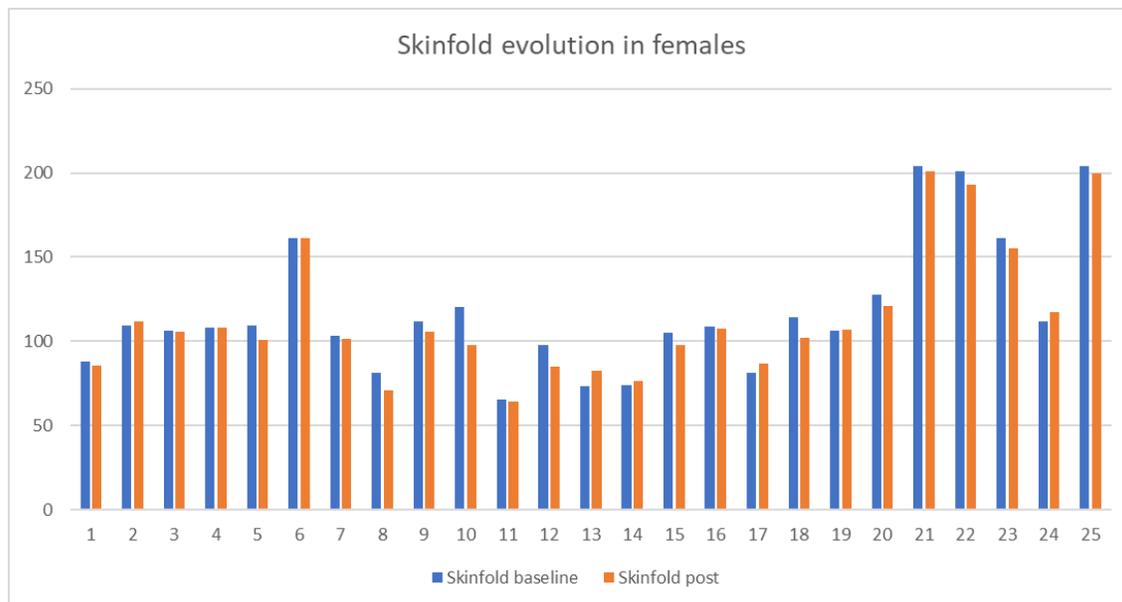
As can it be observed, the trend for male participants centres around an average of 103 mm of skinfold before undergoing the active mobility program to 98.8 mm after completing the program, with a slight average decrease of about 4%.



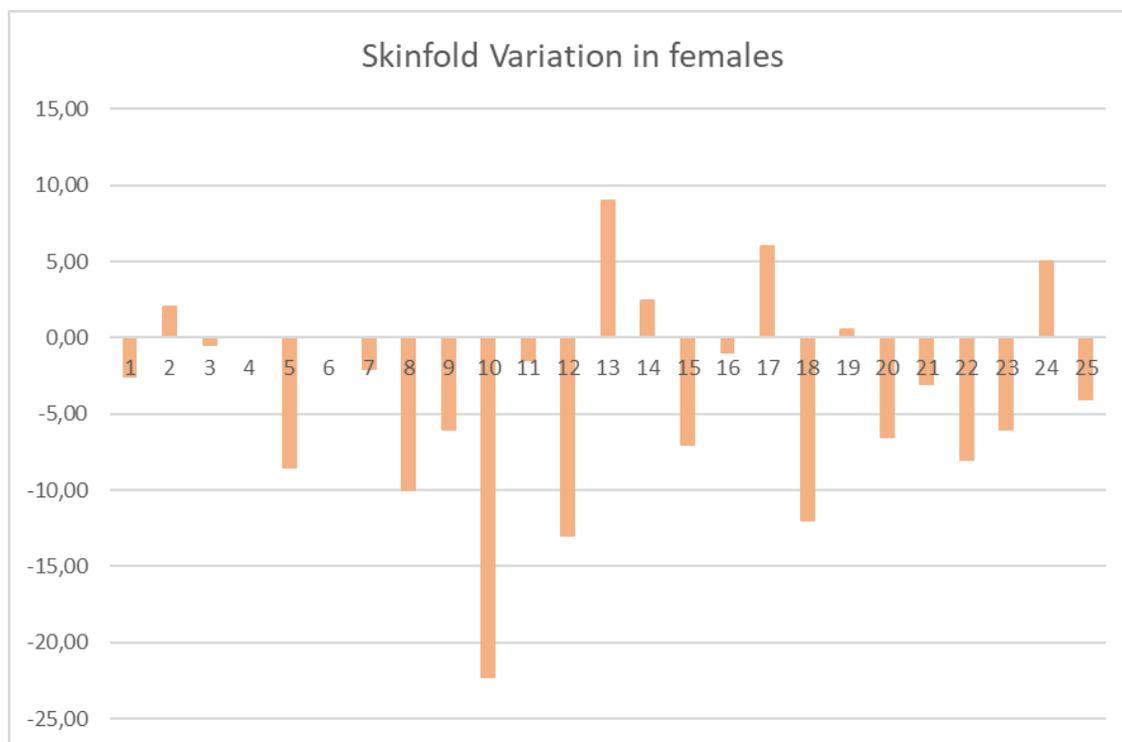
In the case of male participants, an average decrease of 4.43 mm was observed in the overall skinfolds (triceps, subscapular, suprailiac, abdomen, and thighs). This could indicate that the practice of healthy mobility has a positive impact, potentially leading to an overall reduction in the amount of subcutaneous fat. According to the data obtained, 33.3% of the participants did not experience significant changes; 57.1% achieved an appreciable reduction, with an average decrease of more than 5 mm, while the remaining 9.6% experienced a slight increase in the volume of their skinfolds.

For female participants, the observed trend is similar.





The average participants obtained overall average values of 117.4 mm before undergoing the healthy mobility test, reaching 113.8 mm after the measurement period. In this case, an average decrease of about 3.6 mm was observed. Below is the graph showing the variation in overall skinfold capacity.



The behaviour in the case of female participants was analogous to that of male participants. The situation led to an average decrease of 3.55 mm in overall skinfolds (triceps,

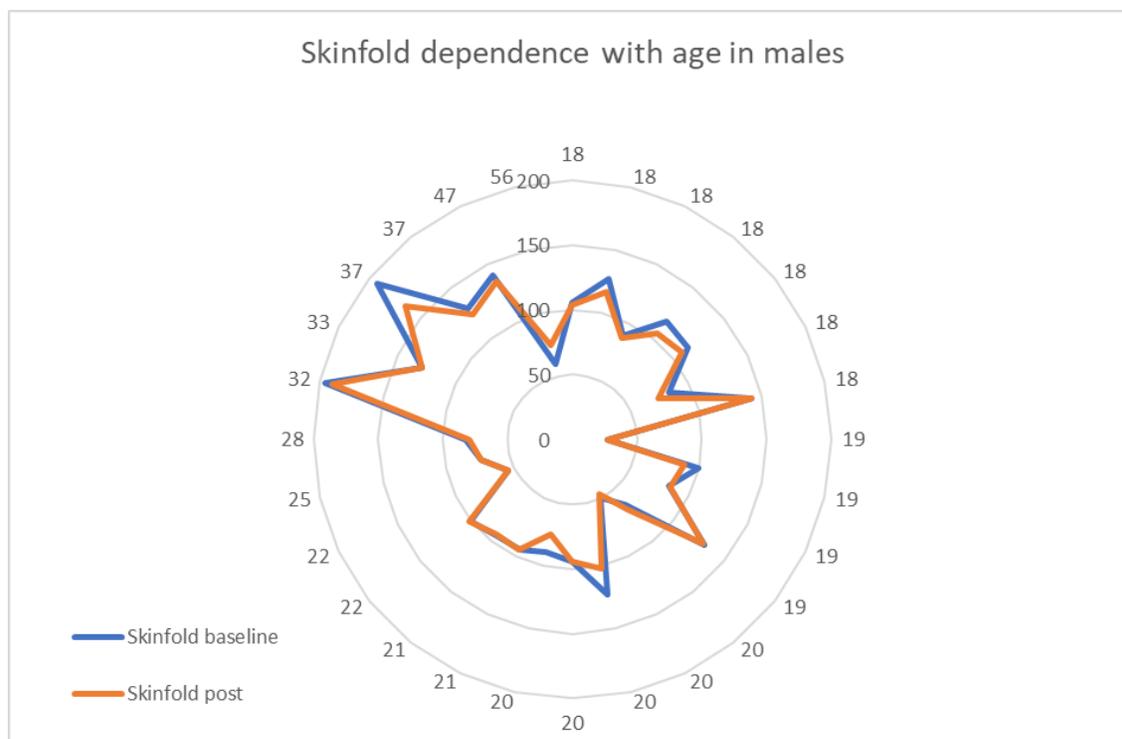




subscapular, suprailiac, abdomen, and thighs). Similarly, this could indicate that the practice of healthy mobility has a positive impact on the participants, with a decrease in the amount of subcutaneous fat. According to the results obtained, 20% of the participants did not experience significant changes; nearly 60% achieved an average decrease of more than 6 mm, while the remaining 20% experienced a slight increase in the volume of their skinfolds, which in some cases exceeded 10 mm overall.

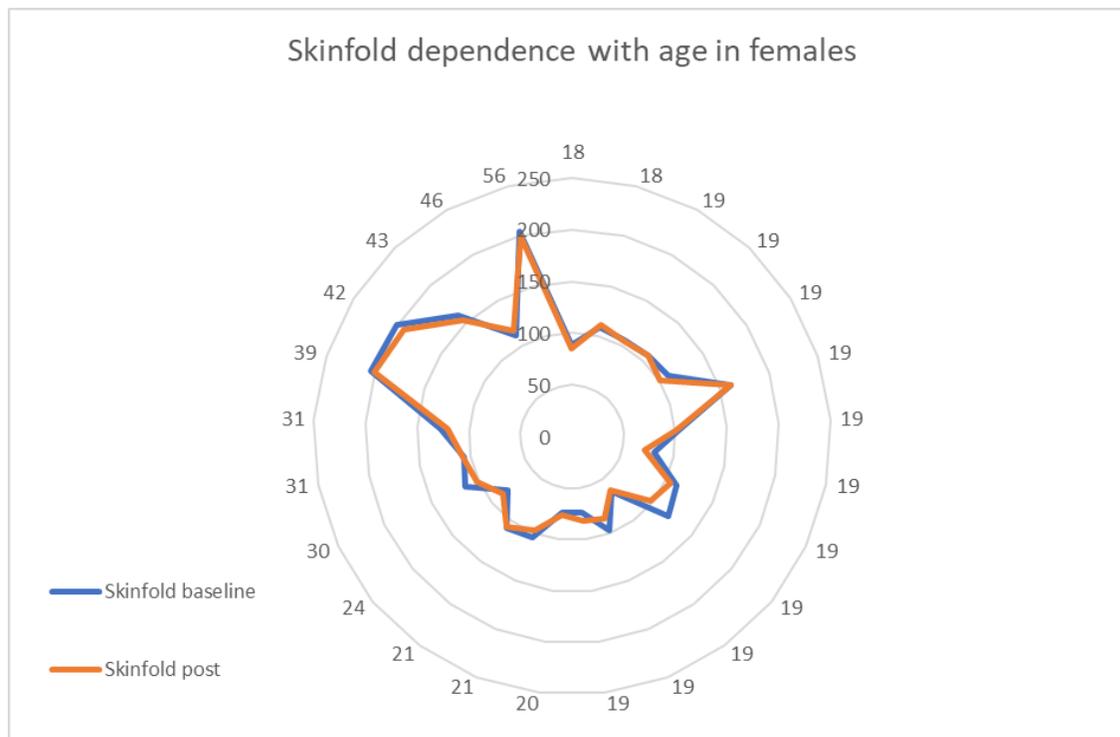
Regarding the age of the participants, no dependencies were observed in the capacity for skinfold variation. Below are the graphs with the corresponding analysis for both male and female participants.

Therefore, it can be considered that the accumulation or reduction of subcutaneous fat, and thus the capacity of skinfold volume, is not a determining factor in relation to age or gender.



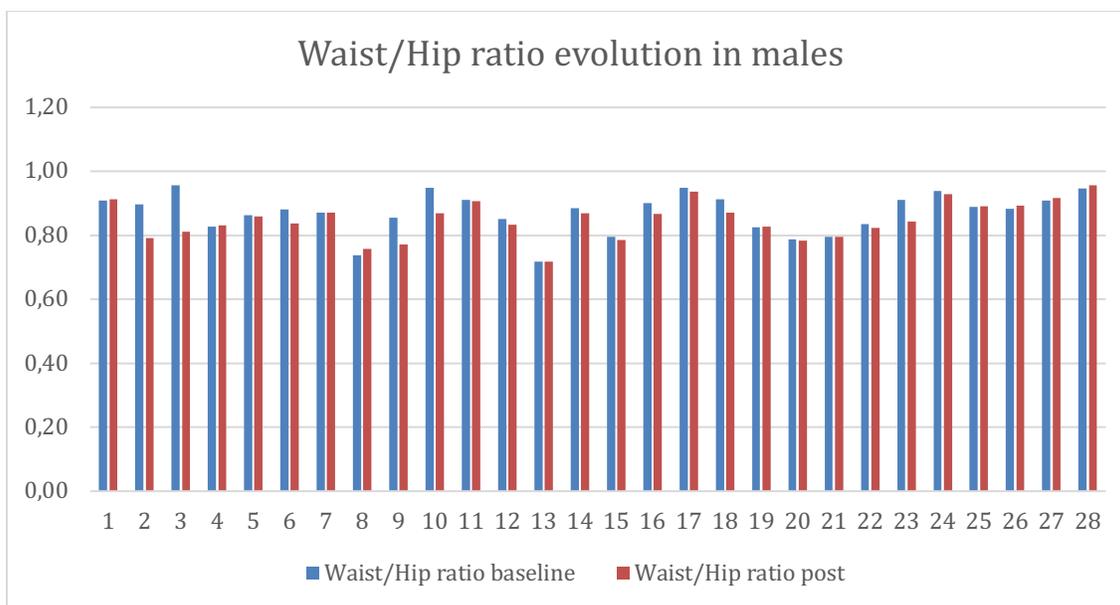
According to the analysis conducted for participants, both male and female, aged between 18 and 56 years, no dependency was observed in the capacity for skinfold volume variation with age after following the healthy mobility program.





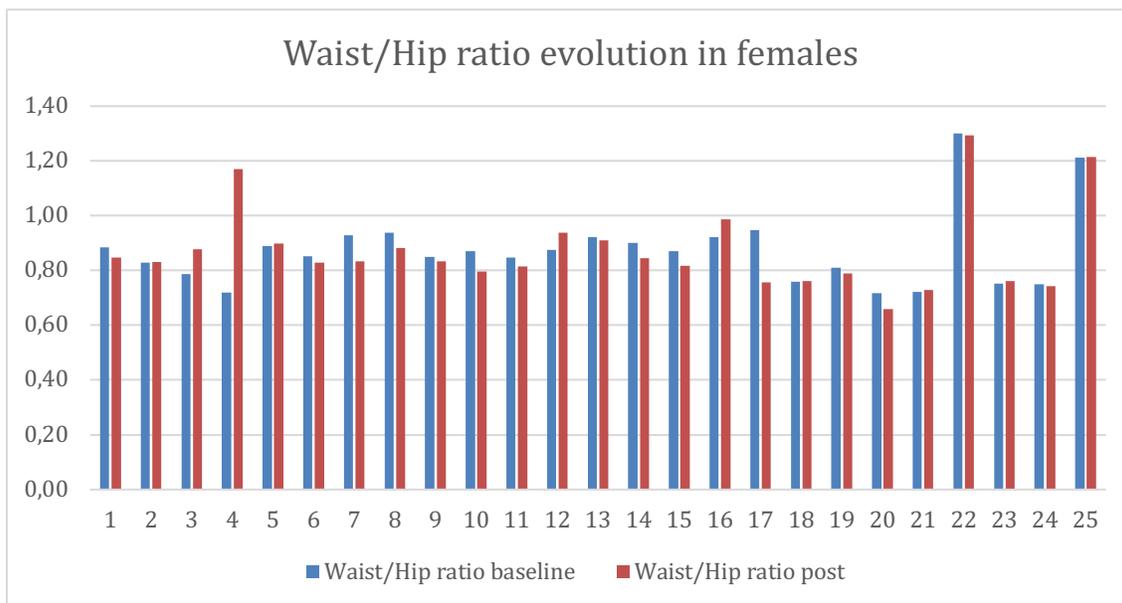
3.2 Influence of Healthy Mobility on Waist/Hip Ratio

Another parameter estimated by measuring the participants was the waist/hip ratio. In this regard, the evolution before and after subjecting the participants to the active healthy mobility program was measured. The following results were obtained.





In the case of male participants, at the beginning of the program, average values of around 0.8710 were obtained for the W/H ratio (waist to hip), while at the end of the program, this ratio decreased to an average value of 0.8485. As can be observed, most participants achieved a reduction in this ratio, and only a few participants (17.8%) experienced an increase in this ratio.



For female participants, the results indicated average values of 0.8742 for the W/H ratio at the beginning of the program and 0.8724 at the end of the program. In this case, the decrease was much less pronounced (0.2% compared to 2.5% in the case of men).

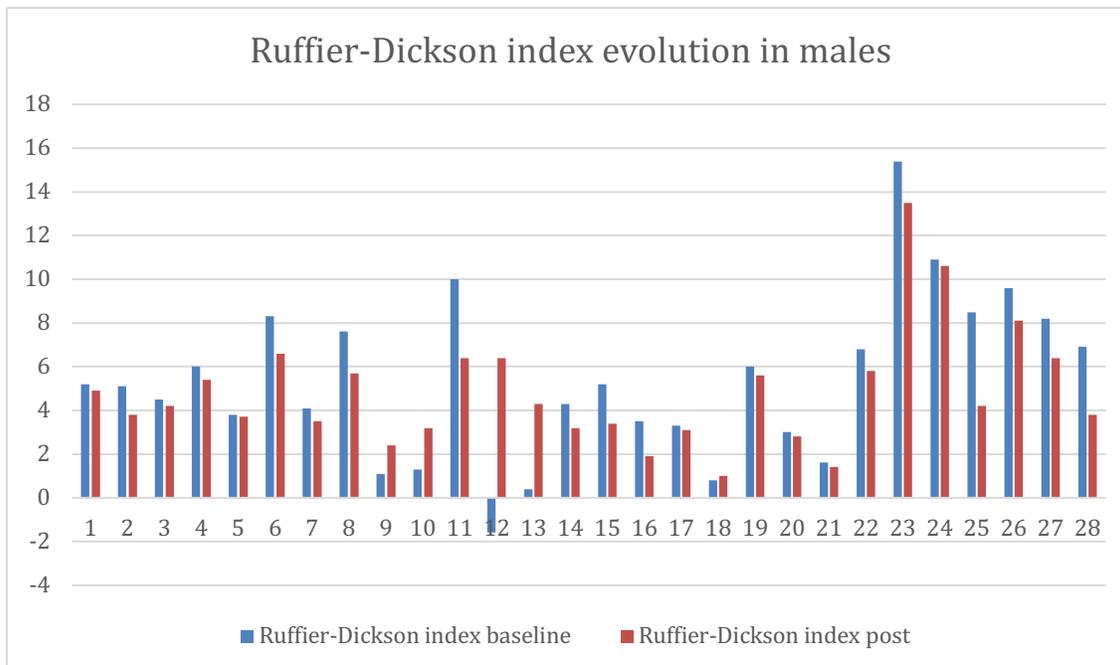
Regarding the influence of age, the behaviour is analogous to the previous parameters.

3.3 Influence of Healthy Mobility on Ruffier-Dickson Index

In general, the Ruffier-Dickson test employs different heart rate measurements at separate times. It measures the resting heart rate before exercise (HRrest), the heart rate after performing squats (HRpost), and the heart rate value 1 minute after exercise (HR1min).

Ultimately, these values are used to calculate the Ruffier-Dickson index, which allows for the evaluation of cardiovascular condition and the heart’s recovery capacity. Below are the results for male participants.

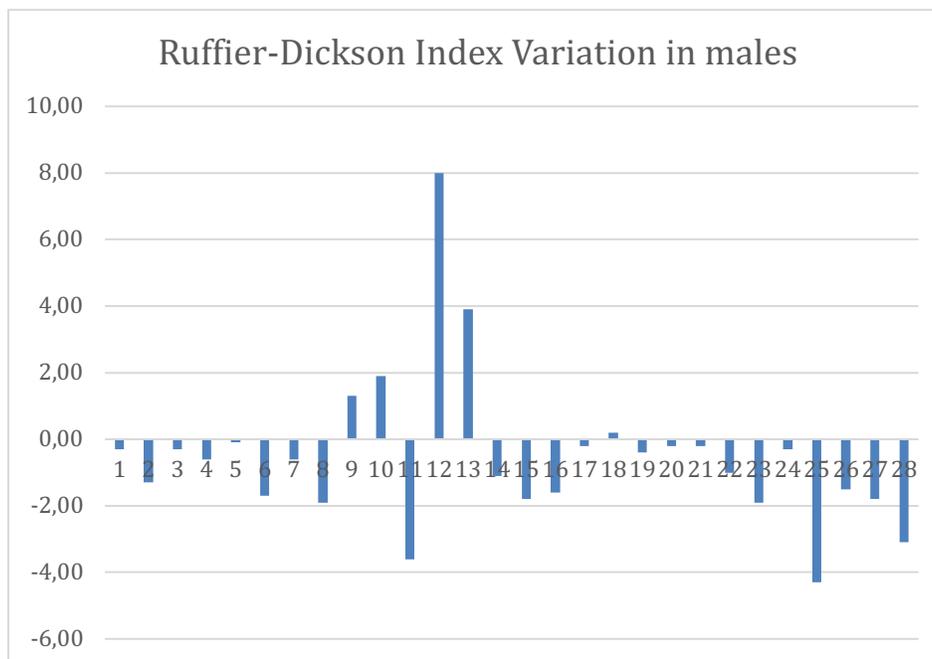




The values obtained at the beginning of the test indicate an average Ruffier-Dickson index of around 5.35 points, decreasing to an average value of 4.83 at the end of the test, implying an average decrease of about 0.52 points. Although there are some anomalous points in some participants, it is noteworthy that 82.14% of the participants achieved a reduction in this index, which translates into an improvement in their cardiovascular health.

Seventeen participants fall within a range of 1 to 5, indicating particularly good physical condition. Nine participants achieved acceptable good physical condition (range of 6 to 10), and only two participants are in poor physical condition (more than 10 points).

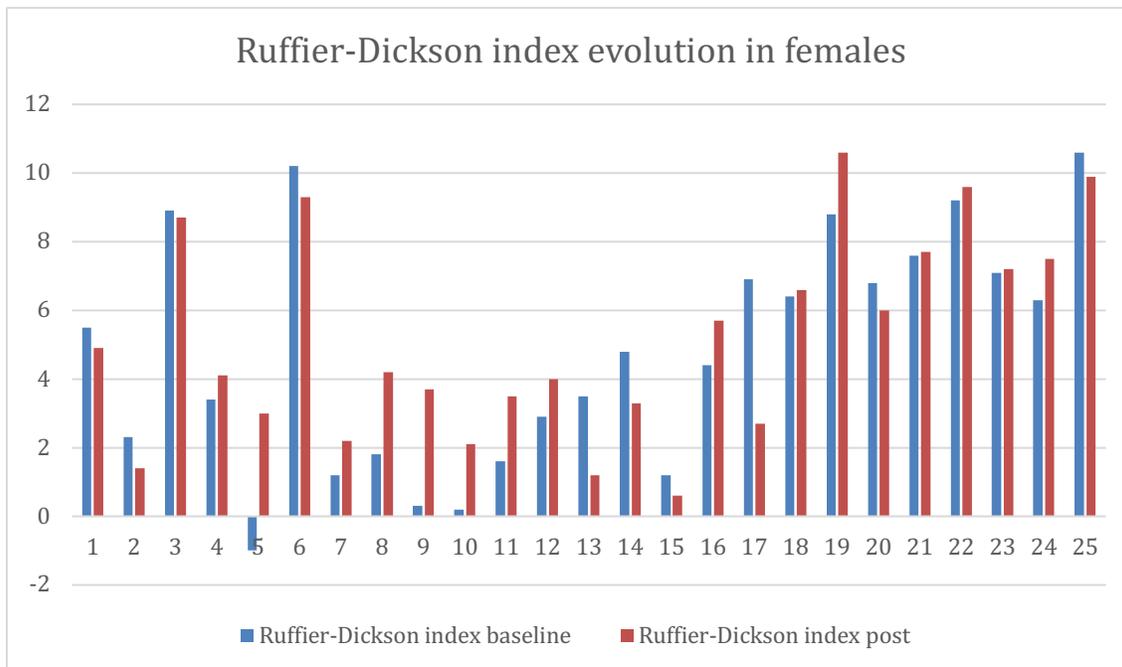


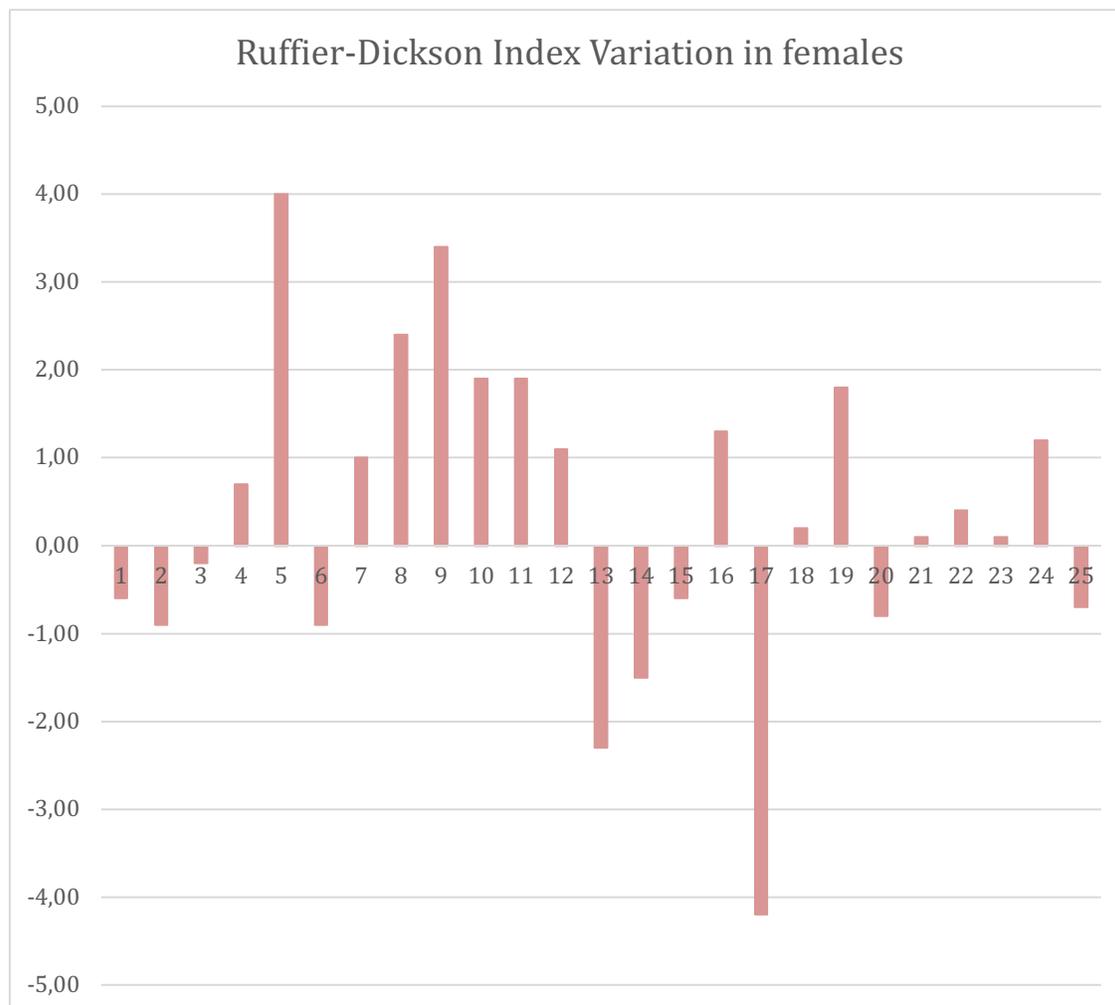


The behaviour observed in male participants was very satisfactory. The measurement period with healthy mobility generated an average decrease of 0.52 points in the overall values obtained for the Ruffier-Dickson index. This indicates a beneficial phenomenon from the point of view of heart rate and its recovery speed. According to the results obtained, 85% of male participants achieved significant beneficial changes, resulting in a decrease in this parameter of more than one point. Most of these participants achieved significant increases in their cardiac capacity. On the other hand, the remaining 15% did not improve, even experiencing significant increases.

Female participants achieved equally satisfactory results. In this case, the measurement period with healthy mobility generated an average decrease of 0.352 points in the overall values obtained for the Ruffier-Dickson index, above the values obtained for their male counterparts. Again, this can be considered a beneficial fact from the point of view of heart rate and its recovery speed.







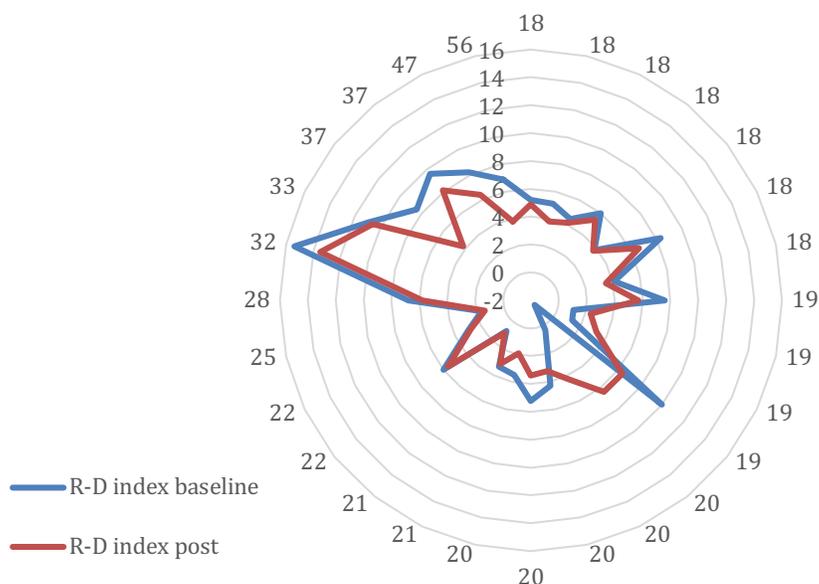
Based on the results obtained, we can interpret that 40% of the participants achieved significant beneficial changes, resulting in a decrease in this parameter of more than 1.2 points. However, 60% of the participants did not achieve appreciable improvement. Additionally, 32% of the participants did not improve their records, even experiencing a slight increase of more than two points in a couple of cases.

Regarding the influence of the participants' ages, for male participants, no significant biases are observed. The variation in this index can be considered independent of the age range.

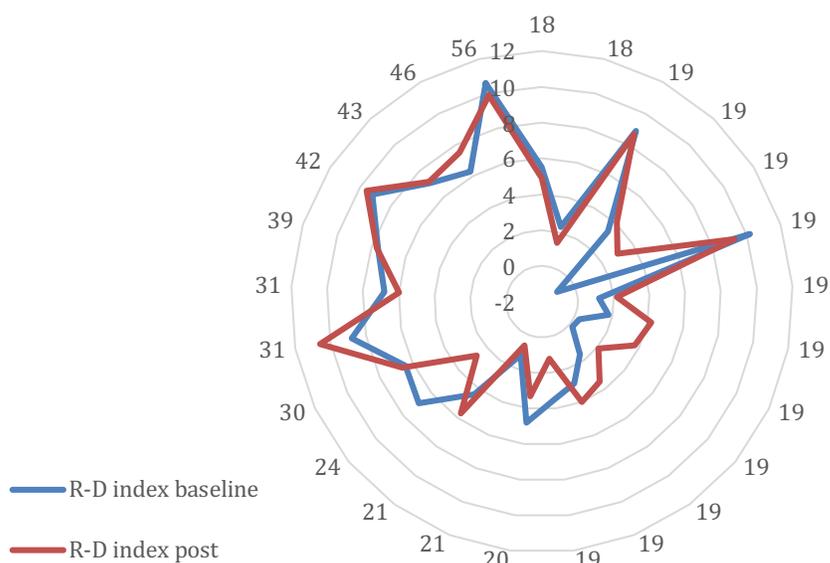




Ruffier-Dickson index dependence with age in males



Ruffier-Dickson index dependence with age in females



On the other hand, for female participants, the results seem to be more pronounced for younger ages, although the analysis should not be considered conclusive in this regard.





3.4 Influence of Healthy Mobility on Aerobic Capacity

The estimation of maximum oxygen volume (VO_2max) is a key measure for evaluating aerobic capacity and the efficiency of the cardiovascular system during exercise. In our case, we have made an estimation based on the participants' behaviour through the so-called VO_2max . This parameter can be defined as the maximum amount of oxygen the body can use during intense exercise. It is measured in millilitres of oxygen per kilogram of body weight per minute (ml/kg/min).

Really, it is an indicator for evaluating aerobic capacity and performance in endurance sports. The higher the VO_2max , the greater the body's capacity to perform prolonged exercises without excessive fatigue.

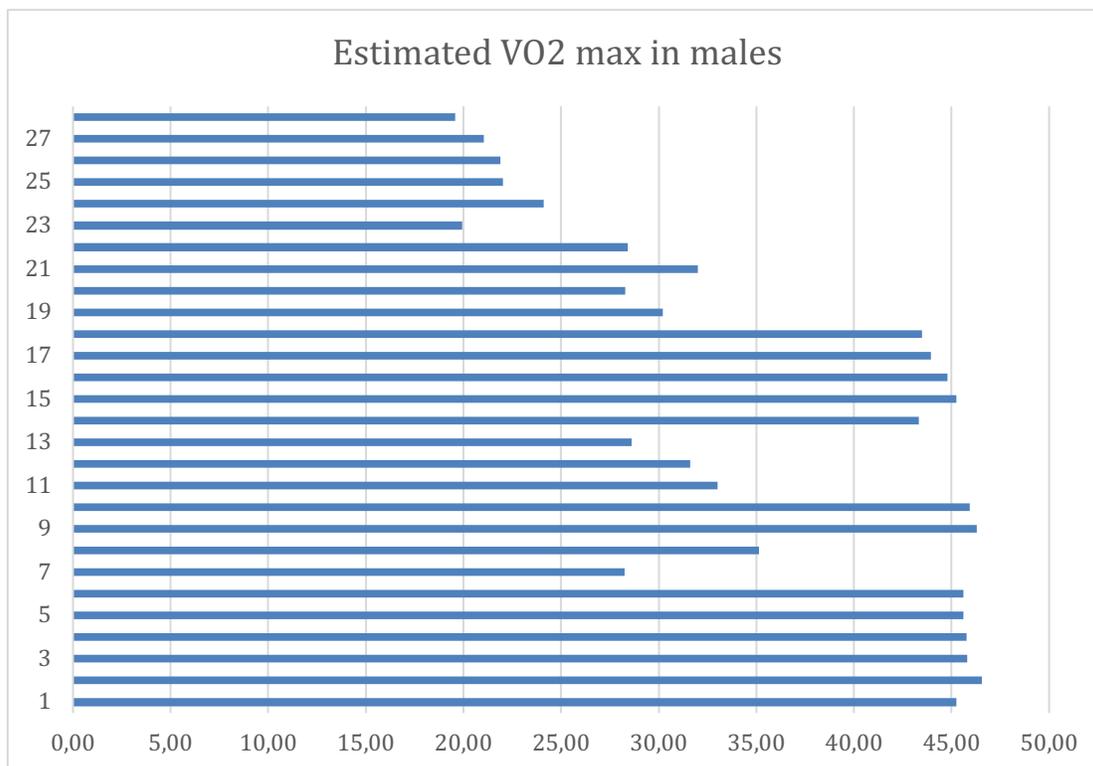
Reference values differ depending on gender and age. In our case, the values that could be considered adequate for male participants in our environment should be in the range of 40-50 ml/kg.min, while for female participants, the appropriate range should be between 35-45 ml/kg.min.

In other words, the estimation of VO_2max is a valuable tool for understanding progress in aerobic capacity and cardiovascular health after a period of training or healthy mobility.

In our case, we made an estimation based on the measured heart rate data after the measurement period with the participants in the healthy mobility program. Although the results obtained are not exhaustive, we can make some consideration of the participants' situation, considering the average reference values mentioned above.

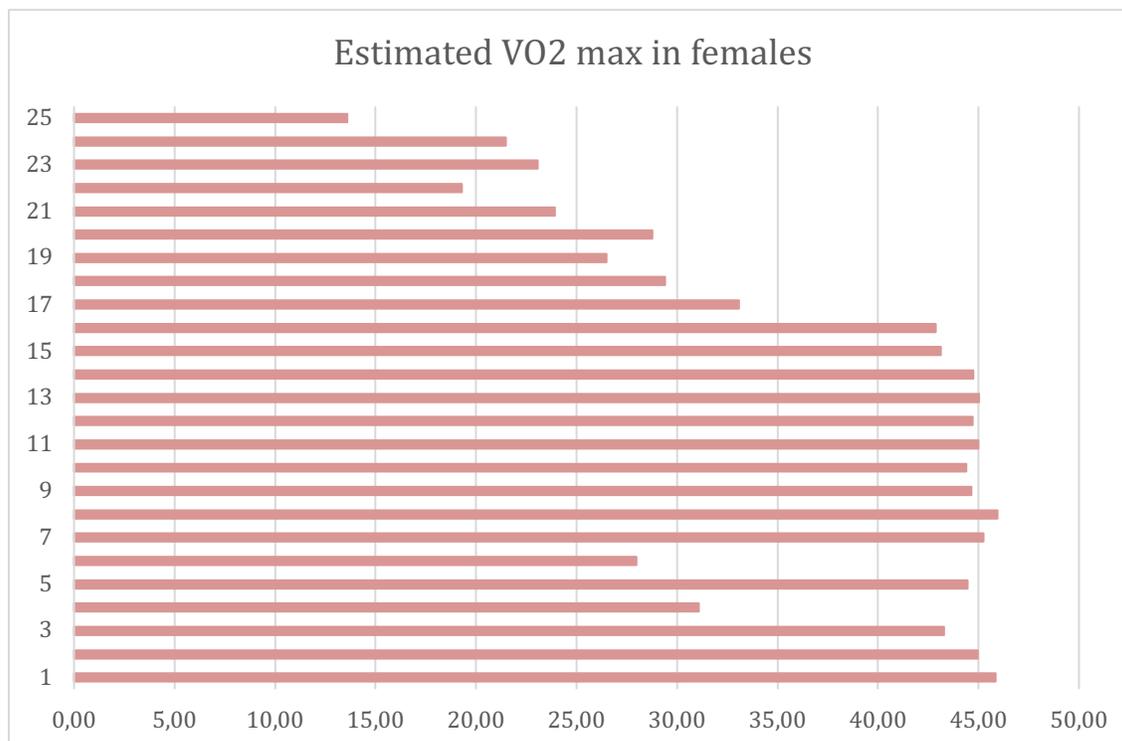
For male participants, the estimated maximum oxygen volume ranged between 19.6 and 46.2 ml/kg.min. The average value obtained was 35.4, which means that most participants are in the lower range of their physical condition. In fact, only 65% of male participants exceed 40 ml/kg.min, while 15% do not reach the value of 30 ml/kg.min, and 20% are between 30 and 40 ml/kg.min.





On the other hand, female participants are in better shape than their male counterparts. In this case, the estimated maximum oxygen volume ranged between 13.6 and 45.8 ml/kg.min. The average value obtained was 35.13, like that of the male participants. This implies that, in general, female participants are close to the expected range for their physical condition. In this case, the estimated data reveal that 82% of female participants exceed 35 ml/kg.min, while 6% do not reach the value of 30 ml/kg.min, and 12% are between 30 and 35 ml/kg.min.





4. Conclusion

In view of the results obtained, we can conclude that the healthy mobility program by bicycle or walking had a positive impact on the anthropometric measurements, skinfold measurements (subcutaneous fat), and cardiovascular capacity of the participants.

Finally, if we consider the waist-to-hip ratio (WHR), understood as a measure that compares the circumference of the waist with the circumference of the hips, we can consider that this ratio is important because it helps to evaluate the distribution of body fat and can be a significant indicator of risk for diseases such as diabetes, heart disease, and strokes.

In general, a high WHR value indicates a higher proportion of abdominal fat compared to hip fat, which is associated with a higher risk of health problems. On the other hand, a low WHR suggests a lower amount of abdominal fat, which is usually related to a lower risk of chronic diseases.

Taking this into account, the average participants in the healthy mobility program have a WHR value of around 0.83 points for male participants and a WHR value of 0.87 points for female participants. In this sense, most participants have a moderate health risk in the case of women and a minimal risk in the case of men.

Regarding the weight of the participants included in the program, it is worth noting that there were nearly no significant changes in the overall average weight (from 72 kg to 71.8 kg).





However, slight variations were noted by gender: men showed a slight decrease (from 73.28 kg to 72.96 kg), while women showed a slight increase (from 69.69 kg to 69.70 kg).

The body mass index remained stable on average (23.8). Women showed a slight increase (from 24.36 to 24.46), while men showed a slight decrease (from 23.15 to 23.04).

Regarding the accumulation of subcutaneous fat, the triceps skinfold of the participants experienced a slight increase of 0.7 mm (from 15.6 mm to 16.3 mm), indicating a minor increase in subcutaneous fat in this area. The subscapular skinfold experienced a significant decrease of 3.5 mm (from 19.5 mm to 16 mm), suggesting a reduction in subcutaneous fat in this area. In the case of the suprailiac skinfold, there was a minimal increase of 0.1 mm (from 18.9 mm to 19 mm), a.

As for the abdomen and thigh skinfolds, the variations were not significant, from 18.7 mm to 18.8 mm and from 21.4 mm to 21.2 mm, respectively.

In the case of the data related to the Ruffier-Dickson test, based on the results obtained, it can be inferred that the cardiovascular capacity of the participants has improved, given the context of healthy mobility. The average decrease in the Ruffier-Dickson index, for both men and women, indicates a significant improvement in cardiovascular capacity and heart recovery after exercise. This is a positive result, highlighting the benefits of healthy mobility on cardiovascular health.

In general, in the case of male participants, healthy mobility had a moderately positive effect on BMI, with an average decrease of 0.06 points. Although some participants did not experience changes, most showed a significant reduction, suggesting an improvement in body composition.

For female participants, the results were more pronounced, with an average decrease of 0.10 points in BMI. This indicates that healthy mobility had a more notable impact on the body composition of women, with the majority achieving significant reductions in BMI.

Healthy mobility by bicycle or walking has shown positive effects on body composition and cardiovascular capacity of the participants. Although changes in subcutaneous fat vary among individuals, the improvement in the Ruffier-Dickson index is particularly noteworthy, indicating better cardiovascular recovery. These results suggest that healthy mobility can be an effective strategy to improve overall health and physical condition, although the effects may be more evident in some individuals than in others.

The healthy mobility program by bicycle or walking did not produce significant changes in the average weight and BMI of the participants. However, slight variations were observed in skinfolds, with a notable reduction in the subscapular skinfold, suggesting a possible improvement in body composition. These results indicate that healthy mobility can have positive effects on body fat distribution and cardiovascular capacity, although the changes may be subtle and require a longer period to become more evident.

