**Influence of Exercise on Anthropometric Indicators of Cardiovascular Risk in Elderly Women**

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**Abstract**

**Background:** Although there is evidence of the benefits of physical exercise on cardiovascular health (CV), only a few studies evaluate the effectiveness of community exercise programs in reducing CV risk indicators.

**Objective:** To compare anthropometric indicators of CV risk among elderly women who do not exercise.

**Methods:** In this cross-sectional study, the sample consisted of two groups: EMIPOA composed of 305 women (68.19±2.82 years; 69.31±13.88 kg, 1.54±0.07 m; body mass index (BMI) 29.30±5.54 kg/m²) coming from the Porto Alegre Multidimensional Study on Elderly Individuals; and PEG, consisting of 50 elderly women (68.28±4.68 years; 66.08±9.48 kg, 1.56±0.06 m; and BMI 27.29±3.62 kg/m²) participating in an exercise program. There following items were assessed: body mass (BM), BMI, abdominal circumference (AC), waist circumference (WC), abdomen/hip ratio (AHR), waist/hip ratio (WHR), body shape index (BSI) and body fat. The groups were stratified (60-69 years and 70-79 years). Normality of data was tested (Shapiro-Wilk and Kolmogorov-Smirnov) and the groups were compared (Student’s t test for independent samples or Mann-Whitney), considering p≤0.05 as significance level.

**Results:** The PEG (60-69 years) presented lower values than EMIPOA (60-69 years) for: BM, BMI, AC, WC, AHR, WHR and BSI. Height, the sum of skinfold thickness and body fat did not differ. For the 70-79 years stratum, only height difference was found (PEG>EMIPOA).

**Conclusions:** Participation in a physical exercise program influenced the levels of anthropometric indicators of CV risk and this influence was attenuated in older individuals.

**Keywords:** Health of the elderly; Exercise; Anthropometry; Risk factors

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**Introduction**

The Brazilian population follows an international trend of increased aging rate driven by a decline in fertility and mortality, in addition to increased life expectancy. In Brazil alone, there are more than 15 million elderly people¹. Porto Alegre is the second Brazilian capital with the highest proportion of elderly people, second only to Rio de Janeiro². This demographic transition brings increased prevalence of non-transmissible chronic diseases (NTCDs) and, consequently, an increase in mortality from these diseases³.

In Brazil and in other countries, cardiovascular (CV) diseases are the leading cause of morbidity and mortality⁴. These include ischemic heart disease, acute myocardial infarction, coronary artery disease and systemic hypertension⁵. In Brazil, morbidity of CVD is even greater in people with low income⁶.
The rapid increase in the prevalence of CVD in the end of the last century caused an alarming socio-economic scenario to be administered by governments and the private sector, significantly increasing expenses to cover treatment for these diseases. Mitigation of this problem depends on the development of global strategies for the prevention of CVD and health promotion. Evaluation of cardiovascular (CV) risk is of great importance for the early detection and timely treatment of CVD and also to provide support for more effective planning of public policies aimed at population health.

Traditional models for CV risk prediction consider the main risk factors: age, sex, blood pressure, smoking, history of diabetes mellitus and lipid profile. However, in primary care, this evaluation is not often feasible because of the difficulty in determining blood markers, whether because of delays in having the tests done or lack of resources to have the tests done. The use of anthropometric variables associated with other indicators available, routinely evaluated by primary care professionals.

The measurement of skin folds is commonly used to estimate body fat percentage. Body mass index (BMI) is the most studied and affordable variable. Although it is a general measure of obesity, BMI is considered strong indicator of mortality. Measures related to abdominal fat, waist circumference (WC) and abdominal circumference (AC), waist/hip ratios (WHR) and abdomen/hip ratio (AHR) have presented stronger associations with CVD than BMI, especially in women. More recently, a new mortality risk indicator developed, the body shape index (BSI), which considers waist circumference, BMI and height. This indicator was more accurate than the other ones in the prediction of cardiovascular risk in older people (55-79 years).

The main form of intervention in health promotion and CVD prevention is based on changes in people’s lifestyle. Increase in physical activity at leisure time is among the priorities in the strategic action plans on the global and nacional levels to face NTCD. High levels of physical fitness are associated with decreased incidence of CVD.

For elderly adults, it is recommended generally to perform moderate physical activity for at least 30 minutes daily, as well as intense physical activities two to three times per week. Community programs of physical exercise are important for maintaining the health and quality of life of older people. However, in most cases, these programs only focus on socialization, not considering any biological aspects associated with the individual’s functional capacity. Furthermore, regular control of exercise intensity and volume as well as individualization of overload are typically neglected. Ideally, global physical exercise programs should focus on different motor qualities in the same session of exercises.

There is a lack of studies evaluating the effectiveness of community exercise programs in reducing CVD risk indicators. Deeper understanding of possible morphological changes, resulting from a regular program of exercise can, above all, serve as a basis for more effective training structuring.

The objective of this study was to compare the levels of anthropometric CV health indicators (BMI, body fat, AHR, WHR and BSI) of older practitioners and non-practitioners of physical exercises.

Methods

The sample in this study was composed of two groups of elderly women aged ≥60, all living in Porto Alegre, RS. The first group comprised the elderly women selected for the Porto Alegre Multidimensional Study on Elderly Women (EMIPOA), a population-based survey conducted by the Institute of Geriatrics and Gerontology from Pontifícia Universidade Católica do Rio Grande do Sul (IGG-PUCRS). The second group (PEG) comprised elderly women engaged in physical exercises in a community exercise program developed as an extension project by PUCRS.

ABBREVIATIONS AND ACRONYMS

- AC – abdominal circumference
- AHR – abdomen/hip ratio
- BM – body mass
- BMI – body mass index
- BSI – body shape index
- CV – cardiovascular
- CVD – cardiovascular disease
- EMIPOA – Porto Alegre Multidimensional Study on Elderly Individuals
- NTCD – non-transmissible chronic diseases
- PEG – physical exercise group
- WC – waist circumference
- WHR – waist/hip ratio
The EMIPOA sample selection was organized in two steps. Initially, 1,164 elderly individuals were randomly selected and interviewed in their homes using a multidimensional investigation questionnaire. These elderly individuals were invited to participate in the second stage, which included a set of assessments by a multidisciplinary team. The samples were matched for housing area. Only women living in the same regions presented by the PEG elderly women were included in this study. Of the 472 elderly men and women who participated in the second stage and lived in the same regions, 305 women were included (68.19±2.82 years; 69.31±13.88 kg; 1.54±0.07 m; BMI 29.30±5.54 kg/m²).

The PEG group consisted of 50 women (68.28±4.68 years; 66.08±9.48 kg; 1.56±0.06 m; BMI 27.29±3.62 kg/m²). The program offered exercise and volleyball classes for 50 minutes, twice a week. Only the elderly women who have done exercise classes for at least three years were only included.

This study has been approved by the Research Ethics Commission of PUCRS under no. 1066/05-CEP. All participants signed an Informed Consent Form.

Data collection took place at the Research and Physical Activity Laboratory, PUCRS. All procedures were conducted by trained researchers with experience in physical evaluations.

Body mass was measured by digital scale (Plenna®, Snow, Bom Retiro, Brazil) with a precision of 100 g. Height was obtained with the help of a professional wall stadiometer (Sanny®, Standard, São Bernardo do Campo, Brazil) with precision of 0.1 cm. BMI was calculated (kg/m²). To estimate fat percentage, the protocol for women was used, based on the sum of three skinfolds (triceps, suprailiac and thighs) to calculate body density and the Siri²⁵ equation to calculate fat percentage. The skinfolds were measured using a scientific caliper with precision of 0.1 mm (Sanny®, Standard, São Bernardo do Campo, Brazil).

To calculate WHR and AWR, waist (midpoint between the last rib and the iliac crest), abdomen (transversal umbilical line) and hip circumference (at the level of the greatest prominence of the greatest trochanters) were measured using anthropometric tape (Sanny®, Standard, São Bernardo do Campo, Brazil) with 0.1 cm precision.

BSI was calculated by waist circumference divided by BMI raised to 2/3 times height raised to ½ [waist circumference/(IMC²/₃ x Height¹/₂)]²⁶.

Statistical treatment

For the statistical treatment of the data, the groups were initially stratified by age groups (60 to 69 and 70 to 79 years). Data normality was tested from the Shapiro-Wilk test when the sample size ≤50, and the Kolmogorov-Smirnov test when >50. Then, descriptive statistics was used: mean and standard deviation or median and interquartile range. To compare the anthropometric indicators of CV risk among the groups, Student’s t test was used for independent samples when the data distribution was parametric and Mann-Whitney in cases of non-parametric distribution. In all statistical tests, the significance level was α≤0.05.

Results

Table 1 shows the results of anthropometric indicators of CV risk among EMIPOA and PEG groups. In the 60-69 years stratum, PEG presented significantly lower values than EMIPOA for: body mass, BMI, abdominal circumference, waist circumference, AHR, WHR and BSI. There was no difference for the following variables: height, sum of skinfolds and body fat percentage. As for the stratum 70-79, a significant difference was only found for height. PEG was, on average, 4 cm higher than EMIPOA.

Except for fat percentage and sum of skinfolds, the other variables showed a statistically significant difference, at least in one of the strata, the largest number of differences was found in the stratum 60-69 years.
<table>
<thead>
<tr>
<th>Age group</th>
<th>EMIPAO</th>
<th>Mean±SD</th>
<th>P</th>
<th>PEG</th>
<th>Mean±SD</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body mass (kg)</td>
<td>60-69&lt;sup&gt;i&lt;/sup&gt;</td>
<td>184</td>
<td>69.19±19.03</td>
<td>0.021*</td>
<td>62.51±13.95</td>
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<td>70-79&lt;sup&gt;i&lt;/sup&gt;</td>
<td>121</td>
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<td>67.25±10.23</td>
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<td>Total</td>
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<td>69.31±13.88</td>
<td>--</td>
<td>66.08±9.48</td>
<td>--</td>
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<tr>
<td>Height (m)</td>
<td>60-69&lt;sup&gt;i&lt;/sup&gt;</td>
<td>184</td>
<td>1.55±0.06</td>
<td>0.684</td>
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<td>1.56±0.06</td>
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<td>BMI (kg/m&lt;sup&gt;2&lt;/sup&gt;)</td>
<td>60-69&lt;sup&gt;i&lt;/sup&gt;</td>
<td>184</td>
<td>29.6±5.56</td>
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<td>27.01±3.69</td>
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<td>27.29±3.62</td>
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<td>Σ Skinfolds (mm)</td>
<td>60-69&lt;sup&gt;i&lt;/sup&gt;</td>
<td>184</td>
<td>93.45±25.23</td>
<td>0.066</td>
<td>84.49±23.19</td>
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<td></td>
<td>70-79&lt;sup&gt;i&lt;/sup&gt;</td>
<td>121</td>
<td>87.36±27.63</td>
<td>0.288</td>
<td>81.53±21.49</td>
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<td>Total</td>
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<td>91.03±27.63</td>
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<td>83.37±22.38</td>
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<td>Body fat (%)</td>
<td>60-69&lt;sup&gt;i&lt;/sup&gt;</td>
<td>184</td>
<td>40.0±9.51</td>
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<td>36.68±8.95</td>
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<td>38.37±10.6</td>
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<td>36.44±8.62</td>
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<td>Abdominal circumference (cm)</td>
<td>60-69&lt;sup&gt;i&lt;/sup&gt;</td>
<td>184</td>
<td>96.46±12.44</td>
<td>0.001*</td>
<td>87.25±9.5</td>
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<td>97.01±13.39</td>
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<td>90.47±10.01</td>
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<td>Waist circumference (cm)</td>
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<td>90.57±12.4</td>
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<td>83.14±9.23</td>
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<td>86.55±8.75</td>
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<td>Total</td>
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<td>90.28±11.69</td>
<td>--</td>
<td>84.44±9.12</td>
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<tr>
<td>AHR</td>
<td>60-69&lt;sup&gt;i&lt;/sup&gt;</td>
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<td>0.94±0.08</td>
<td>0.013*</td>
<td>0.91±0.06</td>
<td>0.826</td>
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<tr>
<td></td>
<td>70-79&lt;sup&gt;i&lt;/sup&gt;</td>
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<td>0.96±0.08</td>
<td>0.552</td>
<td>0.97±0.08</td>
<td>0.103</td>
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<tr>
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<td>Total</td>
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<td>0.92±0.08</td>
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<tr>
<td>WHR</td>
<td>60-69&lt;sup&gt;i&lt;/sup&gt;</td>
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<td>0.89±0.11</td>
<td>0.009*</td>
<td>0.84±0.09</td>
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<td></td>
<td>70-79&lt;sup&gt;i&lt;/sup&gt;</td>
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<td>0.87±0.12</td>
<td>0.445</td>
<td>0.86±0.12</td>
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<td>Total</td>
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<td>0.89±0.08</td>
<td>--</td>
<td>0.85±0.06</td>
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<tr>
<td>BSI (m&lt;sup&gt;1/6&lt;/sup&gt;/kg&lt;sup&gt;2/3&lt;/sup&gt;)</td>
<td>60-69&lt;sup&gt;i&lt;/sup&gt;</td>
<td>184</td>
<td>0.077±0.005</td>
<td>0.034*</td>
<td>0.073±0.003</td>
<td>0.641</td>
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<tr>
<td></td>
<td>70-79&lt;sup&gt;i&lt;/sup&gt;</td>
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<td>0.078±0.005</td>
<td>0.093</td>
<td>0.075±0.004</td>
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<td>0.077±0.005</td>
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<td>0.074±0.004</td>
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</table>

EMIPAO — group deriving from the Porto Alegre Multidimensional Study on Elderly Women; PEG — group of elderly women from a physical exercise program; BMI — body mass index; AHR — abdomen/hip ratio; WHR — waist/hip ratio; BSI — body shape index; <sup>i</sup>nonparametric variable; SD — standard deviation; β — statistical power; *significant difference (Student’s t test or Mann-Whitney).
Discussion

In order to compare the levels of anthropometric CV health indicators of elderly female practitioners and non-practitioners of physical exercise, it was found that not all variables analyzed showed the expected behavior.

PEG in the stratum 60-69 years presented lower body mass values, consistent with the findings of other studies. Literature shows that elderly practitioners of physical exercises should have body mass lower than non-practitioners, or at least an attenuation of its increase related to aging.

As for height, no significant differences among the groups was expected, because it is a genetically influenced variable. However, PEG (70-79 years) presented significantly higher values than EMIPAO. Although the actual influence of lifestyle in reducing the height of elderly individuals is not yet known, Sagiv et al. found that the regular practice of moderate to intense resistance exercise over life is associated with attenuation of loss of height resulting from aging. This attenuation appears to be due to the maintenance of bone density and intervertebral spaces or potentially greater trunk flexibility in the elderly individuals who do physical exercises, thus giving them a more verticalized posture.

As for BMI, it was found that physical exercise may apparently have contributed to a slight decrease of this variable, but this is only significant for elderly women aged 60-69 years. Koster et al. have reported an inverse relationship between the level of physical fitness and BMI in elderly women.

Aging produces changes in body composition, even when there is no concomitant changes in body mass and/or BMI. Accumulation of body fat (fat and sum of skinfolds) related to aging is more associated with lifestyle and level of physical activity than aging itself.

Several authors argue that physically active people have lower amounts of body fat. However, the fact that no significant differences have been found suggests a potential inadequacy of the exercise program conducted. It would be necessary that the program generated a higher weekly calorie expenditure to achieve effective impact on variables related to body fat.

The evaluation method may also have influenced the results related to body fat. The skinfolds may not have been sensitive enough to detect differences between groups, which is related to body fat redistribution. With aging, there is a significant redistribution of subcutaneous fat to ectopic deposits.

Redistribution of body fat directly influences the values of some CV health indicators, from AHR to WHR, as they are related to fat accumulation in the central intra-abdominal region. Both for abdominal and waist circumferences and for AHR and WHR, the PEG presented lower values. As for these variables, the literature lacks cross-sectional studies that have evaluated the association between them and the level of physical activity or regular exercising. However, some studies have shown reduction in waist circumference values, WHR and intra-abdominal fat after physical training.

Reflecting the results for waist circumference and BMI, BSI presented the same behavior. Significantly lower values for the PEG compared to EMIPAO. This is an important finding, since this variable has been more specific than the other anthropometric variables in CV risk stratification in elderly women.

The significant difference in cardiovascular risk indicators found between the groups in the stratum of 60-69 years, pointed to some possible hypotheses. The first is related to potential reduction of trainability with aging. Older individuals would have a lower trainability, i.e., it would be more difficult to improve fitness or functionality for the same relative stimulus of training. This hypothesis seems consistent with the fact that there is a reduction in the adaptive capacity of the tissues and systems to stimuli with aging. Evidence is still lacking, and this issue is still controversial in the literature. Few studies have demonstrated a reduction in trainability, while others showed no significant differences between old and young individuals in relation to trainability.

In describing the general adaptation theory, Selye points to the need for stimulus to be given in an optimal intensity range for promoting adaptation, because, being too below standard, stimulus would be weak and would not promote adaptation. Being suboptimal, some stimulus could, at the most, promote the maintenance of capacity, but without any significant improvement in performance. If stimulus is very strong, above this optimal range, it could lead to injury or adverse effects. It is believed that this optimal range should decrease with age and with other limiting factors of performance, such as pathological conditions, in which there would be a relative increase of this threshold to promote adaptation, and a reduction of this maximum threshold to avoid injury or adverse effects.
effects. In addition, elderly individuals would require a longer time to undergo adaptation to physical exercise compared to younger individuals, that is, the results would take longer to be noticed. The elderly would require higher relative intensities and higher frequency of training than younger individuals.

A second hypothesis is that added to this scenario, physical education teachers usually tend to be too careful with older people, who are usually more debilitated, mainly due to fear of the risk of complications arising from exercising loads. This behavior would reduce more significantly the relative intensity of training, making it even harder to obtain some positive physiological effect arising from exercising. Based on these assumptions, it is suggested, in this case, that older individuals have an even stronger training control, considering the greater difficulty of promoting positive adaptations on these individuals.

These population-based studies often establish comparisons between a sample and populations with different biopsychosocial characteristics. This may generate bias in the interpretation of parameters for the classification of the population. From this perspective, this study brings a difference when comparing a group (PEG) with data from a local population living in the same region (EMIPOA).

It is important to consider that this study presents a cross-sectional design rather than a quasi-experimental design with a control group and an intervention group, which limits the conclusions and potential inference of the results obtained. The assumptions made to try to explain the lack of differences in the stratum 70-79 years between the groups still need more evidence. This fact should be considered as a gap in the corpus of knowledge of exercise prescription, but the hypotheses presented serve as a starting point to new studies that seek to give scientific support to these theories, which must provide appropriate experimental designs and study the influence of aging and senescence on trainability.

Conclusions

The findings suggest that a structured exercise program can improve the CV health indicators of participants, but the elderly of this study showed no fully satisfactory results. A review of the program is needed so they can achieve the desired results, especially with regard to the effectiveness of physical exercises for individuals older than 69. Greater care in controlling training intensity and volume of the elderly is suggested, especially with advancing age.

Potential Conflicts of Interest
This study has no relevant conflicts of interest.

Sources of Funding
This study had no external funding sources.

Academic Association
This study is not associated with any graduate programs.

References


