EFFECTS OF NUTRITIONAL STATUS ON PULMONARY IMMUNE FUNCTION AND RESPONSE IN ELDERLY INDIVIDUALS

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ABSTRACT

Objectives: The aging process, as well as caloric-protein malnutrition, is associated with a progressive decline in lung function and a reduction in systemic immune response. However, it is unknown to what extent aging and caloric malnutrition can affect these responses. **Method:** A randomized clinical trial was conducted at the Evangelical University of Goiás (UniEVANGÉLICA), where 66 elderly individuals (aged 60 to 85 years) were evaluated for lung function, pulmonary immune response through IL-10 measurement in condensed air, peripheral strength through handgrip strength, and respiratory muscle strength through manovacuometry. **Results:** The results showed that of the 66 elderly individuals evaluated, 44 (67.28%) were classified as hypocaloric, 19 (28.12%) as normocaloric, and 3 (4.68%) as hypercaloric. When comparing the hypocaloric group with the normocaloric group, results show that the hypocaloric group had a reduction in forced vital capacity (FVC, $p<0.0214$), forced expiratory volume in the first second (FEV1, $p<0.0039$), and Tiffeneau index ($p<0.0353$), as well as a reduction in right ($p<0.0032$) and left ($p<0.123$) handgrip strength. In addition, the number of sit-to-stand repetitions in 1 minute (functional capacity) was lower for the hypocaloric group ($p<0.0428$), as was oxygen desaturation ($p<0.0445$). **Conclusions**: A hypocaloric dietary pattern in elderly individuals without professional guidance impairs pulmonary function and immune response, reflecting loss of muscle strength and functional capacity.

Keywords: elderly; resistance training; pulmonary inflammation; cytokines.

INTRODUCTION

Aging causes significant changes in the immune response, a phenomenon known as immunosenescence (Bachi et al., 2023). With advancing age, there is a decrease in the production of naive T cells and an increase in the proportion of memory T cells, which compromises the immune system's ability to respond to new antigens (Rodrigues et al., 2020). In addition, B cell function is also impaired, resulting in less effective antibody production (Frasca et al., 2020). Immunosenescence is also associated with a chronic low-grade inflammatory state called "inflammaging," which may contribute to the development of age-related chronic diseases such as atherosclerosis and neurodegenerative diseases (Bachi et al., 2023). These factors combined make older adults more susceptible to infections, autoimmune diseases, and reduced vaccine efficacy (Santoro et al., 2021).

Caloric malnutrition in older adults is a prevalent condition that can have profound effects on the immune response (Kawakami et al., 1999). With age, the

immune system naturally weakens, a process known as immunosenescence (Kawakami et al., 1999). Caloric malnutrition exacerbates this decline, resulting in lower production of immune cells, such as T lymphocytes, and a decrease in phagocyte function (Kawakami et al., 1999). In addition, the production of pro-inflammatory cytokines may increase, leading to a chronic low-grade inflammatory state known as "*inflammaging*" (Bachi et al., 2023). This state reduces the body's ability to fight infections and increases susceptibility to disease, complicating recovery from clinical conditions and contributing to higher morbidity and mortality among malnourished older adults (Bachi et al., 2023; Kawakami et al., 1999). Therefore, the present study aimed to investigate how nutritional status can affect pulmonary immune function and response and functional capacity in sedentary elderly individuals.

METHODOLOGY

Population and Study Design

Sixty-six elderly individuals aged between 60 and 85 years, sedentary for at least 1 year, of both sexes, were evaluated for their nutritional status.

Nutritional Assessment and Classification

The volunteers were evaluated using a 24-hour dietary recall (Fisberg and Marchioni, 2012) and a food frequency questionnaire (Fisberg and Marchioni, 2012). The volunteers were then classified into low-calorie, normal-calorie, and high-calorie dietary patterns. To calculate the energy content of the foods consumed by the volunteers according to their QR24h reports, the home measurement table of the Brazilian Institute of Geography and Statistics (University of São Paulo, 2017) and the Table for the Assessment of Food Consumption in Home Measurements (Pinheiro 2008) were used. The formula used to calculate energy requirements was that of the Food and Nutrition Board, Institute of Medicine, National Academies (Institute of Medicine, 2005).

Lung Function

Lung function was assessed using a Master Screen spirometer (Jaeger, Germany), employing the forced maneuver, following the standards proposed by the Brazilian Society of Pulmonology and Tisiology. All volunteers underwent spirometry

testing before and after administration of a fast-acting bronchodilator (Salbutamol 400 mcg). The parameters evaluated were FVC, FEV1, FEV1/FVC, PFE, and FEF25-75 (Moraes-Ferreira et al., 2022).

Peripheral Strength Assessment (Palmar Grip Strength)

The palmar grip strength of the upper limbs (right and left arms) was assessed using a Jamar hydraulic dynamometer (Moraes-Ferreira et al., 2022). The results were presented in Kg/f (kilogram force).

Functional Capacity Assessment (Oxygen Saturation in the 1-Minute Sit-to-Stand Test)

Functional capacity was assessed using the 60-second sit-to-stand test with monitoring of partial oxygen saturation (SpO_2) (Bohannon 2010). The results were expressed as the number of times the participant was able to sit and stand in one minute, as well as the initial and final SpO2 and the SpO2 delta (initial SpO2 – final SpO2).

Collection, Processing, and Analysis of Condensed Air

Condensed air was obtained by tidal breathing into a tube called RTube (Respiratory Research, USA), in which the volunteer breathed for 15 minutes. After this period, the condensed air was collected and stored at -86ºC for analysis of IL-10 levels, as already standardized in our laboratory (Moraes-Ferreira et al., 2022).

Measurements of IL-10 Levels in Condensed Air

IL-10 cytokine levels were measured in condensed air using the DuoSet ELISA kit (R&D Systems, USA). Readings were performed according to the manufacturer's instructions, following routine procedures in our laboratory, using the SpectraMax i3 multi-reader (Molecular Devices, USA) (Moraes-Ferreira et al., 2022).

Statistical Analysis

GraphPad Prism 5.0 software was used for statistical analysis and graph construction. Data normality was assessed using the Kolmogorov-Smirnov test. The unpaired Student's t-test was used. Values of $p < 0.05$ were considered statistically significant.

RESULTS

Table 1 shows the characteristics of the elderly volunteers in the study.

Parameters	Hypocaloric (n=44)	Normal calorie (n=19)	p
Age	68.17±6.07	67.55±6.02	>0.05
Gender	Male (11) Female (33)	Male Women (13)	>0.05
Weight	65.02±11.91	63.41±11.28	<0.0072
Height	1.54±0.04	1.59±0.06	>0.05
BMI	29.63±4.55	25.08±4.89	<0.0011
% Fat	38.53±7.83	30.93±12.56	<0.0086
% Lean Mass	24.86±4.08	26.79±6.58	<0.0448
Waist Circumference	92.64±10.90	82.94±10.78	<0.0027
Hip circumference	105.26±10.18	93.01±16.28	<0.0009
C/Q ratio	0.92±0.27	0.86±0.15	>0.05
Left calf circumference	35.25±4.45	35.98±3.10	>0.05
Right calf circumference	34.89±3.63	35.96±3.32	>0.05

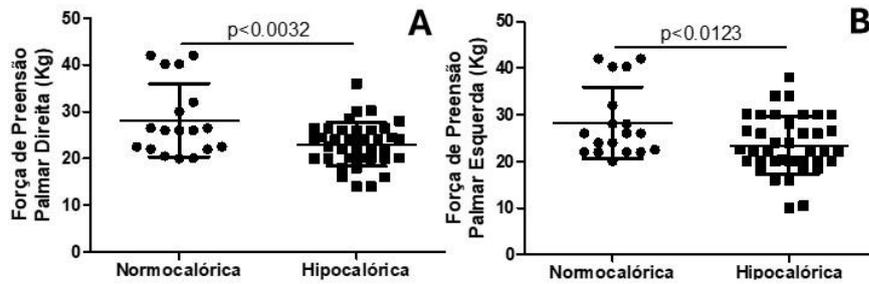Table 1 – Results presented as mean and standard deviation. WHR = waist-to-hip ratio.

The results presented in Figure 1 show the parameters of lung function: forced vital capacity (FVC, Figure 1A) and forced expiratory volume in the first second (FEV1, Figure 1B).

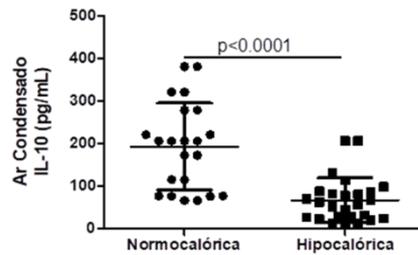**Figure 1.** Pulmonary function (FVC and FEV1)
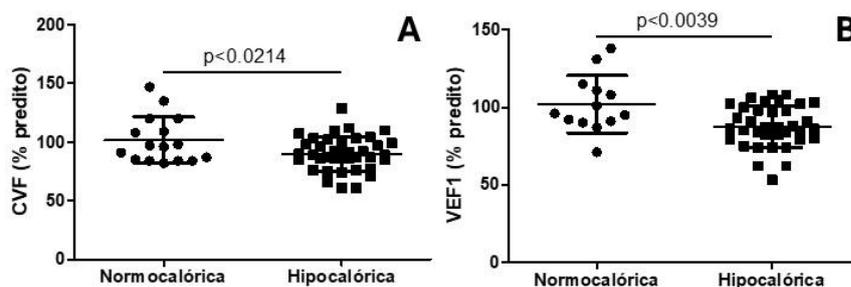
Source: Author's own work.
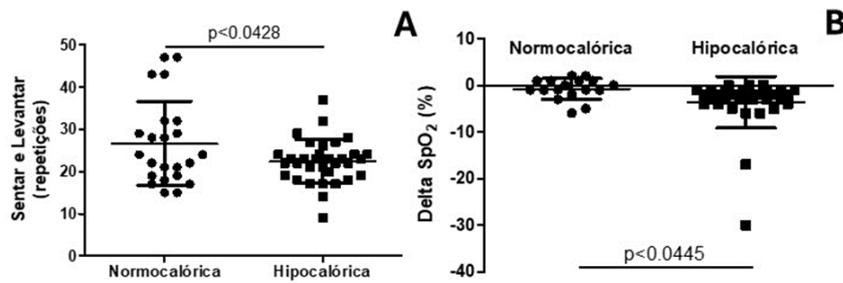
Figure 2. Handgrip strength

Source: From the author.

Figure 3. IL-10 levels in condensed air (BC)

Source: From the author.

Figure 4. Functional capacity assessment

Source: Author's own work.

CONCLUSION

Calorie deficiency in the elderly results in impaired pulmonary function and immune response, as well as loss of muscle strength and functional capacity.

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