Original article

A scientific study on diets, physical exercises, and morphological aspects of Sarcopenia: a description of methodological approaches

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Abstract

Introduction: The aging process is characterized by several morphological and functional changes associated with reduced functional capacity of organs. One of them is sarcopenia, a progressive loss of muscle mass process associated with a reduction in the number and size of muscle fibers. The morphological evidence of skeletal muscle sarcopenia is a parameter for assessing the degree of loss of function. Objective: Considering the importance of such evidence on the cell morphology on sarcopenia, held a retrospective literature review to selected articles in Medline, Lilacs, SciELO and PubMed, from 2000 to 2010, identifying the design of studies related to diet, exercise and morphology of skeletal muscle in sarcopenia published in the last 10 years. Methods: After selection by the proposed inclusion criteria, were analyzed for the journal title and the article, year of publication, country of origin, type of methodology used, type and authorship, and research subjects. Results: During the period from 2000 to 2010, there were 57 papers, only 8 described morphology of skeletal muscle-related sarcopenia, diet and exercise. In all searches were observed the quantitative data analysis, and methodological approaches observed were only two: literature review and experimental study. Conclusion: The publications are characterized by multiple authors are published in journals in different fields (nutrition, age, morphology, biology and experimental gerontology).

Keywords: sarcopenia, diet, protein, exercise, cell morphology.

1 Introduction

Life quality is one of the most intensively studied issues in health sciences. With the recent increase in life expectancy, the number of elderly has been gradually growing according to the World Health Organization (2007). Such growth, presents the major challenge of providing good quality of life during the age-progression process, especially for those who work in health care.

Biological aging or senescence is a process that includes physiological, social, and psychic declines that cause significant changes such as Sarcopenia, one of the most important examples, which is characterized by a reduction in the functional ability that influences the quality of life of the elderly (MATSUDO, 2001).

Sarcopenia is a progressive process characterized by a 3 to 8% reduction of lean muscle mass per decade after the age of 30 years (PADDON-JONES and RASMUSSEN, 2009). It can affect 30% of the individuals over 60 years of age and more than 50% of those over 80 years (BAUMGARTNER, KOEHLER, GALLAGHER et al., 1998; JANSSEN, HAYMSFIELD and ROSS, 2002). Individuals with advanced Sarcopenia present functional limitations due to loss of strength, especially in the lower limbs, which limits their quality of life and physical autonomy. Sarcopenia is also characterized by morphological changes in the muscle cells resulting in a reduction in the size and number of fibers and loss of Type II fibers (glycolytic fibers) (LARSSON, SJODIN and KARLSSON, 1978). Some mechanisms described in the literature are associated to the process of Sarcopenia, such as the protein metabolism and its cellular signaling, the voluntary or imposed decrease in the level of physical activity, the poor protein nutrition, and the reduction of the anabolic efficiency of the protein ingested (CUTHBERTSON, SMITH, BABRAJ et al., 2005; FUJITA, DREYER, DRUMMOND et al., 2007; CAMPBELL, 2007). It is known that protein synthesis, especially the synthesis of muscle cells, is determined by several factors and that with proper nutritional support, physical activity stimuli promote significant muscle protein synthesis. In such case, the diet's amino acid profile is of fundamental importance. The content of the essential amino acids present in food, the protein digestibility, and the distribution of these amino acids among the daily meals are also factors that may interfere seriously with the results of the protein synthesis stimulated by physical exercises (GUILET, PROD´HOMME, BALAGE et al., 2004).

Sarcopenia is a substantial risk factor for frailty, loss of independence, and physical inability for the elderly. Therefore, understanding the mechanisms that lead to loss

of muscle and physical inability with age is a priority for those who work in health care, including public health intervention programs. Hence, it is necessary to investigate the impact of the protein quality of meals upon the morphological aspects of the skeletal muscle in the process of Sarcopenia in individuals engaged in physical activities as they age.

Taking into consideration the importance of identifying the tendencies of the morphological approaches and the type of study outlines used in researching the role of diet and physical exercises in the morphological aspects of Sarcopenia, a national and international literature review on this topic was conducted, which may assist the health professionals who work with the elderly.

The purpose of the present study was to explore the characteristics of authorship, methodological approaches, and types of outlines used in the studies related to the role of diets in the morphological aspects of the sarcopenic skeletal muscle that have been published in the last ten years. This study also aimed at describing the rate of adoption of each approach and type of outline.

2 Methods

In order to investigate the national and international studies published on the role of diet and physical exercises in the morphological aspects of Sarcopenia, a retrospective literature review was conducted in September 2010 using the following databases: PubMed; Medline; Lilacs; and Scielo from the last 10 years (2010-2000). These databases were chosen because they include worldwide publications in the field of health sciences and two of them include Latin American and Caribbean literature (Lilacs) and Brazilian literature (Scielo), which in general are not indexed in major databases like Medline. In addition to the publications indexed in Medline, PubMed comprises other publications in the field of health and medicine from different countries in several languages. The search for publications was conducted using the "Sarcopenia', "protein", and "diet" as keywords searching for words that appear in titles, abstracts, names of substances, proper names, and topics. The languages selected in the search were Portuguese, Spanish, and English. The publications found were cataloged regardless of the methodological approach adopted. The articles were then selected based on some inclusion criteria such as those characterized by full-text articles published in indexed journals in the last ten years written in Portuguese, Spanish, and English and that included a morphological analysis of the skeletal muscle.

The publications involving human and/or animal subjects and which related with diet and physical exercises were considered. Nevertheless, publications such as theses, monographs, books, book chapters, papers presented at conferences, reports, government as well as national and international entity material, and studies that do not include the diet protein or do not describe adequately the characteristics of the subject diet or are not related to physical exercises were disregarded. The protocol used was the collection of information about the journal tile, article title, year of publication, country of origin, methodology used (field description, bibliographical description, action research, exploratory, theoretical reflections, and experience report), authorship (a single or multiple authors), and subjects of study (humans or animals).

3 Results

Due to the considerable number of publications found using the word Sarcopenia, the search results were refined and limited to the findings obtained with the word protein. Afterwards, the search results were again refined and limited to the publications containing the word diet (Table 1).

Through the results obtained from the databases searched, the total number of articles that fit the inclusion criteria described above was determined as shown in Table 2.

The search resulted in forty nine articles that have been published in the last 10 years in international journals, but only 8 made use of a morphological analysis of the skeletal muscle to address Sarcopenia and its association with diet and physical exercises. From those 8 studies, the language of publication, the use of humans or animals as research subjects, and the different diet aspects covered, more specifically diet protein and physical exercises, were highlighted as shown in Table 3.

The methodological approach in the 8 studies selected was quantitative. With respect to the study outline, from the 8 studies chosen, 5 were characterized as descriptive literature reviews and the other 3 as experimental studies. None of them fit the other methodological approaches or study outlines proposed in the methods section of the present article.

Table 1. Frequency distribution of the publications retrieved second database and queried keyword search.

Database	Number of results		
	Sarcopenia	+ Protein	+ Diet
PubMed	989	450	57
Medline	890	303	27
Lilacs	15	1	0
Scielo	11	0	0
Total (not repeated)	1015	451	57

Table 2. Frequency distribution of publications according to meeting the criteria established for inclusion analysis.

	Yes	Not	Not described
Published within 10 years	49	8	-
Animal studies	17	33	7
Described the diet	45	11	1
Addressed the dietary protein	34	20	3
Approached the exercise	28	28	1
Performed morphological analysis	8	30	19

Table 3. Distribution of articles according to publication language, subjects of study, description of characteristics of diet and exercise.

Variable	Yes	Not
English language	8	0
Animal studies	4	2
Diet	7	1
Diet protein	6	2
Exercise	6	2

A descriptive research is based on the description and classification of the observed phenomena. This type of research is widely used in the field of health science. It is divided into field research and bibliographical research. The former describes natural phenomena examining thoroughly the practices, behavior, and attitudes of people or groups in real life, and the latter includes a survey, selection, and the recording of relevant topics to the research (POLIT and HUNGLER, 1995).

In an experimental research, the researcher manipulates or is able to exert some control over the independent variable studying its effect on the dependent variable of interest (POLIT and HUNGLER, 1995).

A possible explanation to the fact that morphology cellular studies are mostly experimental is that they are designed to test the manipulation of variables that interfere with micro and macroscopic aspects of the structures and tissues in humans or animals used in experimentations. In general, simple descriptive analyses cannot lead to further scientific advances since the natural shape of cell structure have already been adequately described using microscopic techniques. The scientific advances in this area focus on changes caused by modifications in independent variables and not on a simple description of structures and tissues. Especially considering the morphological studies on Sarcopenia, there seems to have a great number of publications that describe the morphological characteristics of the tissue. On the other hand, the manipulation of dietary variables, mainly the diet protein, associated to physical exercises in sarcopenic individuals deserves further investigation. A number of publications address diet and muscle tissue isolated, and in most cases, it can be observed the evaluation of morphological changes of the muscle associated to physical exercises only.

With regard to the authors' country of origin or the academic institutions with which they are involved, 5 studies were carried out by researchers from the United Sates, 1 by French researchers, 1 by researchers from Italy, and 1 by Japanese researchers (Chart 1). Recently, studies on Sarcopenia have been carried out in different countries around the world. This can be due to the fact that life expectancy has been increasing in both developed and developing countries, which has stimulated more research on age-related changes

Chart 1. Title of articles, bibliographic references, and the institution responsible for research.

	Article title	References	Responsible institution for publishing
1	Molecular mechanisms in aging and current strategies to counteract sarcopenia.	SAKUMA, K. and YAMAGUCHI, A. *Current Aging Science*, 2010, vol. 3, p. 90-101.	Research Center for Physical Fitness, Sports and Health, Toyohashi University of Technology. Japan
2	Human skeletal muscle aging and the oxidative system: cellular events.	ROSSI, P., MARZANI, B., GIARDINA, S., NEGRO, M. and MARZATICO, F. *Current Aging Science*, 2008, vol. 1, no. 3, p. 182-91.	Department of Physiological and Pharmacological Cellular and Molecular Sciences, University of Pavia. Italy
3	Muscle proteins during 60-day bedrest in women: impact of exercise or nutrition.	LEMOINE, JK., HAUS, JM., TRAPE, SW. and TRAPE, TA. *Muscle Nerve*, 2009, vol. 39, no. 4, p. 463-71.	Human Performance Laboratory, Ball State University, Muncie, Indiana. USA.
4	Lifelong exercise and mild (8%) caloric restriction attenuate age-induced alterations in plantaris muscle morphology, oxidative stress and IGF-1 in Fischer-344 rat.	KIM, JL., KWAK, HB., LEEUWENBURGH, C. and LAWLER, JM. *Experimental Gerontology*, 2008, vol. 43, no. 4, p. 317-29.	Redox Biology; Cell Signaling Laboratory, Department of Health and Kinesiology, Texas University. USA.
5	Dietary protein and resistance training effects on muscle and body composition in older persons.	CAMPBELL, WW. and LEIDY, HJ. *Journal of the American College of Nutrition*, 2007, vol. 26, no. 6, p. 696S-703S.	Department of Foods and Nutrition, Ingestive Behavior Research Center, Purdue University, Indiana. USA.
6	Does long-term intermittent treatment with glutamine improve the well-being of fed and fasted very old rats?	MIGNON, M., BEAUFRÈRE, AM., COMBARET, L. and MEYNIAL-DENIS. *Journal of Parenteral and Enteral Nutrition*, 2007, vol. 31, no. 6, p. 456-62.	INRA, UMR 1019, Human Nutrition Unit, Saint Genes-Champanelle, French.
7	Skeletal muscle apoptosis, sarcopenia and frailty at old age.	MARZETTI, E. and LEEUWENBURGH, C. *Experimental Gerontology*, 2006, vol. 41, no. 12, p. 1234-8.	Department of Aging and Geriatrics, College of Medicine, University of Florida, Division of Biology of Aging, Institute on Aging, Biochemistry of Aging Laboratory, Gainesville, FL. USA
8	Muscle fiber specific apoptosis and TNF-alpha signaling in sarcopenia are attenuated by life-long calorie restriction.	PHILLIPS, T. and LEEUWENBURGH, C. *FASEB Journal*, 2005, vol. 19, no. 6, p. 668-70.	University of Florida, Department of Aging and Geriatric Research, College of Medicine, Biochemistry of Aging Laboratory, Gainesville, Florida. USA.

(LIDOR and MILLER, 1999; MATSUDO, MATSUDO and BARROS NETO, 2000). Therefore, the studies carried out in the last 20 years have covered almost all health related aspects as well as fitness, diseases, and the aging process.

The main topic in the journals from which the articles were selected was quite different and can be considered heterogeneous (Chart 1). The studies analyzed were published in the following journals: "Current Aging Sciences" (2 articles); "Muscle Nerve" (1 article); "Experimental Gerontology" (2 articles), "Journal of the American College of Nutrition" (1 article); "Journal of Parenteral and Enteral Nutrition" (1 article), and "FASEB - The Journal of the Federation of American Societies for Experimental Biology" (1 article).

A literature review conducted by Lidor and Miller (1999) on aging surveying scientific publications in 6 international journals in the field of physical education in the last 30 years revealed that the growing interest in the aging process is not necessarily evident in the publications in the field of sports science. That is the reason why there are more publications on Sarcopenia, diet and physical exercises available in other areas of knowledge such as medicine, nutrition, and especially gerontology (Chart 2). The development of international initiatives for discussing this issue independently, i.e not as part of other issues, can be evidenced by the emergence of journals targeted specifically to the area of aging such as the "Journal of Aging and Physical Activity", a scientific journal created in 1994 to address the aging process and its relation to physical activities. Research groups in the areas of aging, geriatrics, and gerontology all over the world have been gathering and publishing their own multidisciplinary journals. The fact that such studies are published in journals of different areas and not only in specific publications in the fields of morphology and anatomy supports this thesis. Nowadays, science can be characterized, among other things, by the importance of team work. Research groups organized according to specific topics and formed by multidisciplinary professionals and experts grew significantly in importance in the 20th century (BUSH and HATTERY, 1956; ETZKOWITZ, 1992), a process that evidences a substantial evolution of modern science which can be compared to the evolution of professionalization of scientific research in the past years. Hence, it can be said that the cooperation, team work, and interdisciplinarity are among the most important characteristics of modern science and creation of research groups based on specific topics and not on areas that have already been fully acknowledged in the fundamental sciences.

Empirical evidences support the way that members of a well-established consolidated research group provide researchers with a competitive advantage compared to scientists who work in groups that are weaker concerning publications in well-known and well-read recognized journals. A study that gathered information data about the research teams in Biology and Biomedicine at the Spanish Council for Scientific Research, as well as their curriculum vitae, evidenced that one fourth of the scientists work as members of interdisciplinary teams in the process of consolidating the knowledge generated (REY-ROCHA, GARZÓN-GARCÍA and MARTÍN-SEMPERE, 2006). The findings of that study evidence the importance of the development and consolidation of research groups that have a minimum number of tenured research positions as well as a minimal number of fellowship holders and graduate students. This would explain the current tendency for health areas to publish articles with multiple authors (Chart 3). The consolidation of multiprofessional research groups has clear influence on academic productivity performance indicators and on the quantitative assessment of the scientific activities of the group members. The information data of scientists who belong to consolidated research groups are quantitatively better than those of their peers in terms of the number of articles that have been published in journals listed in the Journal Citation Reports, but not in terms of the impact of such publications.

However, it can be said that there is only a small number of publications that address the morphological aspects of Sarcopenia associated to diet and physical exercises since the search conducted in the present study was based only on internationally recognized databases which are a source of rigorously selected information in terms of quality. It is likely

Chart 2. Issues discussed in the text, subject area in which the journal has published the article, and country of origin of the institution to which the authors are affiliated.

Articles	Issues discussed in the text	Thematic área of the journal	Country of origin
1	Effects of diet with or without resistance exercise on sarcopenia in elderly humans	Aging sciences	Japan
2	Effects of oxidative stress in skeletal muscle during aging and its relation to exercise in humans and animals.	Aging sciences	Italy
3	Effects of diet on sarcopenia during immobilization in elderly human subjects	Muscles and nerves	USA
4	Effects of caloric restriction on sarcopenia and oxidative stress in aged rats lifelong trained	Experimental gerontology	USA
5	Effects of dietary protein in humans addressing the general and morphological aspects	Clinical nutrition	USA
6	Effects of dietary protein and exercise on cell morphology in elderly human	Entreal and parenteral clinical nutriiton	French
7	Effects of caloric restriction on apoptosis of myocytes in the frail elderly	Gerontology	USA
8	Effects of caloric restriction in inflammation and muscle atrophy in aged animals	Experimental biology	USA

Chart 3. Study outline and authorship.

Article	Study outline	Authorship
1	Bibliographical research	Double
2	Bibliographical research	Multiple
3	Experimental	Multiple
4	Experimental	Multiple
5	Bibliographical research	Double
6	Bibliographical research	Multiple
7	Experimental	Double
8	Bibliographical research	Double

that there are many publications in low-impact-factor journals or even in journals that are not indexed in the databases searched. The results obtained indicate the limitation of the search for bibliographic references using only international databases and restrictedly selected keywords. Researchers that aim to get information and data from other studies in specific areas of knowledge should conduct a more extensive and thorough search without using keywords in international databases, which proved very limiting. On the other hand, it can be said that the publications which are not indexed in the major bibliographic databases probably do not meet the scientific quality criteria.

Due to the small number of publications in journals indexed in internationally recognized databases in the health area, those who conduct research on aging focusing on the morphological aspects of cells and tissues should aim at higher quality for their publications considering indexed journals that allow a wider spread of knowledge about the morphological changes caused by Sarcopenia and their relationship with protein and physical exercises.

4 Conclusion

From the results obtained in this study, it can be concluded that between 2000 and 2010, fifty seven indexed articles were found in major health-related databases that addressed Sarcopenia, diet, and physical exercises. Among those articles, only 8 described morphological aspects of the skeletal muscle related to Sarcopenia. All searches were conducted using quantitative analysis of the data, and the methodological approaches used were literature review and experimental study. The publications were characterized by multiple authors or a group of authors who belong to research teams and were published in journals of different areas (nutrition, aging, morphology, gerontology, and experimental biology).

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