

Translational Medicine In Geriatrics: A Systematic Review

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Abstract

Studies on aging and the application of translational medicine (TM) practices have become increasingly relevant due to the soaring prevalence of chronic diseases associated with an aging population. There is growing evidence of the importance of translational science and medicine in improving patient health. The number of studies with a TM approach in geriatrics has increased in recent years, however, greater knowledge is needed on what types of studies are published in this scientific field. Therefore, this paper aims to describe and classify the findings in the literature on the types of studies in translational medicine in geriatrics. It is a systematic review of the literature. Searches were carried out in the Pubmed, Lilacs, Medline, and CAPES databases to find studies published between 2009 and 2019. These studies were also classified according to the stage and type of translational research. After the assessment with inclusion and exclusion criteria, 21 articles were selected, classified as T1 14%, T2 4%, T3 9%, T4 48% and NA 28%. Our results support that TM studies with older adults have a wide variability in terms of method, topics covered, classification of the research stage, and published journals. Research trends, such as the translational care model, the use of mass cytometry technique, "in silico" research, and translational Geroscience models were identified. We conclude that there is a need for greater investments in geriatric practice with TM principles, in order to optimize the efficiency and effectiveness of research and develop knowledge that can improve health care for older adults, with better clinical applications.

Keywords: Translational Medicine, Geriatrics, Older Adults, Translational Research

INTRODUCTION

The term Translational Medicine (TM) is considered recent in the scientific literature, however, its results are emerging more and more in the world (LUPATINI et al., 2019). TM studies in geriatrics also accompany this growing condition, mainly due to the aging of the population and the desire of the older adults to live with a better quality of life (WITHAN et al., 2019). TM is an interdisciplinary branch of the biomedical field supported by three main pillars: benchside, bedside, and community. Combining resources, knowledge, and techniques, this field of knowledge aims to promote improvements in prevention, diagnosis, and therapies (CH'NG et al., 2017). Studies on aging and the application of TM practices has become increasingly relevant due to the increasing prevalence of chronic diseases associated with the aging of the population, impacting the nations' health and financial systems (GILL, 2019; CH'NG et al., 2017).

The strategies of researchers on aging and geroscientists must be aligned, in order to prevent and decrease the incidence of chronic diseases, mainly due to their potential to cause disability, sequels and, therefore, lower quality of life. This principle is proven in an animal model with the deceleration of aging at the cellular and molecular level and, therefore, scientists seek to transfer this to humans. The applicability of this methodology in gerontological studies is a challenge due to the vulnerability and diversity of the population, being even more negatively affected by the scarce funding and reduced number of interested parties (COSSETTE et al., 2016).

Therefore, the populational aging associated with a higher prevalence of chronic diseases with a negative impact on quality of life, demonstrates the urgency of developing scientific means of achieving a healthy longevity (WITHAN et al., 2019). Therefore, the aim of this study was to describe and classify the findings in the literature on the types of studies in translational medicine in geriatrics.

MATERIALS AND METHODS

Search sources

To elaborate this systematic review, the PubMed, Lilacs, Medline, and CAPES databases were searched, in order to select scientific productions using the following search strings: (Medical Research Translational [Title]) OR (Translational Medicine [Title]) AND geriatrics [Text Word]. To systematize the information regarding the systematic review process, the START® software (START®, v2.03, Campinas, Brazil, 2015) computational tool was used. The purpose of this software was to assist in the Systematic Review process in all its stages: planning, execution and analysis of results (ZAMBONI et al., 2014)

Procedures

After searching the databases using the mentioned strings, from the results with publication dates between 2009 and 2019, the authors selected only articles available in full, in order to select papers that met the interests of this study, based on the adequacy to the inclusion criteria required in this research. Studies that did not meet the inclusion criteria were disqualified for participation in the study. The last access to the databases was made on October 25, 2019.

Inclusion and exclusion criteria

The inclusion criteria for selecting articles were: a) studies that assessed individuals aged 60 years or older; b) papers available in full and published in scientific databases or in hard copy; c) articles that somehow addressed the theme of Translational Medicine; d) studies carried out between 2009 and 2019. The exclusion criteria were: a) studies that did not address the theme of Translational Medicine; b) animal studies; e) studies that were not in Portuguese, English, or Spanish.

Quality criteria of primary studies

In order to assess the quality of the selected papers, it was initially analyzed whether they had been published in peer-reviewed periodical or annals of events, when articles, or approved by an examining board, when they were undergraduate, master's, or doctoral theses. When analyzing the articles, the population used in the study or discussion and the statistical methods employed were used as quality criteria.

Selection process of primary studies

Search strings were built with the keywords and their synonyms. The strings were submitted to the search engine. After careful analysis of the abstract, and application of the inclusion and exclusion criteria, the papers were selected and two reviewers confirmed their relevance.

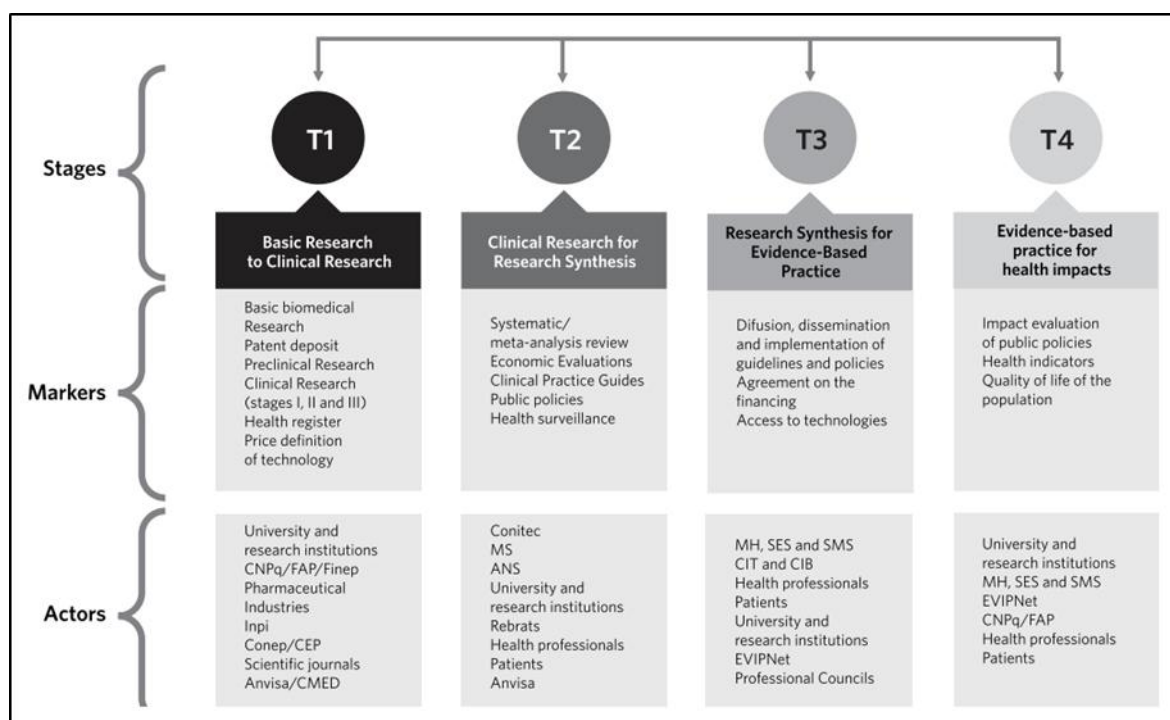
Information extraction strategy

The papers selected after observing the inclusion and exclusion criteria were read in full and summarized, highlighting the methods used for the assessment and the considered parameters, when necessary. The "data extraction forms" were filled out for the texts considered valid, in order to systematize the basic information (bibliographic data, publication date, abstract, among others). These forms are intended to summarize the articles and organize the subjects covered in each paper.

Summarization, classification, and presentation of results

The information extracted from the selected articles were: authorship, year of publication, country where the study was carried out, publication journal, study aims, delineation, main conclusions, and classification. The studies were classified according to the stage of translational research (Figure 1): basic sciences applied for clinical effectiveness (T1), clinical research for research synthesis (T2), research synthesis for evidence-based practices (T3), and evidence-based practices for health impacts (T4) (LUPATINI et al., 2019).

The results were descriptively presented, based on the information provided by each of the included studies. For a better presentation and discussion of the articles, we structured them in topics, namely: primary TM studies with older adults and secondary TM studies with older adults.



Source: LUPATINI et al. (2019)

Figure 1. Stages, markers, and actors of translational research in the Brazilian perspective and in the context of the *Sistema Único de Saúde* (SUS, Brazilian Unified Health System)

RESULTS

Initially, 66 articles were found, but thirty-three were excluded, five of which because they were duplicates, 19 that did not address the geriatric theme, two in German, and seven that were not health-related topics. After stratification, 33 articles were selected to be fully read, and 12 articles were subsequently excluded because they did not address the topic of Translational Medicine. Thus, 21 articles were defined to be studied for complying with the inclusion and exclusion criteria. By combining subjective and objective measures, this process demonstrates the viability of the method, as it identifies reference papers in geriatric medicine that can contribute to the improvement of education and clinical practice in geriatrics.

Among the studies included, an alternating pattern was identified in the number of articles published per year, being 19.05% published in 2011, 19.05% in 2014, 14.29% in 2017, and two articles (9.52%) per year in 2012, 2013, 2015, 2016, and 2018. The literature review was the most used among the studies (33.33%), followed by a retrospective or prospective cohort (28.57%), editorial cohort (14.29%), and only one article in each of the other designs, such as, randomized clinical trial (4.76%), transversal (4.76%), longitudinal (4.76%), case control (4.76%), and experience report (4.76%). A total of 47.62% of the studies were conducted in the USA, followed by 9.52% in England, 9.52% in Italy, 9.52% in Switzerland, and countries such as Belgium, Germany, Taiwan, Canada, and Malaysia conducted only one study each (4.76%). 15 scientific journals were identified: 19.05% of the articles were published in the Journal of the American Geriatrics Society, and 19.05% in the Journal of Translational Medicine, only one article was published in each of the other journals. As for classification, T4 studies represent 42.86%, T1 studies represent 14.29%, T3 studies represent 9.52%, and T2 studies represent 4.76%, while studies that did not fit into any of these categories, such as editorials and some review articles, were classified as not-applicable (NA) (28.57%), these data are summarized in **Table 1**. Sixty-eight keywords were identified in the articles included in this study, the most frequent descriptors (≥ 2) were presented in **Table 2**.

Table 1. Summary of the studies included in this review (2009-2019).

Authors	Year	Type of study	Country	Journal	Objective	Main conclusions	Classification
Chien, J. Y., Ho, R. J. Y.	2011	Review article	USA	Journal of Pharmaceutical Sciences	To review the ClinicalTrials.gov database in order to analyze a trend in the inclusion of older adults and children in studies over the past 10 years.	More clinical trials are needed to guide optimal dosing recommendations for older adults and children.	T3

Ch'ng et al.	2017	Review article	Malaysia	Journal of American medical directors association	To map out the trends in translational research, translation stage, and funding for studies related to geriatrics that have been published (NEJM, JAMA, BMJ, and Lancet).	Translational research in geriatrics are focused on T2 and T3 studies. T3 and T4 studies are extremely dependent on public funding.	NA
Cossette et al.	2016	Quasi-experimental study	Canada	The American Geriatrics Society	To assess the effect of a translational knowledge (TK) strategy to reduce the use of potentially inappropriate medicine (PIM) in hospitalized older adults.	The use of the TK strategy resulted in a decrease in the use of PIM in hospitalized older adults.	T4
Dodson et al.	2016	Observational cohort with longitudinal follow-up	USA	The American Geriatrics Society	To determine the prognostic value of slow walking speed (WS) in the prognosis one year after acute myocardial infarction (AMI).	Slow WS is a marker of frailty, being common one month after AMI in older adults and is associated with twice the risk of dying or in hospital readmission in one year.	T4
Focan et al	2013	Prospective cohort	Belgium	Pathologie Biologie	To offer a detailed geriatric assessment in patients over 70 years old with cancer. To define models to assess circadian rhythm changes, cancer, and aging.	Study still in implementation stage.	T1
Greco et al.	2012	Review article	England	Journal of Translational Medicine	To use the bibliographic research approach (<i>in silico</i>) to discover a set of biomarkers for Alzheimer's disease (AD).	The use of data mining and "in silico" analysis can be used to locate biomarkers for AD and, by extension, for other disorders.	T1
Li et al.	2015	Review article	Taiwan	BMC Geriatrics	To assess the combined association of chronic disease and low muscle mass with physical performance in older adults.	The simultaneity of low muscle mass and chronic disease contributes to a greater risk of impaired physical performance than any of the other factors in older adults.	T4

Lingblom et al.	2018	Cross-sectional study	USA	Journal of Translational Medicine	To use a mass cytometry evaluation of the respiratory syncytial virus-specific T-cell response to characterize the cellular response to the virus in vaccinated individuals.	The high parameter of mass cytometry can help to trace immunological components associated with the differential response to the vaccine.	T2
Mazza et al.	2017	Longitudinal study	Italy	Journal of Translational Medicine	To investigate the association between food choice and cognitive function in older adults.	There is a positive association between the pattern of legume consumption and cognitive performance in older adults.	T4
Morgenstern et al.	2015	Randomized and controlled study	USA	Translational Stroke Research	To examine the benefit of using medical alert devices to activate emergency medical systems for elderly women living alone.	The study showed no difference between the elderly women who used it and those who did not use the medical alert device.	T4
Naylor et al.	2009	Prospective, quasi-experimental study	USA	Journal of Evaluation in Clinical Practice	To assess the impact of the translational care model (TCM), on a major US health plan, to meet the needs of older adults with chronic diseases during acute illness episodes.	The TCM for older adults with chronic diseases can be considered a success.	T4
Piette et al.	2011	Experience report	USA	Translational Behavioral Medicine	To demonstrate the experience of a medical clinic with a patient-aligned care team (PACT).	The experience of the PACT has shown that innovative services can improve the intensity and quality of self-management support without unacceptable and increasing demands of the physician's time.	T4
Sayer, A. A.	2014	Editorial	England	Age and aging	To discuss how to transfer research knowledge to clinical practice in geriatric sarcopenia syndrome.	Geriatricians should be suspicious of the high rate of sarcopenia in older adults in health care	NA

						services. They should measure and assess the LM, MS, and VM of the older adults and recommend ST programs. Dietary recommendations are still ambiguous.	
Schwenk et al.	2014	Case study and control	Germany	Journal of Alzheimer's Disease	To determine an FT and PRT program to improve motor performance in patients with dementia.	An intense exercise program can be implemented in a geriatric rehabilitation environment to improve motor performance in patients with dementia.	T4
Scimeca et al.	2017	Retrospective study	Italy	Journal of Translational Medicine	To verify whether a balance between bone morphogenetic proteins (BMPs) and myostatin pathways regulates sarcopenia in patients with subcapital femur fractures and osteoarthritis.	The role of BMPs and myostatin pathways in the pathophysiology of human sarcopenia allows proposing BMP-2/7 and anti-myostatin recombinant human antibodies as a possible therapeutic option for sarcopenia.	T1
Seals, D. R., Melov, S.	2014	Review article	USA	Aging	To discuss how "Translational Geroscience" (TG) can contribute to increase longevity.	One of the main focuses of TG should be to optimize physical and cognitive function throughout life.	NA
Sibille, E.	2013	Editorial	USA	The American Association for Geriatric Psychiatry	To analyze the possibilities for neurobiology to increase the translational opportunities and changes in geriatric psychiatry.	Greater investments should be made in the investigation of biological mechanisms involved in psychiatric disorders to understand the pathways to resilience and successful aging.	NA
Supiano, et al.	2012	Review article	USA	Journal of the American Geriatrics	This report describes the experience of the	The GRECC program, after 30 years of	NA

				Society	Geriatric Research, Education, and Clinical Centers (GRECCs) program with American war veterans as a model for translating research knowledge into clinical practice.	operation, remains a “rare gem for veterans” and is ready to contribute to studies on aging and the geriatric clinic of the future.	
Vaucher et al.	2014	Cohort and exploratory study	Switzerland	Biomed Central Geriatrics	To verify the association of a neuropsychological test (NT) for older adults and to provide physicians with predictive values of driving performance when tracking cognitively healthy older adults.	The NT is not specific enough for doctors to justify the revocation of driver’s license without further investigations.	T4
Vaughan et al.	2018	Review article	USA	Journal American Geriatric Society	To describe the results of the conference and establish a translational research agenda on the geriatric syndrome of “urinary incontinence (UI)”.	A table was created with recommendations and ideas for future translational research in UI.	T4
Wick, G.	2014	Editorial	Switzerland	Gerontology	To discuss how to transfer gerontological knowledge into practice.	Gerontologists need to disclose their results to the general population.	NA

Key: BMJ = British Medical Journal; TK = translational knowledge; AD = Alzheimer's disease; PACT = patient-aligned care team; MS = muscle strength; AMI = acute myocardial infarction; UI = urinary incontinence; JAMA = The Journal of the American Medical Association; TCM = Translational care model; LM = lean mass; PIM = potentially inappropriate medicine; NA = not applicable; NEJM = The New England Journal of Medicine; GRECC = Geriatric Research, Education, and Clinical Centers; BMP = bone morphogenetic proteins; T1 = basic sciences translated into clinical effectiveness; T2 = efficacy translated into clinical efficacy; T3 = efficacy translated into the provision of health care services; T4 = delivery translated to the population's health; ST = strength training; FT = functional training; PRT = progressive resistance training; NT = neuropsychological test; WS = walking speed.

Source: Author (2020)

Table 2. Descriptors inserted in the keywords of the articles, with frequency ≥ 2 (2009-2019).

Keywords	Absolute frequency
Older adults/Elderly	5
Cognitive Dysfunction	3
Chronic disease	3
Aging	3
Geriatrics	2
Translational Medical Research	2
Medical services	2

Source: Own authorship (2020).

DISCUSSION

Primary TM studies with older adults

Primary studies are those that correspond to original investigations (COSSETTE et al., 2016; DODSON et al., 2016; FOCAN et al., 2013; LINGBLOM et al., 2018; MAZZA et al., 2017; MORGENSTERN et al., 2015; NAYLOR et al., 2009; SCHWENK et al., 2014; SCIMECA et al., 2017; VAUCHER et al., 2014). The translational care model proved to be efficient for a comprehensive care of the needs of older adults with chronic diseases, and to reduce the number of inadequate medicines for older adults (COSSETTE et al., 2016; NAYLOR et al., 2009). According to Naylor et al. (2011), the Translational Care Model (TCM) refers to a variety of services and environments designed to guarantee the continuity of health care and avoid the aggravation of problems among populations at risk. The same authors point out that the TCM focuses on all health problems and risks that can contribute to rehospitalization, aiming to enhance the health of older adults. The researchers also describe ten essential elements of the TCM in that study, emphasizing the multidisciplinary approach and communication, which include health professionals, family members, caregivers, and older adults (NAYLOR et al., 2009).

The different TCM protocols included in this review proved to be efficient for their proposed outcomes, both in the community and hospitalized older adults. On the other hand, both studies highlighted barriers to the implementation of translational care models, taking organizational and regulatory barriers, scarcity of financial incentives, absence of translational scripts, and low knowledge of the health team as examples. Therefore, greater investments in TCM studies in different realities can expand the knowledge of this field of study, which is still exploratory and, thus, facilitate its application in clinical practices to improve the health of older adults, one of the objectives of TM (NAYLOR et al., 2009).

Translational research transforms scientific discoveries resulting from laboratory, clinical, and population studies into new clinical tools and applications that improve health care (WANG, 2012). In this perspective, the studies included in the review demonstrated these new possibilities, for example: the relevance of walking speed assessment in the prognosis of mortality and hospital readmission in older adults after acute myocardial infarction (DODSON et al., 2016); circadian rhythm assessment in older adults with cancer using actimetry (FOCAN et al., 2013); and their legume consumption pattern as a mean of providing better cognitive performance for older adults (MAZZA et al., 2017). According to Marko-Varga et al. (2017), mass cytometry is a promising tool for translational research, being able to determine the presence of mutations that predispose to some types of cancer and the individual's response to treatment. In addition, in the study by Lingblom et al. (2018), with 20 healthy older adults, concluded that high-parameter mass cytometry (CyTOF) can help to determine the immunological components associated with the differential response to the vaccine, which can contribute to determine the prediction of responses to vaccines in older adults. These studies reinforce the field of knowledge of translational research as a multimodal process that integrates the exchange of information to optimize the efficiency and effectiveness of its scientific way.

A study by Scimeca et al. (2017), assessed the relationship between the expression of bone morphogenetic proteins (BMP) - 2/4-7, myostatin and phosphorylated Smads 1-5-8, and muscle quality in terms of fiber atrophy (sarcopenia) and satellite cells activity in older adult patients undergoing femur and hip arthroplasty surgery. They concluded that the role of BMPs and myostatin pathways in the pathophysiology of human sarcopenia allows proposing the BMP-2/7 and the anti-myostatin recombinant human antibodies as a possible therapeutic option for sarcopenia (SCIMECA et al., 2017).

The translational model of geriatric rehabilitation through physical exercise showed improvements in motor performance in patients with mild and moderate dementia. Difficulties were encountered, as the study was implemented in the routine of a geriatric ward, presenting some conflicts with the team due to daily care, provision of beds, and inability to participate in tests for patients with an acute impairment, in addition to possible bias influence among the nurses, as they were located close to each other. Even so, the translational design presented a treatment strategy with low cost resources, the resistance and the functional training, proposing configurations that can be implemented in a realistic and successful way. Therefore, this study expands the field of possibilities for physical exercise intervention programs for older adults with dementia in clinics (SCHWENK et al., 2014).

New technologies for monitoring and effectiveness of care are also part of the scope of TM. However, Morgenstern et al. (2015) did not demonstrate the feasibility and effectiveness of medical alert devices in elderly women with at least one stroke risk factor. The authors suggest that further studies using cellular systems should be carried out, as they are used in any location and are aesthetically more adaptable than the devices used in the study. Furthermore, Wang (2012) highlights that safety may be a more important requirement in the preclinical stage than effectiveness, especially in the field of the device.

Secondary TM studies with older adults

Secondary studies are those that sought to draw conclusions from primary studies. 11 studies were found classified with this study design (CH'NG et al., 2017; CHIEN; HO, 2011; GRECO et al., 2012; LI et al., 2015; PIETTE et al., 2011; SAYER, 2014; SEALS; MELOV, 2014; SIBILLE, 2013; SUPIANO et al., 2012; VAUGHAN et al., 2018; WICK, 2014).

The experience reports of translational care models that focused on older adult patients proved to be effective (PIETTE et al., 2011; SUPIANO et al., 2012). The models produced innovative services that can improve the quality of support for self-management, without an unacceptable increase in the demands from the physician's time; for example, an elevated number of high-risk patients for identification, coordination systems for patient care, a form of communication between the team, self-management programs, among other services (PIETTE et al., 2011). Another interesting aspect in these models is the emphasis given to collaboration between physicians and researchers for the development of new translational research programs and clinical demonstration projects in several areas, such as dementia, palliative care at home, physical exercise, geriatric syndrome, among others (SUPIANO et al., 2012). Both approaches were applied in real time, and the authors encourage further studies to assess the effectiveness of these models in other realities.

The review articles showed a methodological heterogeneity, being one in the ClinicalTrials.gov database (CHIEN; HO, 2011), one review of five cohort studies (LI et al., 2015), an in silico bibliographic search (GRECO et al., 2012) and one review of

the research conference on urinary incontinence in older adults (VAUGHAN et al., 2018). This type of search made it possible to verify that less than 10% of drug tests are performed considering the pharmacokinetics of older adults, so it is suggested that the establishment of adequate dosing for older adults needs to be rethought. In older adults, low muscle mass and chronic disease, concomitantly, contributed to a greater risk of impaired physical performance than any of the clinical factors analyzed. Therefore, the incorporation of this information is important in new diagnostic tools and treatments.

Interestingly, Vaughan et al. (2018) described the strategies of the “Urinary Incontinence in Older Adults: a Translational Research Agenda for a Complex Geriatric Syndrome” conference. The main strategy was a meeting in the form of a debate forum, where several researchers were brought together, from areas such as epidemiology, basic and applied research, and translational research focusing on urinary incontinence (UI) in older adults. In this way, it was possible to structure a translational research agenda for UI in older adults, and, in addition, to create a network of researchers on the topic (VAUGHAN et al., 2018). This study may encourage more researchers from other geriatric syndromes, or even from the management of multiple geriatric syndromes, to develop a translational research agenda.

In the study by Greco et al., (2012) the discovery of Alzheimer's disease (AD) biomarkers was carried out using a method called “*in silico*”. This technique is a computer-based approach that allows a comprehensive analysis of a body of information integrated with publicly available literature sources and other databases of relevant information to the proposed theme, in this case AD (GRECO et al., 2012). According to Marsolo et al. (2015), these new research approaches can contribute to new studies and strategies with clinical applicability that improve human health and reduce the incidence, morbidity, and mortality of diseases.

The three editorials included in this study have the transference and dissemination of research findings for clinical practice in geriatrics as their main subject (SAYER, 2014; SIBILLE, 2013; WICK, 2014). In geriatric psychiatry, Sibille (2013) highlights that the main challenge is to characterize the relevant biological pathways within the vast human complexity, and the opportunities offered by the unique biological changes that occur in the aged brain. In this sense, Sayer (2014) points out that sarcopenia, as a geriatric syndrome, is the target of many studies. However, this knowledge does not yet have exuberant clinical applicability and, therefore, it is time to shift knowledge. Another highlighted aspect is the dissemination of these studies, Wick (2014) states that the results of the translation of studies in gerontology must be more accessible to the whole society, and that complex scientific data must be translated into simple words.

Two other articles were included in the “letter to the editor” category (CH’NG et al., 2017; SEALS; MELOV, 2014). The term “Translational Geroscience” is understood as a continuous and bidirectional study that includes research from the fundamental mechanisms of aging, using basic models, to populational aging in community contexts, with the ultimate goal of promoting ideal this longevity, called “Healthspan” (SEALS; MELOV, 2014). This author stresses the need for greater training of geroscience researchers to meet the basic health needs and expectations for an ideal longevity.

The findings of our study do not corroborate with a previous study regarding the classification of the translational stage of the articles included (Ch’ng et al., 2017). In our findings, most studies were classified as T4 (48%) and NA (28%), while Ch’ng et al. (2017) refer to a predominance of studies in T2 stage (70.3%) and T3 (14.5%). This difference can be explained by the number of journals analyzed by the studies, in our review we included 15 types of journals. The quality of the included studies was not assessed in this review; however, the greater number of journals publishing translational research may lead to greater production of translational knowledge in the clinical and public health stages. The NA classification showed a high percentage because we did not insert any exclusion criteria regarding the study design. For Ch’ng et al. (2017), greater public and private investments should be made to ensure higher quality of TM studies in geriatrics.

CONCLUSION

The findings of this study made it possible to identify, analyze and classify the studies published in the literature on translational medicine in geriatrics. Knowledge about TM in geriatrics becomes important due to population aging and the search for the best conditions for healthy aging. Therefore, a systematization of these studies expanded the knowledge and shows how TM research trends in clinical practice to improve the health of the elderly. Our results confirm that the studies of Translational Medicine with older adults have wide a variability in terms of method, topics covered, classification of the research stage, and published journals. In most studies, the translational research model with or for older adults has proven to be effective, either in the application of a new method or in human health. Greater investments in this type of study are needed, in order to optimize the efficiency and effectiveness of research, and to advance knowledge that can improve the care of older adult patients with better clinical applications.

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