

# SEDENTARY BEHAVIOR AND NUTRITIONAL STATUS AMONG OLDER ADULTS: A META-ANALYSIS



REVIEW ARTICLES  
ARTIGOS DE REVISÃO  
ARTÍCULOS DE REVISIÓN

COMPORTAMENTO SEDENTÁRIO E ESTADO NUTRICIONAL DE IDOSOS: UMA METANÁLISE

COMPORTAMIENTO SEDENTARIO Y EL ESTADO NUTRICIONAL DE LOS ANCIANOS:  
UNA META-ANÁLISIS

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## ABSTRACT

The accelerated modernization process has entailed changes in the lifestyle of people, such as exposure to sedentary behavior, and this in turn may affect the nutritional status. The aim of this systematic review with meta-analysis was to analyze observational studies that assessed the association between exposure time to sedentary behavior and nutritional status (overweight/malnutrition) in individuals aged  $\geq 60$  years. BVS, PubMed and Web of Science were the databases used in the search for observational studies, published until November 28, 2017, which have examined the association between exposure time to sedentary behavior and nutritional status. Two authors undertook the reading of titles and abstracts and applied the STROBE checklist independently. The Odds Ratio was calculated using the random effects model. Eight studies were included in this meta-analysis and involved 21415 individuals. All the studies covered most of the items suggested by the STROBE checklist. Of the total, four studies showed association between sedentary behavior and nutritional status. Longer exposure to sedentary behavior did not increase the odds of overweight and/or obesity (OR 1.32; 95% CI 0.95-1.84). It is suggested that further studies with standardized criteria for measuring sedentary behavior and nutritional status are undertaken. **Level of Evidence II; Systematic review of level II studies.**

**Keywords:** Sedentary lifestyle; Overweight; Malnutrition; Aged.

## RESUMO

*O acelerado processo de modernização tem acarretado mudanças no estilo de vida das pessoas, como a exposição ao comportamento sedentário, e esta, por sua vez, pode afetar o estado nutricional. O objetivo desta revisão sistemática com meta-análise foi analisar estudos observacionais, que avaliaram a associação entre tempo de exposição ao comportamento sedentário e estado nutricional (excesso de peso/desnutrição) em indivíduos com idade  $\geq 60$  anos. BVS, PubMed e Web of Science foram as bases de dados utilizadas para a busca de estudos observacionais, publicados até 28 de novembro de 2017, que analisaram a associação entre tempo de exposição ao comportamento sedentário e estado nutricional. Dois autores realizaram a leitura de títulos e resumos e aplicaram o checklist STROBE de forma independente. Odds Ratio foi calculado utilizando o modelo de efeito aleatório. Foram incluídos nesta metanálise oito estudos, envolvendo 21415 indivíduos. Todos os estudos atenderam a maior parte dos itens sugeridos pelo checklist STROBE. Do total, quatro estudos apresentaram associação entre comportamento sedentário e estado nutricional. Maior tempo exposto ao comportamento sedentário não aumentou as chances de sobrepeso e/ou obesidade (OR 1,32; 95%; IC 0,95-1,84). Sugere-se que novos estudos com critérios padronizados de mensuração de comportamento sedentário e estado nutricional sejam realizados. **Nível de Evidência II; Revisão sistemática de estudos de nível II.***

**Descritores:** Estilo de vida sedentário; Sobrepeso; Desnutrição; Idoso.

## RESUMEN

*El proceso de modernización acelerado ha consistido en cambios en el estilo de vida de las personas, entre ellas la exposición a conductas sedentarias, y esto, a su vez, puede afectar el estado nutricional. El objetivo de esta revisión sistemática con meta-análisis fue analizar los estudios observacionales que evaluaron la asociación entre el tiempo de exposición a conductas sedentarias y estado nutricional (sobrepeso/desnutrición) en individuos de edad  $\geq 60$  años. BVS, PubMed y Web of Science fueron las bases de datos utilizadas para la búsqueda de estudios observacionales, publicadas hasta el 28 de noviembre de 2017, que han examinado la asociación entre el tiempo de exposición a conductas sedentarias y el estado nutricional. Dos autores realizaron la lectura de los títulos, resúmenes y aplicación de la lista de verificación STROBE, independientemente. El Odds Ratio se calculó utilizando el modelo de efectos aleatorios. Fueron incluidos en este meta-análisis ocho estudios, involucrando 21415 individuos. Todos los estudios respondieron a la mayoría de los elementos sugeridos por la lista de verificación STROBE. Del total, cuatro estudios mostraron asociación entre conductas sedentarias y estado nutricional. Una mayor exposición a conductas sedentarias no ha aumentado las probabilidades de sobrepeso y obesidad (OR 1.32; 95%; IC 0.95-1.84). Se sugiere que estudios adicionales con criterios de medición estandarizada de conductas sedentarias y estado nutricional se lleve a cabo. **Nivel de Evidencia II; Revisión sistemática de estudios de nivel II.***

**Descriptorios:** Estilo de vida sedentario; Sobrepeso; Desnutrición; Anciano.



## INTRODUCTION

Due to the modernization process occurring in recent years, significant changes in people's lifestyle have been observed, such as altered eating habits, reduced physical activity<sup>1</sup> and increased exposure time to sedentary behavior<sup>2</sup>.

Sedentary behavior is an emerging problem and has been treated as a public health issue<sup>3</sup>. Increased exposure time to this behavior has been associated with several deleterious health factors, such as all-cause mortality<sup>4-6</sup>, depression<sup>7,8</sup>, diabetes type 2<sup>5,9,10</sup>, obesity<sup>11</sup>, metabolic syndrome<sup>5,12</sup>, cardiovascular diseases<sup>5,9,13,14</sup> and certain types of cancer<sup>5</sup>.

In addition, diseases that accompany the aging process, such as changes in eating habits due to senescence, which may lead to excessive or insufficient food consumption in this population, can also contribute negatively to health in the elderly. One health indicator in particular, overweight, characterized by a body mass index (BMI) greater than or equal to 25 kg/m<sup>2</sup><sup>15</sup>, has increased in prevalence worldwide<sup>16</sup>.

Malnutrition, caused by constant inadequate consumption and deficient nutrient absorption, altered transport and use, leading to weight decreases and inflammatory processes common to this condition, is another deleterious elderly health problem<sup>17</sup>. However, little is known about the relationship between exposure time to sedentary behavior and nutritional status in the elderly.

In this context, the aim of the present study was to perform a systematic review through a meta-analysis of observational studies that evaluated associations between exposure time to sedentary behavior and nutritional status (overweight/malnutrition) of subjects aged  $\geq 60$  years old.

## METHODS

### Literature review

A systematic review was carried out based on the search for observational studies published until 28<sup>th</sup> July 2017, at the Virtual Health Library (VHL), National Library of Medicine (PubMed) and Web of Science databases.

The Boolean operators OR and AND were used in the search strategy, with OR used between synonyms of the applied search terms and AND when the objective was to associate two or more different search terms. The search was established through the use of descriptors (DeCS and MeSH terms), Boolean operators, filters and related terms.

The adopted search strategy was based on the combination of the following terms: "sedentary behavior" OR "sitting time" OR "sedentary lifestyle" OR "television viewing" OR "screen-time" OR "computer" OR "driving" AND "nutritional status" OR "nutrition status" OR "obesity" OR "overweight" OR "malnutrition" OR "undernutrition" AND "aged" OR "elderly" OR "older people"; for the PubMed and Web of Science databases and "sedentary behavior" OR "sitting time" OR "sedentary lifestyle" OR "television" OR "driving vehicle" AND "nutritional status" OR "obesity" OR "overweight" OR "malnutrition" AND "aging" OR "elderly" for the VHL database.

### Study selection

Two reviewers (BFC, TIMR) independently read the titles and abstracts of each selected article, and divergences were solved by consensus. In order to include relevant studies not identified in the database-indexed journals, a manual search was performed of the references cited by each article included in the review.

The adopted exclusion criteria were: a) articles written in a language other than Portuguese, English or Spanish; b) studies performed in individuals under the age of 60; c) meta-analysis, systematic reviews, narrative reviews, dissertations and theses. The obtained studies were imported to the EndNote Web reference management program (Thomson Reuters, Carlsbad, CA, USA) to exclude duplicate entries.

## Data extraction

Aspects considered when analysing the selected articles were: author; year of publication; country; age; sample size; type of study (cohort, case-control or cross-sectional); objectives, instruments applied for the definition of sedentary behavior; BMI classification, adjustment variables, effect measures and the amount of items reported by the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) evaluation.

## Study analysis

The selected articles were analyzed by means of the STROBE instrument, comprising 22 items that report aspects that should be included for an adequate description of observational studies.

## Statistical analyses

All analyses were performed using the R software version 3.1.3. The Odds Ratio (OR) and 95% confidence interval (CI) parameters were adopted, significant at  $p \leq 0.05$ . The overall OR was considered in studies where the analysis was stratified separately for men and women.

The random effect model was considered for the meta-analysis of associations between greater exposure time to sedentary behavior and nutritional status<sup>18</sup>.

Heterogeneity was analyzed by means of the I<sup>2</sup> statistic, taking into account the proportion of variation of the effect estimates, instead of considering sample error. For heterogeneity to be considered, I<sup>2</sup> should be higher than 75%<sup>19</sup>.

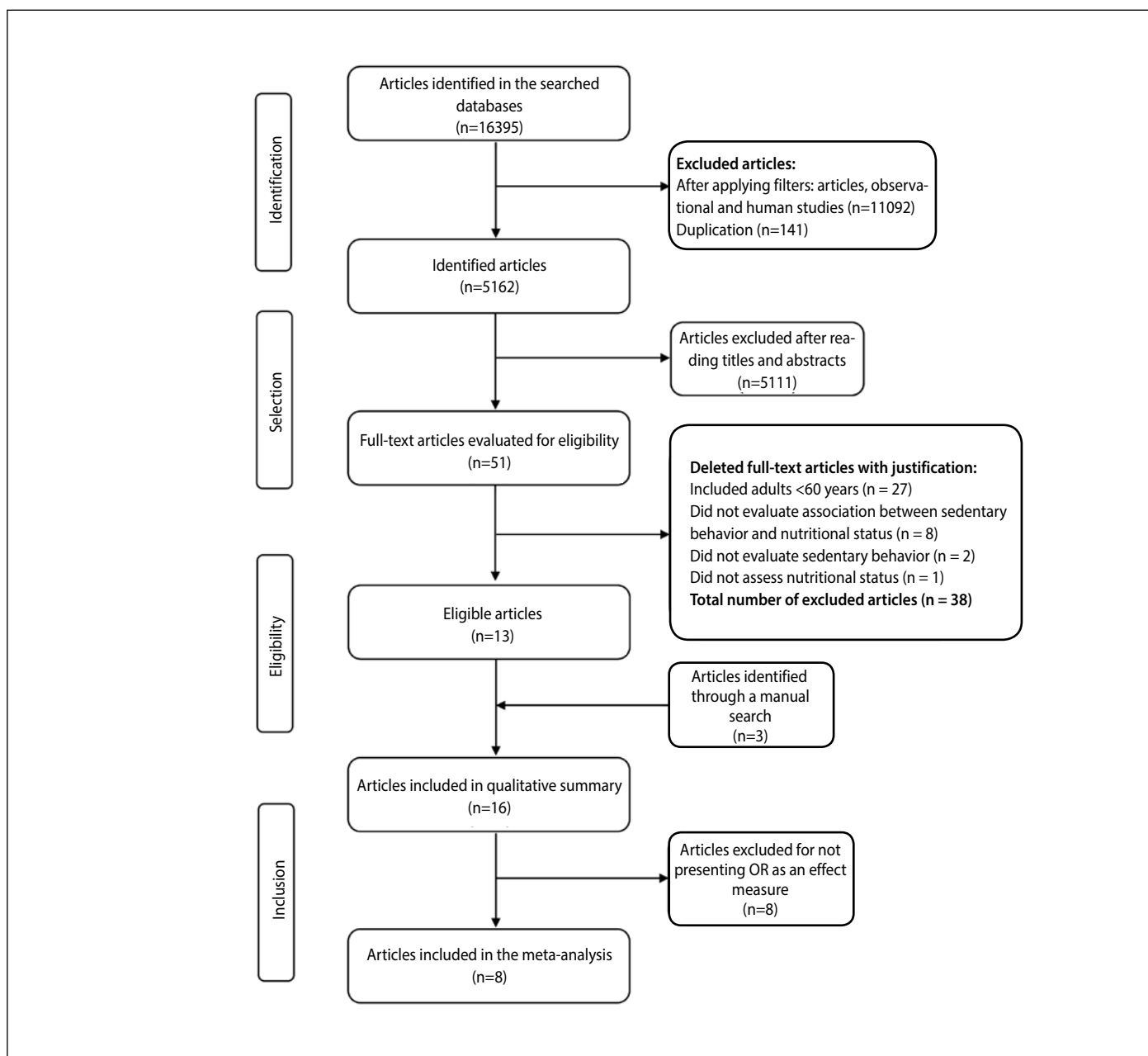
## RESULTS

Figure 1 displays the flowchart of the article selection process. Initially, 16395 articles were identified in the investigated databases. After applying the chosen filters (article category, comprising observational and human studies), 5303 articles displayed potential relevance. Of these, 141 were duplicates and, thus, excluded, with 5042 articles remaining in English, 82 in Spanish and 38 in Portuguese. Of the remaining 5162 articles, 4740 were indexed in the Web of Science database, 391 in Pubmed and 31 in the VHL. After checking titles and abstracts, 51 articles were selected for full reading. Of this total, 38 were excluded with justifications and 13 met the inclusion criteria.

After performing a manual search of the references of the selected articles, 622 studies were identified and three were added to the analysis, totaling 16 articles. Of the remaining articles, eight were excluded because they did not present OR values as an effect measure, with eight articles remaining in the meta-analysis.

The characteristics of each study are listed in Table 1. All eight articles included in the meta-analysis are cross-sectional studies. The study sample ranged from 124 to 14560 elderly people, totaling 21415 people involved in the study. Participant age ranged from 60 to 100 years old. Year of publication ranged from 2007 to 2014. Five studies were carried out in developed countries, (Canada, Spain and Japan<sup>20-24</sup>) and three in developing countries (Brazil, Puerto Rico and the Dominican Republic)<sup>25-27</sup>. All studies evaluated time of exposure to sedentary behavior through questionnaires, presenting different forms of sedentary behavior classification (tertiles, mean and medians).

The activities characterized as markers for sedentary behavior varied among the studies. Two studies evaluated sedentary behavior through total sitting time (hours/day) from the weighted average of sitting times on a week day and a weekend day<sup>25,26</sup>; two evaluated time spent watching TV, reported as hours/day<sup>27</sup> and minutes/day<sup>22</sup>, from the median obtained from the last seven days of the week.



**Figure 1.** Flowchart of the identification of observational studies reporting association between sedentary behavior and nutritional status.

In one study, sedentary behavior was assessed by time spent watching TV or video (minutes/day) during the last seven days<sup>23</sup>. Similarly, another study carried out an analysis on sedentary behavior (minutes/day) in the last seven days regarding leisure sedentary behavior (watching TV, using a computer, reading books and newspapers and listening or talking while sitting)<sup>24</sup>. In two other studies, sedentary behavior was analyzed through sitting time (hours/day)<sup>20,21</sup>.

Regarding body mass index (BMI) classification, two studies used the criteria proposed by the Nutrition Screening Initiative<sup>28</sup>, that classifies an individual as overweight when presenting BMI > 27 kg/m<sup>2</sup><sup>25,26</sup>. In one study, overweight individuals were classified when presenting BMI ≥ 25 kg/m<sup>2</sup>, but the reference for this choice was not reported<sup>23</sup>. Two other studies<sup>21,27</sup> presented the cut-off point proposed by World Health Organization<sup>15</sup>. After contact with three authors who did not present the reference for the BMI cutoffs in their studies<sup>20,22,24</sup>, it was discovered that they also applied the model proposed by the World Health Organization, which classifies overweight individuals as BMI ≥ 25 kg/m<sup>2</sup>, totaling five articles applying the same reference.

Seven studies<sup>20,22–24,25–27</sup> presented a combined outcome of both men and women and one study evaluated only women<sup>21</sup>.

The number of items answered by the checklist varied between the STROBE-analyzed articles. Three studies<sup>20,23,26</sup> complied with 18 STROBE items, another three<sup>21,25,27</sup> with 19 items, and two<sup>22,24</sup> with 20 of the 22 items suggested by the instrument.

The results of the association between greater exposure time to sedentary behavior and overweight are presented in Figure 2. An I<sup>2</sup> of 86% and P<sub>heterogeneity</sub> of 0.0001 were observed. Four studies showed an association between these variables<sup>21,23,24,2</sup>. However, greater exposure time to sedentary behavior did not increase the chance for individuals aged 60 or older being overweight/obesity (OR 1.32, 95% CI 0.95-1.84).

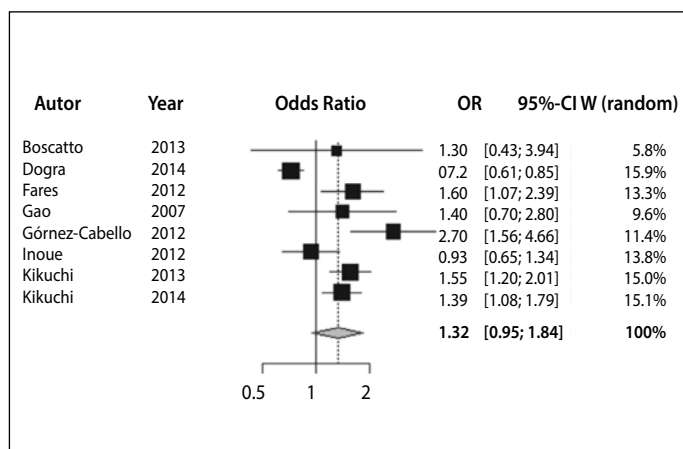
## DISCUSSION

The systematic review conducted herein with a meta-analysis involving eight studies indicated that more time spent in sedentary behavior did not increase the chances of individuals being overweight/obesity.

**Table 1.** Characteristics of the articles included in the meta-analysis.

Auhor and year	Country	Age	Sample	Type of study	Objective	Sedentary behavior		BMI classification	Adjustment	Strobe
						Evaluation instrument	Definition			
Boscatto et al. 2013	Brazil	80-100	124	Cross-sectional	Examine the association between nutritional status and sociodemographic variables, health conditions and lifestyle of both men and women	Questionnaire	Time sitting <4 hours/day 4-6 hours/day ≥6 hours/day	Nutrition Screening Initiative, 1992	Sex, medication use and smoking	19
Dogra e Stathokostas 2014	Canada	≥65	14560	Cross-sectional	Identify potential sociodemographic, physical environmental, psychosocial and health variables correlated to sitting time in the elderly	Questionnaire	Time sitting <4 hours/day ≥4 hours/day	WHO, 1995	Age and sex	18
Fares et al. 2012	Brazil	60-100	768	Cross-sectional	To verify the association of nutritional status with sociodemographic, lifestyle and conditions of both men and women in two different municipalities in Brazil	Questionnaire	Time sitting <4 hours/day 4-6 hours/day ≥6 hours/day	Nutrition Screening Initiative, 1992	Age, sex, family arrangement, smoking, hypertension, arthrosis, medications, lifelong occupation, and alcohol consumption	18
Gao, Nelson e Tucker 2007	Porto Rico and Dominican Republic	≥60	455	Cross-sectional	Examine the association between TV viewing time and prevalence of metabolic syndrome	Questionnaire	Watch TV ≤840 minutes/week >840 minutes/week	WHO, 1995	Age, sex, ethnicity, schooling, family arrangement, smoking, alcohol consumption	19
Gomez-Cabello et al. 2012	Spain	≥65	457	Cross-sectional	Establish the influence of sitting time on the composition of women's bodies	Questionnaire	Time sitting <4 hours/day ≥4 hours/day	WHO, 1995	Active behavior (hours spent walking)	19
Inoue et al. 2012	Japan	65-74	1806	Cross-sectional	Examine the joint association of viewing time and overweight and obesity MVPA in men and women	Questionnaire	Watch TV ≤840 minutes/week >840 minutes/week	WHO, 1995	Age, gender, schooling professional situation, hometown, smoking, alcohol consumption, and physical functionality	20
Kikuchi et al. 2013	Japan	65-74	1665	Cross-sectional	To analyze the association between sociodemographic attributes and time spent watching TV time in both men and women	Questionnaire	Watch TV <2 hours/day >2 hours/day	Underweight <20 kg/m <sup>2</sup> Normal weight 20-24.9 kg/m <sup>2</sup> Overweight ≥25kg/m <sup>2</sup> *	MVPA, Health self-perception and BMI	18
Kikuchi et al. 2014	Japan	65-74	1580	Cross-sectional	Identify SBL categories and examine the association between health and well-being rates in bothmen and women	Questionnaire	SBL (watching TV, using a computer, reading books and newspapers, listening or speaking while sitting) (minutes / day)	WHO, 1995	Age, sex, MVPA, schooling, municipality, professional situation and life arrangement	20

BMI - Body mass index. MVPA - Moderate to vigorous physical activity. SBL - Sedentary behavior in leisure. WHO, 1995 - Underweight BMI <18.5 kg/m<sup>2</sup>; Normal, 18.5-24.9 kg/m<sup>2</sup>; Overweight 25-29.9 kg/m<sup>2</sup> and Obesity ≥ 30 kg/m<sup>2</sup>. Nutrition Screening Initiative, 1992 - Underweight BMI <22.0 kg/m<sup>2</sup>; Normal weight BMI 22.0-27.0 kg/m<sup>2</sup>; Overweight > 27 kg/m<sup>2</sup>. \* Reference not reported by the author.



**Figure 2.** Forest plot of the association between sedentary behavior and overweight in the elderly.

The selected studies presented several divergences in certain parameters, such as age, sample size, adjustment variables, classification and cutoff points for sedentary behavior and BMI. Seven studies included both genders, while only one<sup>21</sup> performed the analysis with women only.

Another noteworthy aspect is the lack of standardization regarding the instruments applied to measure exposure time to sedentary behavior. All studies included in the meta-analysis identified sedentary behavior through questionnaires (self-reported measure). However, other studies have measured sedentary behavior through accelerometers<sup>29-32</sup>.

The identification of sedentary behavior through self-reports has been widely applied in population studies, since this is a low-cost instrument with immediate applicability<sup>33-41</sup>. However, self-reports can underestimate the total sedentary time of individuals by omission or forgetfulness, the latter being common in the elderly population. Nevertheless, a good concurrent validity was verified when compared to a reference standard

in a study with the aim of establishing the reproducibility and concurrent validity of a questionnaire measuring the level of physical activity and sedentary behavior in subjects aged  $\geq 60$ <sup>42</sup>.

According to a literature survey, validated questionnaires applied in the measurement of sedentary behavior in the elderly are rare<sup>43,44</sup> and, therefore, other instruments, such as the International Physical Activity Questionnaire (IPAQ), which deals with physical activity levels and includes specific questions related to total sitting time, have been applied<sup>42,45</sup>.

No consensus in the literature regarding the most applied marker to characterize time exposed to sedentary behavior exists. Of the studies included in this meta-analysis, four identified sedentary behavior through total sitting time<sup>20,21,25,26</sup>, three by time spent watching TV<sup>22,23,27</sup> and one by sedentary leisure behavior<sup>24</sup>. The variability in sedentary behavior markers and their respective cutoff points, in addition to the different characteristics of each study, may justify the high heterogeneity observed herein.

Although several studies use time spent watching TV as one of the main markers for sedentary behavior, a systematic review has demonstrated that this parameter should not be limited to this type of behavior<sup>46</sup>. The fact that some studies do not include other sedentary activities, such as those performed at work or at leisure, could underestimate total exposure time to sedentary behavior.

Some studies<sup>20–22,24,27</sup> classified body mass index as proposed by the World Health Organization. Although this classification does not take into account the body changes that accompany the aging process, it has been one of the most applied references in epidemiological studies worldwide<sup>11,40,47,48</sup>.

None of the articles answered all twenty items evaluated by the STROBE instrument, which suggests the items necessary for a better description of observational studies, although most items suggested by this checklist were addressed. The analysis of studies through a checklist is increasingly recommended in systematic reviews and meta-analyses, since this instrument allows for the inclusion of studies that display greater clarity in data reporting.

No studies establishing an association between more time spent in sedentary behavior and malnutrition in the elderly were identified. Only two<sup>25,26</sup> analyzed the relationship between sedentary behavior and underweight, but no significant results were found for this association. As the purpose of this meta-analysis is to identify the association

between sedentary behavior and overweight/malnutrition and the term “low weight” is only indicative of a risk of malnutrition, these findings shall not be discussed.

Of the eight articles excluded from the meta-analysis because they did not present OR as a measure of effect or because they reported more than one OR, four reported no association between sedentary behavior and overweight<sup>31,32,36,49</sup>, three reported an association<sup>48,50,51</sup> and one, which considered the results stratified by sex, reported a significant association only in women<sup>52</sup>. However, even if these studies were included in this meta-analysis, there would still be insufficient evidence of the relationship between longer exposure times to sedentary behavior and excess weight in the elderly.

This meta-analysis presents important highlights, including a large number of descriptors used in the search, no restriction regarding publication year, the analysis of both titles and abstracts, a checklist performed by two independent authors, a manual search through the references of each article included in the meta-analysis and a list of excluded articles with justifications.

Some limitations should also be noted, such as the fact that a high heterogeneity in the results was observed, due to sample variability, making it difficult to interpret the findings. All studies included in the meta-analysis were cross-sectional, which does not allow for the establishment of a causal relationship.

## CONCLUSIONS

No significant associations were found between longer exposure to sedentary behavior and an overweight condition in subjects aged  $\geq 60$  years old in this meta-analysis systematic review. Thus, the need to develop new studies with standardized criteria directed towards the evaluation of sedentary behavior and nutritional status in older individuals is pointed out.

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