

Ellen Jaqueline Ramos<sup>1</sup>  
Larissa Thais Braz Pereira<sup>1</sup>  
Mariana Julião Guillarducci<sup>2</sup>  
Arlindo Leandro Gomes<sup>1</sup>  
Nathalia Sernizon Guimarães<sup>3</sup>  
Flávia Galvão Cândido<sup>4</sup>  
Olívia Gonçalves Leão Coelho<sup>4</sup>  
Júnia Maria Geraldo Gomes<sup>1</sup>

<sup>1</sup>Federal Institute of Education, Science and Technology of Southeast Minas Gerais, Campus Barbacena, Brazil.

<sup>2</sup>School of Public Health, University of São Paulo, Brazil.

<sup>3</sup>Department of Nutrition, Federal University of Minas Gerais, Brazil.

<sup>4</sup>Department of Nutrition and Health, Federal University of Viçosa, Brazil.

✉ Júnia Maria Gomes

R. Monsenhor José Augusto, 204, São José, Barbacena, Minas Gerais  
CEP: 36205-018

✉ junianut@yahoo.com.br

## ABSTRACT

**Introduction:** Low adherence to the treatment is a major challenge faced by health professionals during the management of type 2 diabetes. **Objective:** To assess the prevalence and risk factors related to dietary adherence in individuals living with type 2 diabetes in Brazil. **Material and Methods:** PubMed, Embase, Cochrane Library and SciELO/Lilacs were searched without restriction to a year of publication and language. **Results:** From 3713 studies, 14 articles involving 2962 individuals living with type 2 diabetes were eligible. The combined proportion of adherence to the diet was 41% (95% CI: 0.267-0.562,  $p < 0.001$ ;  $I^2 = 98.81\%$ ,  $p < 0.001$ ), with the highest 78% and lowest 3%. The combined proportion of nonadherence to the diet was 51% (95% CI: 0.268-0.754,  $p < 0.001$ ;  $I^2 = 99.25\%$ ,  $p < 0.001$ ), with the highest being 98% and the lowest being 9%. The main risk factors for nonadherence to nutritional treatment were low education, low income, and multimorbidity. **Conclusion:** Low adherence to the diet is a concern during nutritional counseling of individuals living with type 2 diabetes in Brazil.

Key-words: Diabetes Mellitus, Type 2; Prevalence; Risk Factors; Treatment Adherence and Compliance.

## RESUMO

**Introdução:** A baixa adesão ao tratamento é um dos principais desafios enfrentados pelos profissionais de saúde durante a gestão da diabetes tipo 2. **Objetivo:** Avaliar a prevalência e os fatores de risco relacionados à adesão à dieta em indivíduos vivendo com diabetes *mellitus* tipo 2 no Brasil. **Material e Métodos:** Foram pesquisadas as bases de dados PubMed, Embase, Cochrane *Library* e SciELO/Lilacs, sem restrição de ano de publicação e idioma. **Resultados:** De 3713 estudos, 14 artigos envolvendo 2962 indivíduos vivendo com diabetes *mellitus* tipo 2 foram elegíveis. A proporção combinada de adesão à dieta foi de 41% (IC 95%: 0,267-0,562,  $p < 0,001$ ;  $I^2 = 98,81\%$ ,  $p < 0,001$ ), sendo a maior 78% e a menor 3%. A proporção combinada de não adesão à dieta foi de 51% (IC 95%: 0,268-0,754,  $p < 0,001$ ;  $I^2 = 99,25\%$ ,  $p < 0,001$ ), sendo a mais elevada de 98% e a mais baixa de 9%. Os principais fatores de risco para a não adesão ao tratamento nutricional foram a baixa escolaridade, a baixa renda e a multimorbidade. **Conclusão:** A baixa adesão à dieta é uma preocupação durante o aconselhamento nutricional de indivíduos vivendo com diabetes *mellitus* tipo 2 no Brasil.

Palavras-chave: Diabetes Mellitus Tipo 2; Prevalência; Fatores de Risco; Cooperação e Adesão ao Tratamento.

Submetido: 14/12/2023

Aceito: 01/02/2024



## INTRODUCTION

Type 2 diabetes *mellitus* (T2DM) is a complex, chronic, and multifactorial disease with a high prevalence worldwide. According to the International Diabetes Federation (IDF), there were nearly 537 million people living with T2DM in 2021 worldwide. Brazil ranks 5th in the international prevalence ranking, with almost 17 million cases.<sup>1</sup> T2DM is considered a global challenge to health systems and the economy because it affects individuals as well as their families and society due to the impacts on quality of life caused by disabilities, loss of productivity, and chronic complications arising from the disease.<sup>2,3</sup>

The therapeutic approach in T2DM includes educational strategies focusing on lasting changes in lifestyle habits and may involve dietary planning, physical activity protocols, and incentives for the absence or cessation of smoking, in addition to the use of medications. However, it is widely recognized that T2DM treatment is complex and difficult for both patients and health professionals to perform, which often results in poor disease control.<sup>4</sup>

Treatment adherence measures a person’s behavior, such as using medication, following a meal plan, or adopting changes in lifestyle, corresponding to the recommendations of the health professional or the multidisciplinary health team.<sup>5,6</sup> Low adherence to treatment is one of the major problems faced by health professionals in the intervention process of individuals with T2DM, often due to the chronicity of the disease, difficulty in changing the patient’s lifestyle habits, or the adoption of self-care responsibilities.<sup>7</sup> Despite the central role of nutrition in T2DM treatment and the difficulties in adhering to nutritional recommendations, to the best of our knowledge, there was no available review about the topic enrolling Brazilian people. In this context, this systematic review and meta-analysis aimed to assess the prevalence and risk factors related to dietary adherence in individuals living with type 2 diabetes in Brazil.

## METHODS

### Protocol and registration

This systematic review was written in

accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis guide (PRISMA 2020) (Appendix A), and its protocol has been registered with PROSPERO (CRD42018098783).<sup>8</sup>

### Data sources and research

To identify the studies and formulate the central question, we used the PECOS anagram (P= Population; E= Exposure; C= Comparison; O= Outcome; S= Studies/ Studies). The following question guided the execution of this systematic review with meta-analysis: What are the prevalence and risk factors for adherence to nutritional treatment in Brazilians with T2DM? (Table 1).

The descriptors used were defined from the Medical Subject Headings (MeSH) and uncontrolled terms (jargons) in the English language, and the Boolean operators OR and AND were used to associate the terms. The following electronic databases were consulted: Medline (PubMed, www.pubmed.com), Embase (www.embase.com), Cochrane Library (www.cochranelibrary.org) and SciELO/Lilacs by Virtual Health Library (BVS, https://bvsmms.saude.gov.br/g). The search for gray literature was carried out by consulting bibliographic references included in the selected articles. The search strategy used is described in Appendix B – Table S2. The search was carried out on July 20, 2023. No restriction regarding the year of publication of the studies or language was applied.

### Selection of studies

Cross-sectional, case-control, and longitudinal studies carried out with Brazilian adults and elderly individuals (age between 18 and 80 years old) diagnosed with T2DM, performing nutritional treatment associated or not with drug treatment at different levels of healthcare, were considered eligible. Exclusion criteria were: i) studies that evaluated individuals with type 1 diabetes *mellitus*, gestational diabetes and prediabetes; ii) research with animals or carried out in countries other than Brazil; iii) absence of nutritional intervention or of outcomes (adherence to nutritional treatment and associated factors); iv) abstracts, in vitro studies, theses, dissertations, monographs, case reports, letters to the editor and literature reviews (narrative, integrative, systematic, and meta-analyses);

**Table 1:** Central question of the systematic review defined through the PECOS protocol.

Description	Abbreviation	Question components
Population	P	Brazilian adults and elderly
Exposure	E	Type 2 diabetes
Comparison	C	Not applicable
Outcome	O	Non-adherence to nutritional treatment
Studies	S	Observational studies

and v) absence of duplicate documents were identified and excluded using the Rayyan web application as a first stage of eligibility. Article titles and abstracts were selected, and the inclusion and exclusion criteria were applied by two authors independently (EJR and LTBP). The Rayyan web application was used for this phase. Soon after, the selected articles were read in full. When necessary, a third reviewer (JMGG) was consulted. The reasons for exclusion were recorded and are presented in Appendix C – Table S3.

### Data extraction and quality assessment

After reading the articles, data were independently extracted and summarized in a standardized table by two authors (EJR and LTBP), who compiled the results after discussion between them. For each article, the following information was extracted: author, responsible for extracting, study design, state, groups, initial and final total N, diseases, sex, mean age, type of nutritional intervention, how adherence to the diet was evaluated, which was considered good adherence to the diet, percentage and N of adherence and nonadherence to diet, physical activity and medication, period of nutritional intervention, mean body mass index (BMI), duration of T2DM, risk factors for nonadherence, other results related to adherence, schooling, average monthly family income, systolic and diastolic blood

pressure, waist circumference, blood glucose, glycated hemoglobin (HbA1c), high density lipoprotein (HDL), low density lipoprotein (LDL), and total cholesterol.

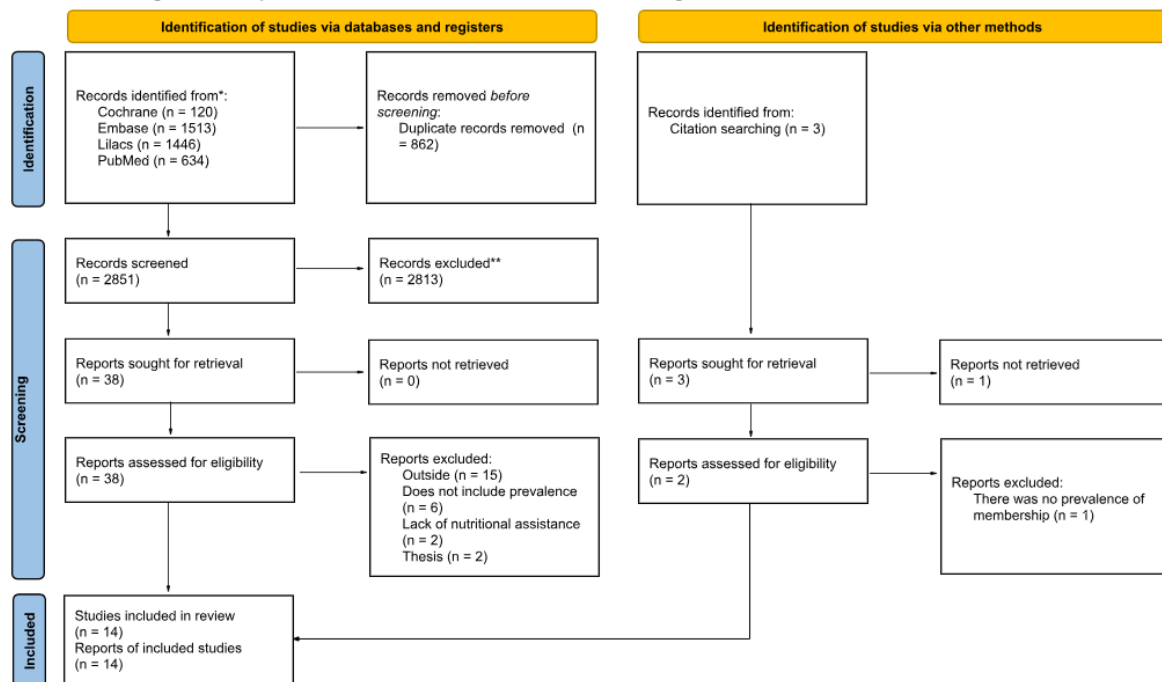
The risk of bias was independently assessed by two authors (EJR and LTBP). In case of disagreement, a third author (JMGG) was consulted for the final consensus. To assess the risk of bias, the JBI Critical Appraisal tool<sup>9</sup> was used. The domains dealt with the congruence between the study methodology with the following items: stated philosophical perspective, research objectives, methods used to collect data, data representation and analysis, and interpretation of results. They also assessed whether the study identified the researcher culturally or theoretically, the researcher’s influence on the research, the appropriateness of participants’ voices, and the ethics of the research. This instrument does not assign a score or classification based on the responses, so we used it to identify weak points/risk of bias in the studies.<sup>9</sup> Graphs summarizing the JBI judgments were plotted using Microsoft Excel.

### Meta-analysis

Forest plots were used to evaluate grouped estimates with a confidence interval equal to 95%. We calculated the Q statistic (significance level <0.1) and the I<sup>2</sup> statistic to assess heterogeneity.

In this meta-analysis of frequency, we estimated

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases, registers and other sources



\*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).

\*\*If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71. doi: 10.1136/bmj.n71. For more information, visit: <http://www.prisma-statement.org/>

Figure 1: Study selection flowchart, according to PRISMA 2020.

that were transformed using the crude proportions method (PRAW). The final combined result and 95% CIs were transformed for ease of interpretation.

## RESULTS

### Selection of studies

Database searches retrieved 3,713 articles, and the gray literature search retrieved three articles. Of these, 862 were duplicates, and 2,851 were traced. Another 2,813 were excluded for not meeting the inclusion criteria. Thus, 38 articles were carefully evaluated and revised in full. Of these, 14 articles were included in this systematic review. The flowchart of the selection process is shown in Figure 1.

### Main characteristics of the studies

Eleven cross-sectional studies,<sup>3,10-19</sup> one retrospective study and two longitudinal studies were included.<sup>20-22</sup> The included studies were published between 1999 and 2021, with 35.7% carried out in the Northeast regions,<sup>3,14,15,17,21</sup> 7.1% in South [18] and 57.1% in Southeast Brazil.<sup>10-13,16,19,20,22</sup> Table 2 presents the main characteristics of the studies.

A total of 2962 participants with T2DM were evaluated in this systematic review. The sample size ranged from 11 to 476 participants.<sup>22,13</sup> The time since diagnosis of T2DM ranged from six months to 16 years.<sup>3,18</sup> The mean age of the participants was 62.5 years old, ranging from 18 to 90 years old, and the mean proportion of women was 70.25% (Chart 2). The most frequent comorbidities reported by the studies were arterial hypertension (32.8%), dyslipidemia (20.8%), and retinopathy (17.9%) (Table 2). Eight studies were carried out with individuals from the Unified Health System (SUS) assisted by the Family Health Strategy (FHS),<sup>3,10,14,15,17</sup> Basic Health Units (UBS),<sup>18,22</sup> or Family Health Program (PSF).<sup>19</sup>

Drug treatment was reported in seven studies. In the Marinho et al<sup>13</sup> study, participants were using metformin (86.8%), sulfonylureas (20.8%), and insulin (68.4%). Arrelias and collaborators reported the use of biguanides (74.6%),<sup>16</sup> sulfonylureas (67.6%), and others (4.1%). Araújo et al<sup>18</sup> included 46 people who used medication, among whom 15% used insulin and the remaining used oral hypoglycemic agents. In Portela et al<sup>3</sup> study, the participants used oral antidiabetics and/or insulin; however, they did not report the percentage. The other authors did not mention the most commonly used drugs.<sup>10,12,14</sup>

### Instruments used to assess dietary adherence

For the instruments used to assess dietary adherence, the Summary of Diabetes Self-Care

Activities Measure (SDSCA),<sup>3,12,13,17</sup> two food diaries and a 24-hour food recall,<sup>20</sup> a 24-hour recall,<sup>21</sup> Food Frequency Questionnaire (FFQ),<sup>10,11,16</sup> semi-structured questionnaire,<sup>14,18,19</sup> specific questionnaire and patients' reports on whether or not they followed the instructions given during consultations (Table 3) were used.<sup>15,22</sup>

The Summary of Diabetes Self-Care Activities (SDSCA) questionnaire assesses aspects of the diabetes treatment regimen in the last seven days,<sup>12,13,17,3</sup> including care with nutrition, physical activity, medication use, blood glucose monitoring, foot care, and smoking. Good adherence was considered if patients were not current smokers and reported at least five days a week of adherence to diet, exercise, foot care, and medication use.<sup>13</sup>

Rizzeto and colleagues evaluated the adherence to the nutritional treatment of a protein-restricted diet (0.6 to 0.8 g of protein/kg/day) of 321 patients with chronic kidney disease on nondialysis treatment (189 with T2DM) through the analysis of medical records from a renal nutrition clinic in Rio de Janeiro.<sup>20</sup> Protein intake was assessed using two food diaries and a 24-hour food recall.<sup>20</sup>

In studies that used FFQ,<sup>10, 11, 16</sup> good adherence to at least three of the six nutritional recommendations established by the Brazilian Society of Diabetes (SBD) was considered good, that is, consumption of total carbohydrates, fiber and portioning of meals. The authors justify this choice because of the relationship between these three recommendations and the glycemic control of patients with T2DM.

In studies that used a semi-structured questionnaire,<sup>18,19</sup> adherence to nutritional treatment was defined by a positive answer to the question related to carrying out dietary control/use of a low-calorie diet. Farias and colleagues considered adherence to nutritional treatment to be regular with regard to the recommended diet,<sup>14</sup> using criteria from the SBD, the

**Table 3:** Comorbidities presented by individuals with type 2 diabetes *mellitus* in the included studies, Brazil, 1999-2021.

Comorbidities	n	%
High blood pressure	971	32.8
Dyslipidemia	615	20.8
Retinopathy	513	17.9
Overweight and obesity	174	5.9
Nephropathy	134	4.5
Neuropathy	130	4.4
Heart disease	87	2.9
Coronary artery disease	70	2.4
Peripheral artery disease	64	2.2
Cerebral vascular disease	31	1.0

Percentage (%) calculated in relation to the total number of participants in the included studies (n= 2962).

**Table 4:** Prevalence of adherence to diet, physical activity and medication in individuals with type 2 diabetes mellitus from included articles, Brazil, 1999-2021.

Reference	Frequency of adherence to the diet (%)	Frequency of nonadherence to the diet (%)	Frequency of adherence to physical activity (%)	Frequency of medication adherence (%)
Araújo et al <sup>18</sup> (1999), Rio Grande do Sul	28.40	-	20.9	68.6
Assunção et al <sup>19</sup> (2008), Minas Gerais	52.44	9.15	NI	NI
Zanetti et al <sup>11</sup> (2010), Minas Gerais	30.7% adhesion to CHO, 48.9% to PTN and 8% to fibers.	NI	NI	NI
Gomes-Villas Boas et al <sup>12</sup> (2012), São Paulo	30.9	NI	55.5	95.7
Farias et al <sup>10</sup> (2014), Minas Gerais	3.10	NI	58.6	84.4
Rodriguez et al <sup>22</sup> (2014), Minas Gerais	36.40	NI	NI	NI
Arrelias et al <sup>16</sup> (2015), Southeast Brazil	NI	98.3	NI	NI
Farias et al <sup>14</sup> (2016), Pernambuco	54.4	45.	33.3	87.7
Oliveira et al <sup>21</sup> (2016), Sergipe	13.30	NI	NI	NI
Rizzetto et al <sup>20</sup> (2017), Rio de Janeiro	25.8	50.7	NI	NI
Marino et al <sup>13</sup> (2018), Rio de Janeiro	29.2	NI	22.5	93.5
Santos et al <sup>15</sup> (2018), Piauí	Not in general, only in specific food groups separately.	NI	NI	NI
Portela et al <sup>3</sup> (2021), Maranhão	42.2	57.8	22.6	91.5

CHO= carbohydrate; NI= not informed; PTN= protein.

Brazilian Consensus on Diabetes and the Brazilian Update on Diabetes.<sup>14,23</sup>

In the specific questionnaire proposed by Barbosa and colleagues and used by Santos and colleagues,<sup>24,15</sup> good adherence to nutritional treatment was considered when it reached the follow-up goal of >50% of the recommended guidelines. Partial adherence was defined when there was an improvement in eating habits but the proposed goal was not achieved (>50%). When less than 50% of the guidelines were followed, it was classified as low adherence to the diet.<sup>15,24</sup>

In the article by Oliveira et al<sup>21</sup>, adherence to nutritional treatment was assessed based on meeting at least 75% of the dietary plan prescribed by a nutritionist, assessed using the recall of 24h.<sup>21</sup> For Rodriguez et al<sup>22</sup>, adherence to nutritional guidelines was recorded based on the patients' reports on whether they followed the guidelines given during consultations and the

comparison of the report with information on eating habits and anthropometric measurements obtained.<sup>22</sup>

### Risk factors related to dietary adherence

The main risk factors for nonadherence to nutritional treatment reported in some of the studies were low educational level,<sup>11,12</sup> BMI,<sup>12</sup> limitation/pain in the upper limbs, diabetic peripheral neuropathy and depression,<sup>13</sup> low income and multimorbidity.<sup>11,14,15,19,17</sup> In the Rizzetto et al<sup>20</sup> study, there was a decrease in creatinine and an increase in the estimated glomerular filtration rate (eGFR) in subjects adhering to the diet.<sup>20</sup> In the research by Marinho et al<sup>13</sup>, only 20% of participants were considered to have good overall adherence to treatment, and these had a lower BMI and a better serum lipid profile than nonadherent.<sup>13</sup> Zanetti et al<sup>11</sup> reported an association between female sex and adherence to a

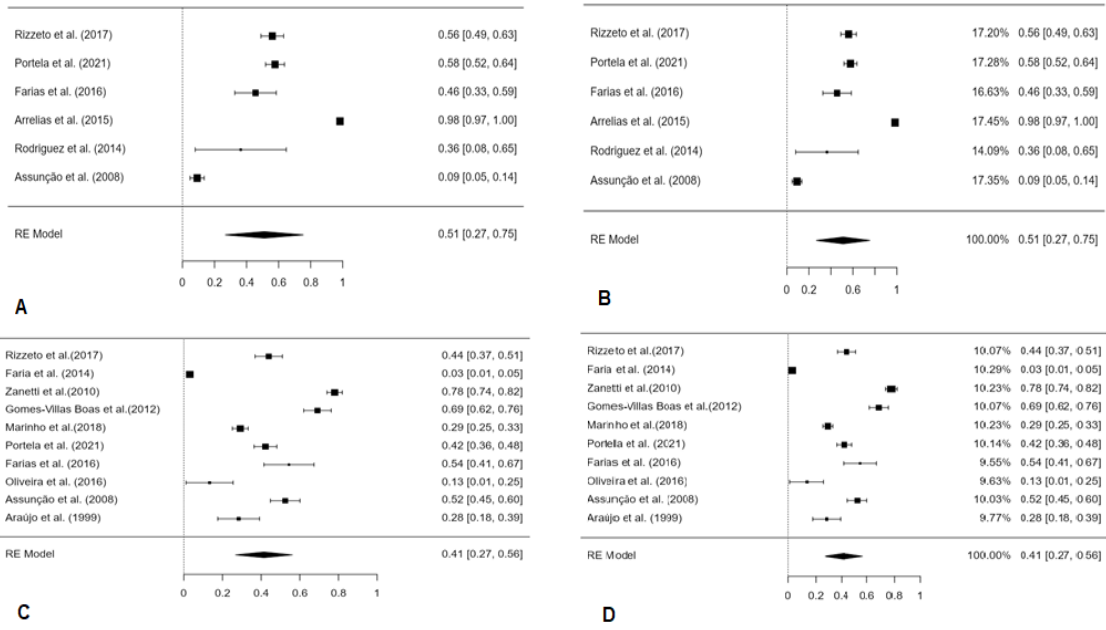
**Table 2 :** Main characteristics of the articles included on dietary adherence in individuals with type 2 diabetes *mellitus* in Brazil, 1999-2021.

<b>Author (year), State</b>	<b>Study design</b>	<b>Aim</b>	<b>Sample size (n)</b>	<b>Mean age (min.-max.) and sex (% women)</b>	<b>Definition of diet adherence</b>
Araújo et al <sup>18</sup> (1999), Rio Grande do Sul	Cross-sectional	To describe characteristics of diabetic patients monitored at a primary health care center	67	NI (30-75 years old), both sexes (76.1% female)	Home interviews by a trained interviewer who used a questionnaire with pre-coded questions and open questions
Assunção et al <sup>19</sup> (2008), Minas Gerais	Cross-sectional	To investigate the association between educational, demographic, socioeconomic and health factors, perception of the disease, social support and adherence to nonpharmacological treatment in patients with diabetes <i>mellitus</i>	164	57.7 years, both genders (71.9% female)	Semi-structured questionnaire, defined by a positive response to the questioned questions
Zanetti et al <sup>11</sup> (2010), Minas Gerais	Cross-sectional	To determine whether there is a relationship between adherence to nutritional recommendations and sociodemographic variables in Brazilian patients with type 2 diabetes <i>mellitus</i>	423	62.40	Food Frequency Questionnaire (FFQ) adherents who met at least three of the six nutritional recommendations established by the SBD
Gomes-Villas Boas et al <sup>12</sup> (2012), São Paulo	Cross-sectional	To analyze the relationship between support, adherence to nonpharmacological (diet and physical exercise) and pharmacological (insulin and/or oral antidiabetic) treatments and clinical and metabolic control of patients with type 2 diabetes <i>mellitus</i>	162	59.4 years old (min 40) both sexes (58% female)	SDSCA
Faria et al <sup>10</sup> (2014), Minas Gerais	Cross-sectional	To analyze adherence to drug and nondrug treatment in 17 units of the Family Health Strategy	423	62.4 years. Both genders (66.7% female)	FFQ, adherents who attended at least three of the six nutritional recommendations were considered adherent of the actions established by the SBD
Rodriguez et al <sup>22</sup> (2014), Minas Gerais	Longitudinal (12 months of follow-up)	To analyze adherence to nutritional counseling in patients with diabetes <i>mellitus</i> (DM) in a Primary Health Care service	11	64.00. Both sexes (91.70% women)	Evolution data reported by patients. Good adherence was considered when those guidelines had 50% or more adherence
Arrelías et al <sup>16</sup> (2015), Southeast Brazil	Cross-sectional	To investigate the association between adherence to type 2 diabetes <i>mellitus</i> treatment and sociodemographic, clinical and metabolic control variables	417	62.50 years old, both sexes (66.2% female)	FFQ

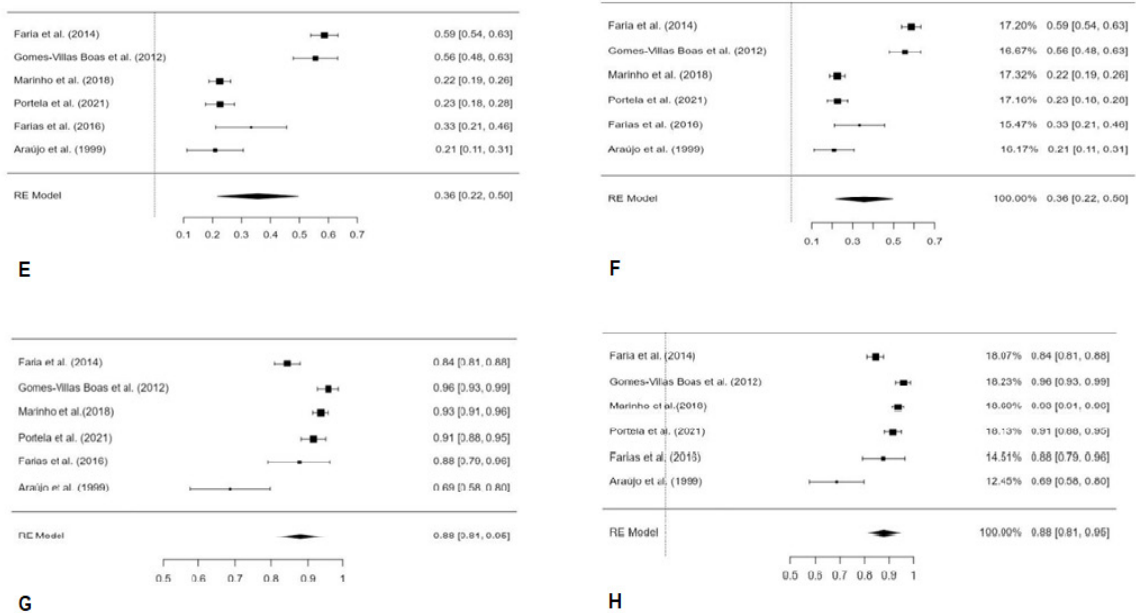
Farias et al <sup>14</sup> , Pernambuco	Cross-sectional	Evaluate adherence to the use of medication, diet and physical activity in diabetic patients residing in a district in the rural area of the municipality of Vitória de Santo Antão - PE	57	NI (34 to 90 years old), both sexes (79% women)	Validated semi-structured questionnaire. Regularity of the recommended diet, physical activity and medication prescribed by the SBD
Oliveira et al <sup>21</sup> (2016), Sergipe	Longitudinal (6 ± 2 months of follow-up)	To evaluate adherence to dietary treatment and the evolution of the nutritional and clinical status of diabetic patients assisted by the Nutrition Outpatient Clinic of the University Hospital of Sergipe	30	56.57 (41 to 75 years old). Both sexes (80% women)	24-hour recall. Good adherence when 75% or more of plan recommendations are followed
Rizzetto et al <sup>20</sup> (2017), Rio de Janeiro	Retrospective	To evaluate the effect of a low-protein diet (LPD) on renal function in patients with CKD	321	65.1 years Both genders (41.8% female)	Dietary counseling and good adherence to LPD defined as reduced protein intake
Marino et al <sup>13</sup> (2018), Rio de Janeiro	Cross-sectional	To investigate adherence to treatment in patients with type 2 diabetes and assess its associated factors	476	65 years old, both genders (63.90% female)	SDSCA. Adherents were those nonsmokers who adhered to the diet at least 5 days a week
Santos et al <sup>15</sup> (2018), Piauí	Cross-sectional	Evaluate adherence to dietary treatment in patients with diabetes <i>mellitus</i> assisted by the family health strategy, verifying the existence of an association between the type of diabetes <i>mellitus</i> and dietary practices, socioeconomic conditions and clinical aspects related to the disease	40	NI (18 to 60 years old), both sexes (67.50% women)	24-hour recall and specific questionnaire. Good adherence achieving >50% of eating habits
Portela et al <sup>3</sup> (2021), Maranhão	Cross-sectional	To analyze sociodemographic and clinical variables related to adherence to self-care activities in people with type 2 diabetes <i>mellitus</i>	270	NI, both genders (69.6% female)	SDSCA
Silva et al <sup>17</sup> (2021), Paraíba	Cross-sectional	To detect factors related to negative adherence to self-care in individuals with diabetes <i>mellitus</i>	250	70.3 years, both sexes (68% female)	SDSCA. Good adherence when self-care activity scores are greater than or equal to five

The prevalence of adherence and nonadherence was analyzed individually, according to the information of the included articles.

CKD: chronic kidney disease; LPD: low protein diet; NI= not informed; QFCA: food consumption frequency questionnaire; SBD: Brazilian Society of Diabetes; SDSCA: Summary of Diabetes Self-Care Activities Measure.

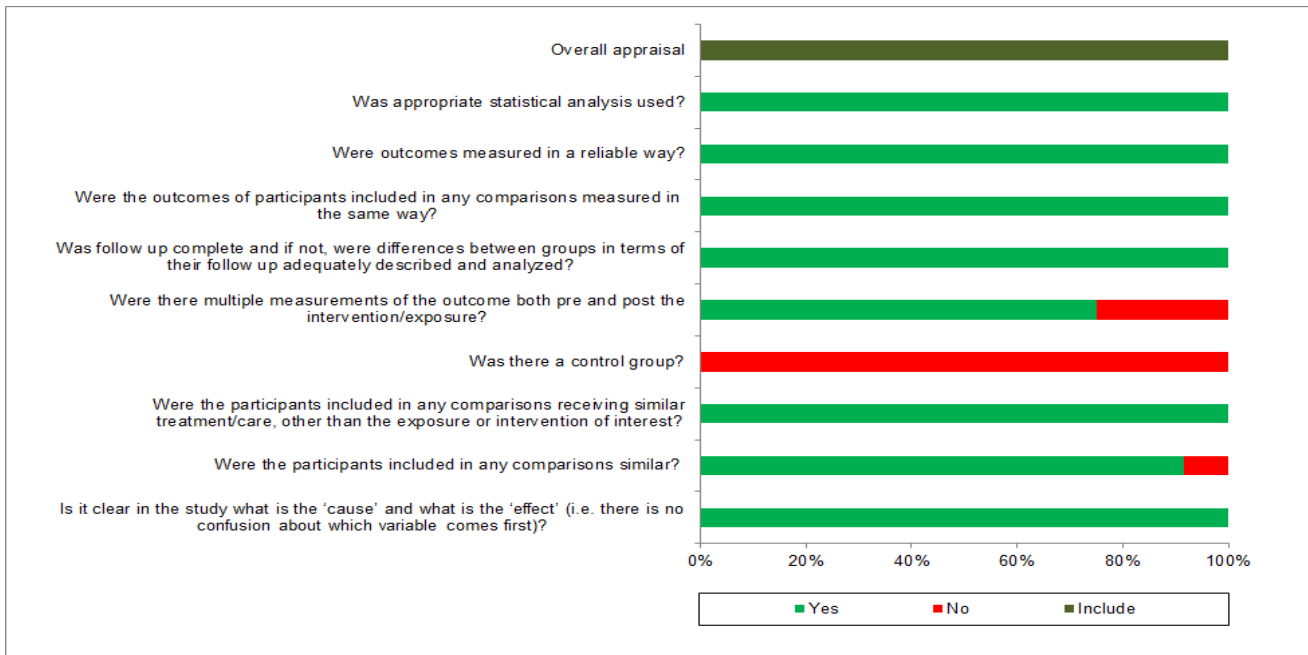


**Figure 2:** Forest plot. (A) Pooled proportion of dietary non-adherence among type 2 DM in Brazil, 2008-2021; (B) Pooled proportion of dietary non-adherence among type 2 DM in Brazil, according to the weight of studies, 2008-2021; (C) Pooled proportion of dietary adherence among type 2 DM in Brazil, 1999-2021; (D) Pooled proportion of dietary adherence among type 2 DM in Brazil, according to the weight of studies, 1999-2021.



**Figure 3:** Forest plot. (E) Pooled proportion of physical activity adherence among type 2 DM in Brazil, 1999-2021; (F) Pooled proportion of physical activity adherence among type 2 DM in Brazil, according to the weight of studies, 1999-2021; (G) Pooled proportion of medication adherence among type 2 DM in Brazil, 1999-2021; (H) Pooled proportion of dietary adherence among type 2 DM in Brazil, according to the weight of the studies, 1999-2021.





**Figure 4:** Risk of bias of included articles.

diet with an adequate cholesterol content. In addition, individuals with four or more years of education were more likely to split meals than those with less education. Additionally, individuals with an income of less than two minimum wages were more likely to adhere to a diet with an adequate cholesterol content. In the Assunção et al<sup>19</sup> study, dietary adherence was positively associated with income, occasional glucose control, motivation with treatment, being part of a diabetic group, having knowledge about diabetes complications, and living in a high-risk area.<sup>19</sup> Arrelias et al<sup>16</sup> did not observe an association between nonadherence and the variables of sex, age, years of diagnosis, and metabolic control. In the Portela et al<sup>3</sup> study, there was no statistical association between general diet and age, education, participation in a diabetes education group, or time since diagnosis. There were reports of greater adherence to general diet in individuals aged 18 to 39 years, with normal BMI and overweight and with nutritional follow-up.

Evidence shows that factors that were determinant for the nonadherence of some participants were being from a rural population, gender differences (males had lower adherence), low income, and some comorbidities (systemic arterial hypertension and obesity).<sup>14</sup> Santos et al<sup>15</sup> concluded that the low income found from 2 to 4 minimum wages may have been a limiting factor for the segment to the prescribed food plan and could reflect the predominance of students and retirees in the sample.

Rodriguez et al<sup>22</sup> did not observe a statistically significant association between adherence to the diet and sociodemographic variables, reported morbidities and nutritional status.

For Assunção et al<sup>19</sup>, adherence to nonpharmacological treatment (physical activity and dietary control) was associated with low income, place of residence, occasional glucose control, knowledge about T2DM complications related to vision, motivation with treatment, being part of a diabetic group, and follow-up with nurses and physiotherapists.

### Pooled estimates of adherence to diet, physical activity, and medication

The combined proportion of nonadherence to the diet of individuals with T2DM was 51% (95% CI: 0.268-0.754,  $p < 0.001$ ;  $I^2 = 99.25\%$ ,  $p < 0.001$ ). The highest (98%) and lowest (9%) prevalence of nonadherence to the diet were reported in the states of São Paulo and Minas Gerais,<sup>16,19</sup> respectively (Figure 2, A and B). The combined proportion of diet adherence of people with T2DM was 41% (95% CI: 0.267-0.562,  $p < 0.001$ ;  $I^2 = 98.81\%$ ,  $p < 0.001$ ). The highest (78%) and lowest (3%) prevalence of dietary adherence were reported in the state of Minas Gerais (Figure 2, C and D).<sup>11,10</sup>

The combined proportion of adherence to physical activity was 36% (95% CI: 0.216-0.497,  $p < 0.001$ ;  $I^2 = 96.98\%$ ,  $p < 0.01$ ). The highest (58.6%) [10] and lowest (21%) adherence to physical activity were reported in the states of Minas Gerais and Rio Grande do Sul,<sup>18</sup> respectively (Figure 3, E and F).

With regard to medication, the combined proportion was 88% (95% CI: 0.813-0.946,  $p < 0.01$ ;  $I^2 = 94.52\%$ ,  $p < 0.001$ ). The highest (95.7%) and lowest (84.4%) medication adherence were reported in the states of São Paulo and Minas Gerais,<sup>12,10</sup> respectively

(Figure 3, G and H).

## Risk of bias

In general, the 12 studies analyzed showed a low risk of bias, as they met most of the questions on checklist (Figure 4).<sup>22,9</sup> Only one study did not obtain similar patients in some comparisons.<sup>14</sup> Three studies presented measurements of results before and after the intervention. None of the studies presented a control group (Figure 4).<sup>20-22</sup>

## DISCUSSION

This is the first systematic review with a meta-analysis that assessed the prevalence and risk factors related to dietary adherence in Brazilian adults living with T2DM. Despite the good pooled proportion of medication adherence of enrolled individuals, the present search evidenced a low combined proportion for dietary adherence, as well as for physical activity, with rates above 50%. Selected studies showed a low risk of bias by the JBI Qualitative Instrument,<sup>3,10-14,16,18-22</sup> presenting affirmative answers ("yes") to more than 70% of the questions,<sup>25</sup> demonstrating good capacity for answering the original question.

Adherence to treatment is an essential factor for people with T2DM,<sup>26</sup> as it helps with metabolic control, improves quality of life, reduces symptoms related to anxiety and depression, and reduces cardiovascular risk and other complications related to T2DM.<sup>27,28</sup> The tripod of assistance marked for healthy eating, practice of physical exercises, and correct use of medication is essential for the successful management of T2DM.<sup>29</sup> However, as observed in our review, the prevalence of adherence to T2DM treatment in Brazil is not ideal for any of the three pillars. In a systematic review with a meta-analysis conducted in Ethiopia,<sup>30</sup> the combined prevalence of diet adherence by people with T2DM was 41.05% (95% CI: 34.86-47.24,  $I^2 = 93.1\%$ ), showing similarity with this meta-analysis carried out in Brazil, which can be explained by the fact that low income and lower education were determinants of adherence in both countries. In a meta-analysis carried out in the United States,<sup>31</sup> the combined prevalence of adherence to physical activity was 77% (95% CI= 0.68; 0.84), which is higher than that performed with Brazilians. Therefore, the influence of risk factors seems to be relevant in the selection of subpopulations at high risk for low adherence.

Regarding medication, a study carried out in Malaysia showed that the adherence rate was 34.2% (95% CI: 27.4 to 41.2),<sup>32</sup> which is considered low in relation to Brazil. Articles report that the high adherence to medication observed in Brazil may be related to the policy of free distribution of medications by the SUS health network and the ease of its consumption,

while good dietary adherence depends on sociocultural factors,<sup>10,33,35</sup> individual motivation, knowledge about the disease, and nutritional monitoring, which is more difficult to obtain in the Brazilian population despite the existence of government income distribution programs.

Some authors observed that low income,<sup>11,14,15,19</sup> low educational level and multimorbidities were associated with poor adherence to the diet.<sup>11,12,14,17</sup> The meta-analysis by Abate et al<sup>30</sup> showed that income and education were determinants of this low adherence. The authors observed that individuals with greater monthly financial availability had a more balanced diet, as it is possible that they are more likely to acquire healthy foods.<sup>30</sup> On the other hand, higher levels of education seem to promote greater knowledge and awareness about healthy habits and eating behavior, in addition to providing better salary opportunities.<sup>30</sup> In addition, multimorbidity reduces quality of life and functional capacity, causing physical and mental disorders, which impairs adherence to treatment.<sup>17,36</sup>

This review carried out a comprehensive search, selecting articles from the main databases and using validated tools to analyze the risk of bias. The main limitations of the present study included the lack of relevant information, such as the mean age, *per capita* income, blood pressure and cholesterol values, participants' education, types of nutritional intervention and absence of risk factors associated with nonadherence in some studies included in the review. The instruments used to assess dietary adherence are limited to the accurately measuring food consumption, since some information depends on the respondents's memory, focus on short-time intake, has inherent bias related to self-report, among other factors.

## CONCLUSION

Although adherence to the diet is important for improving quality of life and T2DM control, research carried out in Brazil has shown low adherence in several Brazilian states, highlighting the need to intensify nutritional education actions and improve nutrition intervention techniques to promote greater dietary adherence in T2DM.

## FUNDING

No funding was received to assist with the preparation of this manuscript.

## CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest.

## ACKNOWLEDGEMENTS

We thank Federal Institute of Southeastern Minas Gerais (IF Sudeste MG).

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